A morphological exploration into gender inclusiveness and environmental attitudes concerning Maker practices in Makerspaces in the United Kingdom, Germany and Austria

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Abstract

This dissertation explores the connection between amateur technology making, gender inclusiveness and environmental protection within the Maker movement. Specifically, it asks whether including more women into Makerspaces in the United Kingdom, Germany and Austria would increase positive environmental impacts of Making practices in those spaces or, vice-versa, if increasing these spaces' positive environmental impact would attract more women to join in. To answer this question, a social constructivist position is adopted. Through a convergent multi-level mixed method design that employs short interviews at Maker Faires, an online survey, and in-depth interviews, 565 Makers in the United Kingdom, Germany and Austria have been consulted. The study examines its question through three steps: firstly, it devises a Making morphology which is necessary in order to differentiate between a variety of Making constellations; secondly, it examines if and how women are excluded from Makerspaces within a specifically devised Makerspace morphology for the UK, Germany and Austria; and thirdly, it explores women's and men's environmental considerations within their Making practice. The study concludes that, although women exhibit more environmentally friendly behaviour, they face increased challenges in joining Makerspace communities and 'just adding them' might not be enough to achieve sustainable inclusiveness. A masculine and patriarchal culture within Making communities is visible in the developed morphology, which often hinders women from simply joining in. The study, therefore, develops a women-inclusive morphology for Makerspaces which is more inclusive and environmentally friendly. It concludes that even though there is the potential for increased gender-diversity sparking more pro-environmental practices, and vice-versa, gender-inclusion especially appears to be a rather complex challenge that makes a straightforward answer to the question problematic. Equally, individual communities are too complex to make broad, deterministic claims. Finally, recommendations for further research and attributes of Makerspace communities to create more inclusive and environmentally sustainable communities are presented.

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Author's declaration

I declare that, except where explicit reference is made to the contribution of others, that this dissertation is the result of my own work and has not been submitted for any other degree at the University of Glasgow or any other institution.

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Chapter 1   Introduction

We live in times of great change and tensions. New technology allows for things unimagined 100 years ago – be it live streaming your everyday life to the whole world or building reusable rockets flying to Mars. The climate crisis and environmental destruction have been a largely unforeseen side effect of all those magnificent developments and, by now, pose a major threat to the way we live and the natural world itself. At the same time, social inequalities shape societies in different ways and demand action. Refugees fight for the right to live in safety, disabled people fight for their right to receive the same opportunities as everyone else, and women fight for the right to be heard and taken seriously. None of these issues exist in a vacuum – disadvantaged groups can connect quickly and effectively through new technological devices, the rocket flying to Mars will be accompanied by immense environmental ramifications and social upheaval evolves more and more around protecting the environment.

This research project explores one of those many intersections. Over the past decade, personal digital fabrication technology has become available to the everyday population. 3D-printers allow for the production of an item at the push of a button. Laser-cutters make intricate engravings and cuttings a possibility. Microcontrollers and coding enable someone to build their own weather station. The possibilities are endless. Despite being available to the general public, this equipment is often still too expensive to afford privately. Makerspaces have offered a solution: they provide these devices alongside other tools for people to use, usually in return for a membership fee. The communities that have developed around these spaces and their tools have connected worldwide and are often referred to as Makers, or the Maker movement (MM). This movement has been dominated by men, especially in America and Europe, leading to calls for a more inclusive community (Henry, 2014; Lewis, 2015; Davies, 2017). Equally, the process of devising your own functioning technology as an amateur can be an environmentally harmful process with huge amounts of waste and cheap materials being transported from one side of the world to another. This study has considered and examined a possible connection between inclusiveness and environmental impact within Makerspace communities in three West-European countries and wants to find out if tackling one of those issues might, through their possible connection, also help tackle the other. It asks: does a more diverse community foster better environmental practices? More specifically, does increased female participation in Makerspaces in the United Kingdom, Germany and Austria contribute to an improvement of positive

environmental impacts of Making practices in those spaces, or vice versa, would an increase in positive environmental impact in those spaces attract more female participants?

In order to understand the research project better, some context is necessary. The MM has developed over the last 12 years and is often said to have received its name from Dale Dougherty who founded and provided the name for *Make:* magazine in 2008. He is, therefore, considered by some the founder of the movement (Cavalcanti, 2013). The US-based company behind the magazine[1] has organised and licensed Maker Faires worldwide since 2006. The Faires are large public gatherings of Makers exhibiting their projects and sharing ideas; according to the company it is "the Greatest Show (& Tell) on Earth" (Maker Faire, 2020). To date, there have been more than 200 such family-friendly events (for impressions see Figure 1-2). Makerspaces themselves have rapidly spread all over the globe and are mainly centred in, but not limited to, urban settings in the northern hemisphere. The community-run wiki-page https://wiki.hackerspaces.org/ encourages spaces to register on the platform. From 30 spaces in 2007 (Davies, 2017, p.8) this listing has grown to 1390 active and 353 planned spaces worldwide by the beginning of February 2020. The way these spaces are run differs widely. Many are run by community groups who have come together to make Making possible for and with each other. Other spaces are set up as charities or businesses which are operated more professionally. More and more Makerspaces are set up in universities/schools to encourage learning beyond the classroom. Others are set up in public places like libraries for public access. Beyond the boundaries of Makerspaces, Makers connect online. Mostly, they share ideas, blueprints and designs for their projects, help each other with knowledge and skill exchanges, and offer support for challenging projects. Relevant websites are, for example, www.instructables.com which gives space to projects ranging from food to sensors or www.cult3d.com which focuses on 3D-printed artefacts.

While the new digital fabrication technology previously mentioned is said to be one of the main drivers of the movement, other drivers and origins play an important role too. Often acknowledged (Davies, 2017; Kuznetsov & Paulos, 2010; Turner, 2018; Millard, 2017) is the hacker culture with its origins in the 1950s/60s (Levy, 2010). It was initially concerned with the (often illegal) hacking of computer software and a clear political agenda. Nowadays, hacking is undergoing a change in meaning. Websites like Pinterest offer 'life hacks', and

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[1] Until June 2018, Make Media Inc. was the company behind *Make:* magazine and Maker Faires. However, it halted operations due to financial difficulty (Constine, 2019) and was transformed into Make Community, LLC (Limited Liability Company). Dougherty was initially CEO of Make Media Inc. and is now president of Make Community, LLC.

'hackathons' are not only widely spread but also put on by large companies, e.g. AutoMobility LA Hackathon, among others sponsored by Amazon Web Services (Hackathon.com, 2019), and official institutions, e.g. White House Hackathon in 2013 (Welsch, 2013). In fact, an overlap in hacking and Making activities has made a differentiation between the two difficult. The mix-up of terms/activities can easily be seen on the previously mentioned website https://wiki.hackerspaces.org/ which does not only list Makerspaces but also hackerspaces.

Another origin that is said to be an ancestor of the movement is the counterculture of the 1960/70s (Turner, 2010). Alongside civil rights activism and anti-war mentalities, this anti-mainstream culture concerned itself with environmentalism as, for example, portrayed by Rachel Carson's *Silent Spring* (published in 1962 before environmental themes were taken up by the counterculture). One of the voices of this ethic was the *Whole Earth Catalog*, a magazine reviewing products. It was regularly published between 1968 and 1972 and promoted a self-sufficient lifestyle through do-it-yourself activities, an ecological understanding of the world and alternative education. The magazine was part of promoting and fostering a DIY ethic

Figure 1-1 Whole Earth Catalogue title, Fall 1969.

which encouraged people to build and repair themselves instead of relying on professionals. A term that, for some, only relates to home improvements and is less of an ethic than a necessity, is for others a lifestyle and goes beyond objects in the home and includes DIY music and radio stations, arts and crafts, or zine making (Wehr, 2012).

Even though many publications acknowledge those connections, much of the academic and non-academic literature surrounding the MM locate its beginnings in two main dynamics: a) the general availability of personal digital fabrication technology and b) the free sharing of information and connection of Makers online (Mota, 2011; Seo-Zindy & Heeks, 2017; Roedl et al., 2015). Some even go so far as to pronounce a new industrial revolution. The main supporter of this theory is prominent Maker Chris Anderson who is author of various modern technology books, editor in chief of *WIRED* magazine for 11 years and CEO of 3DRobotics. He uses the term in the subtitle of his book *Makers – The New Industrial Revolution* and describes how the movement can and will revolutionise the way things are produced, no longer by big companies but by individuals who can produce highly personalised items.

Figure 1-2 Maker Faires. Map of upcoming Faires and some photographic impressions of previous Maker Faires.

But Making is about more than that. Many Makers emphasise the learning opportunities which accompany the activity: learning about technology, how it works and how it is made,

is something valued by many in the movement. Science and technology scholar Sarah Davies (2017), who has to date written the only academic book about the movement, is keen to show that learning by doing and understanding how things work are key for Makers. This learning can be witnessed online: thousands of Makers communicate here to share information about their projects, give each other advice and just offer inspiration. For some, this connection of the global and local is where Making activities turn into a movement, a movement striving to understand the objects that surround us and to make them better (Osborn, 2013). The combination of personal digital fabrication technologies and the possibilities that the internet offers have facilitated and accelerated Making as a movement and give it its unique flavour (Nascimento & Pólvora, 2018; Grimme et al., 2014; Unterfrauner & Voigt, 2017).

The problem with this approach is that Makers are seen as a homogenous unit, no matter where they are in the world, what they make and why they do so. Some, particularly those who stand to gain from the movement growing, e.g. Dougherty, proclaim that we are all Makers and everyone should get involved. However, academics such as science and technology scholars Silvia Lindtner (2015) and Ames et al. (2018) have gone to great length to show how Makers in China, Vietnam or Paraguay understand themselves and what they do – and that this does not always align with Western narratives of *the* Maker movement. These authors, in fact, agree that there is no such thing as a unified movement but a multitude of heterogenous Making communities that cannot be united under one single definition. On the one hand, then, we encounter writers claiming the MM is one thing and only that, and on the other hand we find those who say there is no way to define Makers under one umbrella. In the midst of these positions, some researchers have attempted to devise a conceptualisation of the movement (Millard et al., 2017; Voigt et al., 2016). However, as the literature review shows, none manage to provide something that does justice to all Makers.

One of the first objectives of the present study is, then, to devise such a conceptualisation. More specifically, a political science theory of how to conceptualise ideologies is adapted to this cultural movement context and hopefully provides a solution to the issue of definition. The morphology of ideologies was devised by eminent political theorist Michael Freeden. His flexible yet stable morphologies consist of core, adjacent and peripheral concepts, all of which influence and shape each other within an ideology. This theory is further explained in the chapters to come. In an attempt to apply it to the MM, this dissertation defines core, adjacent and peripheral concepts that influence each other differently in various Making cultures, but still form an overall morphology, thus devising an understanding of the

movement that allows for diversity yet upholds an understanding of its communities as a whole.

Conceptualisation and definition are not the only tensions within Making, however. As mentioned previously, inclusiveness is another aspect that Makers and Makerspaces struggle with. Many studies find that the average Maker is male, white, middle-aged, fairly affluent and of higher educational background (Davies, 2017; Nascimento & Pólvora, 2018; Turner, 2018; Moilanen, 2012). Despite voices pronouncing that we are all Makers, the make-up of Making communities in Western countries is often noticeably homogenous. This has led to those who feel excluded to set up their own designated spaces, most prominently feminist Makerspaces that only allow women or anyone who does not identify as a cis man[2]. Despite this issue being discussed and deliberated within academia and beyond, only one study as of yet has (to the knowledge of the researcher) specifically spoken to women who are part of regular Makerspaces in the UK and asked them for their experiences in those spaces (Lewis, 2015). The study at hand expands on this and explores how women have become part of their regular spaces, why and how they engage in Making activities, and what areas of improvement they see. Considering that there are, as just elaborated, different morphologies of Making in different parts of the world, this dissertation looks specifically at women in Makerspaces in three West-European countries, namely the United Kingdom, Germany and Austria.

However, it does not do so without relation to other issues. Specific attention is given to female Makers and their environmental understanding of their practice. Environmental dimensions of Making are another issue that has raised some attention. Due to its local and personalised nature, Makers generally believe their practice to be sustainable in that it fosters a critical awareness of technological processes, makes them keep certain items longer and encourages repair. Many academics agree (Unterfrauner et al., 2017a; Unterfrauner & Voigt, 2017; Unterfrauner et al., 2019) and have attributed positive environmental effects to the movement. Nevertheless, critical voices have surfaced as well. They claim that being able to, for example, 3D-print anything you like at the push of a button is unlikely to foster pro-environmental behaviour and will, rather, increase plastic usage and waste (Mota, 2011). Others have found that environmental awareness is not a focus among Makers and, thus, their practice will not be sustainable (Rosa et al., 2017; Kohtala & Sampsa, 2015). The study at hand examines a potential connection between gender-inclusiveness and environmental

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[2] Cisgender people are those identifying with the sex they were assigned at birth.

sustainability. Academic literature suggests that women tend to be more environmentally concerned than men (Blocker & Eckberg, 1997; Mohai, 1992; Blocker & Eckberg, 1989; Zelezny et al., 2000; Dietz et al., 2002; Xiao & McCright, 2017) which raises the question of whether increasing women's participation in Makerspaces in the United Kingdom, Germany and Austria would contribute to an improvement of the latter's pro-environmental impact, or vice versa, might an increased focus on positive environmental impact by those spaces encourage more women to join into their communities. Grassroots Makerspaces are often run by volunteers and not wealthy. The study then aims to explore a potential connection between the two issues Makerspaces often struggle with, i.e. gender inclusiveness and environmental sustainability, in the hope it might aid them and their communities in improving both of these areas in conjunction with each other.

The objectives of this study, then, are to: (a) develop a morphology of the movement according to Freeden's morphology of ideologies and, specifically, a morphology for Making in Makerspaces in the UK, Germany and Austria, (b) examine how within this context women are excluded or included, and (c) if and how potential gender-differences relate to environmental practices within Makerspaces. To achieve these, a social constructivist approach is adopted. This endeavour requires qualitative as well as quantitative data. An overall morphology is more reliably devised with a larger dataset that covers a variety of aspects, and inclusiveness and environmental issues are best explored through in-depth interviews. The convergent multi-level mixed methods approach of this study does just that: an online survey which was sent to 131 German, 59 British and 12 Austrian Maker communities gathered overall data regarding motivations, practices and understanding of Maker activities, whereas 20 participants recruited through that survey (406 participants) are interviewed to capture more detailed explorations of their experience of gender aspects and environmental behaviour within their Makerspaces and their own practice. To triangulate findings, 139 short interviews conducted at Maker Faires in the three countries ensure a well-rounded picture of Making within them.

After careful data collection and analysis, the study finds that female participants have indeed exhibited higher levels of environmental concern and behaviour, not just in general but also in their Making practice. However, the study also finds that inclusiveness is not as easy to tackle as one might hope. The collected data shows that Makerspaces in the three countries are often used by communities that are not only heavily skewed towards male participation but also exhibit a very masculine culture. To simply add more women into that culture might not help in creating more diverse Making communities if the culture is not

inclusive. A change in culture will have to accompany attempts to create more diversity. Thus, the research question can be answered with a qualified yes: yes, including more women into Maker communities in the UK, Germany and Austria appears to be linked to an increase of positive environmental impacts by those spaces, but at the same time the culture in Makerspaces which is shaped predominantly by masculine values presents a rather challenging and complex obstacle to achieve that inclusion. Vice versa, becoming more environmentally concerned in their approach might also attract more women into those Making communities but a culture change is still necessary to fully integrate them. Even though a connection between the two issues is established, Maker communities and inclusion are complex challenges. Recommendations for spaces are, thus, not straightforward and demand equally complex changes.

The importance of these findings is considerable. Firstly, devising the morphology of Making is a conceptual accomplishment that has not been achieved previously to the knowledge of the researcher. This accomplishment is two-fold: as already pointed out, conceptualising the MM and giving it an overall framework that allows for stability and flexibility at the same time is difficult; and applying Freeden's political science theory to a cultural movement has, equally, not been achieved in earlier studies. Secondly, little to no research existed before the present study that compares men and women in Makerspaces within the UK, Germany and Austria. As pointed out already, some previous studies have spoken to women in feminist Makerspaces, but no study has interviewed men and women in regular Makerspaces alike and drawn out different viewpoints and how both genders view the difficult inclusion of women. Thirdly, this is also the first study to make the connection between women and environmental concern within the Maker context. Only one study (Millard et al., 2018) so far has stumbled upon a potential connection when examining different aspects within Making and their gendered nature, but this specific connection has not been followed up. Fourthly, having devised a morphology, analysed and examined women's inclusiveness and their connection to the environment within the context of the West European Makerspaces' morphology, the present research shows clearly how some of the elements that define Making in these countries are inherently masculine and patriarchal and, therefore, develops a more inclusive morphology. Thus, answering the main research question is not only important in itself, but in combination with a morphological conceptualisation shows deeper rooted dynamics and structures that need serious consideration if the situation is to be improved.

More generally speaking, examining this topic is a small, yet crucial, contribution to the overall on-going struggles in our society. Notwithstanding that governmental and more global solutions are important too, our everyday lives are infiltrated by choices regarding environmental sustainability and inclusiveness. To carve out these specific choices and dimensions within an everyday, often hobbyist practice is important in ensuring that changes and improvements are made everywhere. At the same time, many Makers are challenging the status quo of technology production. They open the 'do not break the seal' boxes and learn to work and fix them themselves. They promote self-sufficiency and a more critical engagement with our material world. Supporting these amateurs and those who want to join in to be sustainable – socially and environmentally – in their practice will ensure that the movement is not merely a hype but manages to establish itself as a positive people-powered force on the global stage. In what follows, the structure of the dissertation is outlined briefly.

Chapter 2 presents the literature review and lays the foundation on which this study is build. It starts by outlining the already hinted at problems of definition and conceptualisation. Specifically, the role of technology in defining what the MM is (and is not) is considered: as a created project, a tool and skill, a material choice, and a medium through which to share information. This is followed by a presentation of three conceptualisations that can assist in understanding the movement better but are not enough in themselves. In light of the foci on inclusiveness and environmental dimensions, the review then particularly engages with literature surrounding community and political dimensions of Making. The chapter ends by establishing the connection between inclusiveness and environmental concerns and identifying a gap in the literature regarding this connection in the MM. This leads to the research question, namely: does increased female participation in Makerspaces in the United Kingdom, Germany and Austria contribute to an improvement of positive environmental impacts of Making practices in those spaces, or vice versa, would an increase in positive environmental impact in those spaces attract more female participants?

Chapter 3 presents the research design and describes the underlying methodology that was employed to collect data and attain robust findings. It sets out to specify the objectives and scope of the study. The objectives are to devise a general morphology of the MM and give an example that is informed by Makerspace communities in the UK, Austria and Germany, to examine how women experience their in- or exclusion in those spaces, and exploring environmental practices of two genders to find similarities and differences. This is done with Makers from the UK, Germany and Austria who are part of self-identified Makerspaces. The second section of this chapter continues to present the underlying epistemology of the study,

namely social constructivism, and show how Freeden's morphology of ideologies as well as a convergent multi-level mixed methods research approach fits this worldview. Furthermore, details of each method and sampling approaches follow. Finally, data analysis is explained and a short reflection on the researcher's personal role is provided.

Chapter 4 presents the collected data and thus sets the scene for the subsequent analysis chapters. The beginning of this chapter provides an overview of all participants. In total, 565 Makers have participated in this study; 139 in short interviews, 406 in the survey and 20 in in-depth interviews. Out of all participants, 19% were women, 75% men, 2% non-binary and 4% of other/not declared genders. The majority of the chapter presents data on definitions of the MM including important concepts such as community, participants' environmental views and their views on gender-related differences, and issues around inclusiveness with a special focus on gender.

Chapter 5 devises the morphology and, therefore, fulfils the first objective of this study. The bulk of the chapter is divided into three sections: core concepts, adjacent concepts and peripheral concepts. The core concepts which are those deemed essential in defining the basis of Making activities are re/-creating, technology, and personal agency. Adjacent concepts which contest the core concepts further are creativity, digital technologies, community, amateurism, learning, and activism. Not all Makers will identify with all of these concepts, but likely with a handful. This is not the full picture, however. Less important but still relevant concepts have their part in shaping all the previous concepts and fleshing out nuances. The peripheral concepts as defined by this study are: inclusiveness/accessibility, self-actualisation, well-being, traditional technologies, entrepreneurship, and environmental sustainability. Some of these concepts might play a role for some Makers but be irrelevant for others. The chapter closes with portraying a specific morphological constellation that appears to apply to the majority of Makerspaces in the UK, Germany and Austria.

Chapter 6 presents analysis on gender and inclusiveness, thus tackling objective two. It argues that women are not only structurally excluded from Makerspaces but also through a rather masculine set up and culture within the spaces. The collected data from in-depth interviewees on this topic was mainly divided into two aspects: the impact of physical spaces, and the community itself. This chapter begins by showing that general structural exclusion of women already starts outside the Makerspace when they have not even approached a space/community. Women's time, financial budget as well as mobility are generally more constrained than those of men and, thus, allow them less flexibility and freedom to engage

in Making activities. The second part of the chapter continues to argue that community-run Makerspaces are often, by their nature, not very open and welcoming physical spaces. Equally, the community that forms inside of them can be a somewhat closed off one that is defined by a masculine culture noticeable through exhibition of confidence, competitiveness and bragging, and often sexist behaviours. Language and communication of Making activities can add to the feeling that these spaces are designed by and for men. The chapter continues to show how women cope with these circumstances if they manage to become part of a Makerspace. In the end, this chapter develops a second, more inclusive Makerspace morphology. Moreover, it argues that due to the masculine nature of Makerspace communities it might not be easy to include more women unless the culture changes towards this more inclusive and feminine morphology.

Chapter 7 is the third analysis chapter and demonstrates connections between gender and environmental concern in Maker practices. Despite initially inconclusive data, it concludes that female in-depth interviewees, indeed, present as more environmentally concerned than the interviewed men. The chapter starts recapturing the general status of environmental effects within Making as presented in the literature review and data chapters. Section two considers interviewees' answers to the question whether they think there is a gender difference in how Makers consider the environment. Due to their answers not clearly leaning towards one side, environmental profiles are developed for each. They show that the women in the sample seem to be more environmentally concerned in their Maker practice which shows through the reuse of materials, the importance of environmental dimensions in their practice, the spreading of environmental awareness through workshops and helping other spaces set up, and through repair. This chapter is essential in achieving objective three and, therefore, crucial in answering the research question.

Chapter 8 concludes the research with a discussion, recognition of limitations and further research suggestions, a reiteration of the importance of this project and final remarks. The discussion section draws together the findings of all three analysis chapters. It concludes that even though women in Makerspaces in the UK, Germany and Austria might appear more environmentally friendly in their Making practice than men, "just adding women and stir" (Harding, 1995) will increase neither female participation nor pro-environmental behaviour. Due to the often masculine culture within Makerspaces, many women find it difficult to fit in and find their place within these communities. In fact, the study shows that some of the women refer to themselves as 'tomboys' or a 'square peg' while acknowledging that they fit into the masculine culture better than others. This work then makes the case that women in

Makerspaces in the UK, Germany and Austria, indeed, appear more environmentally concerned, but that merely adding them to Maker communities would not be enough to improve environmental effects and gender inclusiveness. It is not an automatic mechanism. Equally, increasing environmental considerations might attract more women but that that alone is not enough to integrate them fully. A change in the masculine culture in the spaces is necessary to create a truly inclusive and environmentally sustainable community. These dynamics are shown to be inherent in how the movement in many of the German, British and Austrian Makerspaces is currently set up. The morphology as established in Morphology of the Maker Movementand analysed in Chapter 6 shows how structurally embedded exclusive practices are and that these structures need to change in order for Makerspaces to be more gender-inclusive. Even though some overall suggestions are provided, the necessary changes might differ slightly from space to space. This aligns with the social constructivist approach of this thesis and, indeed, with Freeden's morphological theory. The dissertation, thus, shows that challenges around gender inclusiveness and environmental sustainability can potentially be tackled together within the specific Makerspace morphology for the UK, Germany and Austria, but require fundamental changes in how many of those spaces work.

Chapter 2   Literature Review

> "[Makers] have construed making as a process by dudes, for dudes"
>
> (Bean & Rosner, 2014, p.27)

Literature has been the basis for devising this research project and supported data collection, analysis and framing of research findings. The following pages approach the MM through social science literature, specifically focusing on technology and society, community building and political theory. Firstly, the development of the movement and conceptualisations are explored. Secondly, further motivations and driving forces are presented.

2.1   Development and Conceptualisation

This section examines literature connected with the two aspects which are often considered to have sparked the movement: the democratisation of technology and the democratisation of information. Additionally, it identifies a few conceptual approaches that help provide some consistency and clarity as to how it could be defined. We will soon discover that despite popular accounts, the MM holds many tensions.

Before moving on, the surrounding terminology has to be inspected briefly. Many different terms can be found when people talk about Making, most prominently *Maker movement* and *maker culture.* This dissertation uses Making with a capital M in order to incorporate a possible difference between Making with a potential philosophical/ideological intent and regular everyday making (e.g. making a cup of tea). Furthermore, Maker movement is for now the term of choice in order to refer to Makers as a whole. In order to distinguish between a movement and a culture, extensive research and analysis are necessary to make an informed decision. A movement appears to incorporate a stronger political dimension which is why this term is employed in this study. It ensures that political notions are not neglected.

Not only do opinions vary regarding defining the MM, but other terms are also contested and overlap: crafting, tinkering, DIY, hacking, etc. The list is long. This dissertation does not aim to flesh out commonalities and differences between the terms which would go beyond what can be accomplished. Nevertheless, potential differences are not neglected and are addressed when relevant. Devising a morphology of the MM aims to provide some direction in guiding a more complex debate. Important to point out in this discussion is the term *hacking* in connection with Making. Both terms have been used by researchers to describe similar activities and are, at times, difficult to distinguish (Davies, 2017; SSL Nagbot, 2016; Kraemer-Mbula & Armstrong, 2017; Lindtner, 2014; Toombs et al., 2014). Even though nuances might exist, in order to ensure the inclusion of a variety of activities that could potentially be labelled Maker activities, both terms are used within this study, especially for contacting Maker- and hackerspaces which overlap in their activities.

2.1.1   Democratisation of Technology

Many studies exploring the MM state two main factors as the reasons for its existence: the democratisation of technology and the democratisation of information, both fuelled through technologies which have become easily available to non-experts. This and the following section provide an overview of relevant literature for each aspect.

The most prominent aspect named as driver for the movement is the use and democratisation of digital technology. In order to understand this aspect better, we need to firstly define what is meant by the term technology. This study bases its definition on Bernard Gendron (1977, p.23) who specifies technology as "any systematized practical knowledge, based on experimentation and/or scientific theory, which enhances the capacity of society to produce goods and services, and which is embodied in productive skills, organization, or machinery." This offers a wide range of possibilities of what technology can be, starting from gardening skills and leading up to a highly complicated electron accelerator. Using this definition ensures a holistic picture of Maker activities. Now, a variety of technological aspects within Maker practices can be devised: tools and materials, the created artefacts themselves, the skills and knowledge required to go through the creation process, and the way Makers are organised, which according to the just cited definition is in itself a form of technology. The different understandings of technology become important in Chapter 5 when a variety of technologies are examined to develop a morphology.

Coming back to the democratisation of technology, we can now find this democratisation on the first three levels. Firstly, tools and materials Makers employ. This, in fact, is the aspect most often referred to when digital technology is raised within the Maker context. Prominent Makers such as Mark Hatch, who is former CEO of TechShop[3] and author of *The Maker Movement Manifesto*, and the already mentioned Anderson and Dougherty agree that the availability of digital tools is at the core of the movement. "It's hard to think of the maker movement without mentioning digital manufacturing technologies like 3D printing, CNC milling, and laser cutting. […] [They] are becoming more affordable, easier to use, and more accessible to designers, engineers, and hobbyists" (Osborn, 2013, p.xv). Academics in the field have echoed this sentiment. Science and technology scholars Bo-Ram Kwon and Junyeong Lee (2017, p.319), who collected data through a survey sent to seven Korean Maker communities, for example define

> the concept of a maker as one who makes things with information technology, as the maker culture is an emerging technological phenomenon that is fuelled by developments in ICT [information and communication technology]. […] What distinguishes contemporary makers from inventors and those who engaged in DIY (doing it yourself) in other eras is the remarkable power afforded them by technology.

Others agree (Mota, 2011; Seo-Zindy & Heeks, 2017; Roedl et al., 2015). Developmental informatics scholars Ryoung Seo-Zindy and Richard Heeks (2017, p.1), for example, focus only on "digital innovation and fabrication networks" when examining research conducted so far on Maker- and hackerspaces in the Global South.

The most prominent example for those digital technologies is the 3D-printer. Whenever digital fabrication technology is mentioned, so is the 3D-printer which – although already developed in 1984 – is now more affordable for everyday people than ever before (Osborn, 2013, p.xv). Dane Stangler and Kate Maxwell (2012, p.9), both scholars from a US-based foundation focusing on education and entrepreneurship, state: "The last hallmark of the new producer economy is that it democratizes technology and, more importantly, the ability to become a producer. An excellent example of this is probably the best-known element of the DIY revolution: 3D printing." Thus, a considerable amount of research focuses on this item specifically (Mota, 2011; Ratto & Ree, 2012; Tully, 2016). While these digital fabrication technologies certainly rank highly among many Makers, this dissertation shows that not

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[3] This is a commercial Makerspace chain that declared bankruptcy in 2018 (Kumparak, 2017).

every Maker finds them essential in their practice. Chapter 5 develops a morphology that gives room to digital technologies but other important factors as well.

Due to all these digital fabrication technologies some authors – academic and non-academic – foresee a revolutionary change in production processes. Anderson (2012, p. 41) is leading the charge: "[T]he Third Industrial Revolution is best seen as the combination of digital manufacturing and personal manufacturing: the industrialization of the Maker Movement." Hatch uses the same revolutionary language and calls the newly available technological tools the arms with which the movement is maintained, and the revolution won (2014, p.26). Only a few academics join in, e.g. Stangler and Maxwell (2012, p.9), and celebrate this new technology as enabler for Makers to become producers. Dougherty claims all Makers are adhering to this perspective: "All together, makers are seeking an alternative to being regarded as consumers, rejecting the idea that you are defined by what you buy. Instead, makers have a sense of what they can do and what they can learn to do" (2013, p.8). Anderson, Hatch and Dougherty are evidently keen to make money through Makers, which is why it is questionable whether all Makers engage in Making because they want to revolutionise production processes. The morphology in Chapter 5 argues that this might be true for some, but indeed not all, and that other motivations might be more important to many.

Figure 2-1 Example projects 1. Left to right: Bicycle Frame Bag, Color Changing Ice Cream, Safari Glamping Tent.

Before moving on to the next technological aspects, it is important to discuss the limitations of the narrow focus on tools as digital fabrication technology. As we have seen, some studies focus exclusively on these technologies without giving less digital technologies a second glance. Others might mention them but only in passing (Nascimento & Pólvora, 2018, p.928).

In contrast, some writings claim that every single person on this planet is a Maker: "We all make things all the time: we cook meals, we write essays, we decorate rooms, we craft play-lists on iPhones for dance parties, we may even sew or carve" (Miller, 2011, p.23). These opposing positions are given more room later on. For now, the importance of a more structural approach that allows for a variety of Making constellations/communities and incorporates these differences is emphasised. A morphology that allows for varieties of Making while providing an overall umbrella for the activities seems important to differentiate between multiple values and beliefs. Equally problematic is the notion of democratising these new technologies when many people are excluded from Makerspaces (where these tools are often made available), e.g. through financial reasons or because the communities are not inclusive. The issue of inclusiveness is one of the focal points of this study and is addressed in detail in Chapter 6.

The second category of technology within the MM is the actual object of a Making process. Compared to the emphasis on digital fabrication technology as tools, the final objects are often much more varied (see Figure 2-1 and Figure 2-2). Whereas coding and electronic projects are naturally considered to be rather modern, a piece of jewellery or furniture that was prepared with a laser cutter or CNC milling machine might not necessarily appear more sophisticated than its traditionally made counterpart. Nevertheless, when talking about democratising technology, it is not only the tools people refer to, but also the sheer variety of objects an amateur can now make or engage with (Stangler & Maxwell, 2012, p.6). Within academic literature, the end products themselves have not yet been looked at in detail to the knowledge of the researcher. The diversity and potential range of things one can make are acknowledged by almost all authors, however, they have rarely been discussed in a theoretical light. This cannot be accomplished here, but further research is highly recommended.

Thus, we arrive at our third conception of technology: the skills and knowledge used in order to successfully go through the creation process. Naturally, with the introduction of new technology new skills and knowledge of how to operate and use that technology are necessary. However, Makers do value learning and understanding in general, which is shown when devising a morphology. Therefore, acquiring knowledge of how things work and how they are made is not only limited to new tools but extends to all sorts of artefacts and processes. Exploring websites that collect instructions and Maker projects gives an insight into the wide array of projects people learn about and Make (again, for examples see Figure 2-1 and Figure 2-2).
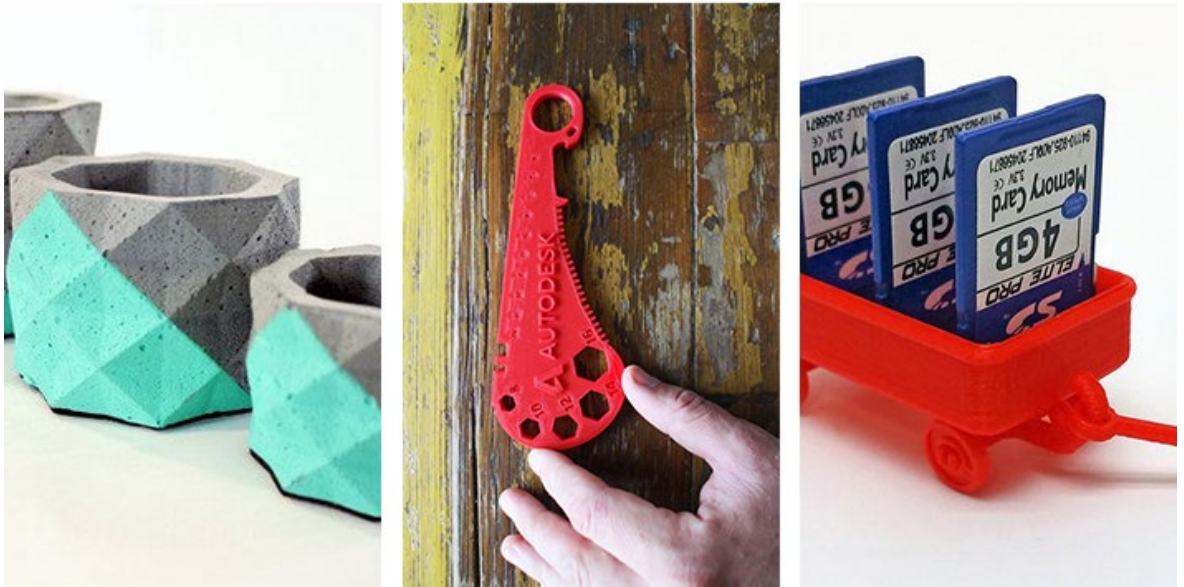
Figure 2-2 Example projects 2. Left to right: Geometric Concrete Pot Mold, Make Your Own Tools, Red Wagon and possible SD card holder.

Mark Frauenfelder (2010), prominent Maker and author of *Made by Hand: My Adventures in the World of Do-It-Yourself*, emphasises the importance of learning through Making:

> They [many people that e-mailed him] have told me that making things has changed the way they look at the world around them, opening new doors and presenting new opportunities to get deeply involved in processes that require knowledge, skill building, creativity, critical thinking, decision making, risk taking, social interaction, and resourcefulness. They understand that when you do something yourself, the thing that changes most profoundly is you (p.223).

He argues that Making automatically increases your learning, not just about the object, but regarding your view of the world. By conducting interviews with 30 Makers in 12 US-based spaces, Davies (2017) explores the hacker spirit and finds two of the eight aspects she mentions directly engaging with learning and knowledge: "understanding how things work" (p.65) and "learning by doing" (p.67). Talking about the former, she reports "a sense of alienation and frustration with the world […] – the sense that most people had lost touch with the realities of creation and production" (p.65). The motivation to learn is present in other studies. Scholars of sustainable design and innovation Martin Charter and Scott Keiller (2014, p.10), for example, asked participants of hackerspaces through a survey why they participate in such a space. Two of the top three reasons that were chosen emphasise the importance of learning: both "to be intellectually stimulated" and "learning new skills" reached an almost 100% agreement rate. The third among them is "to meet others who share my interests" which does not stand in stark contrast to the other two but might indicate a different weighing of reasons for participation and the need for a morphology that accounts for both. Another report that looks at Makerspaces in South Africa (Kraemer-Mbula &

Armstrong, 2017) lists skills development as one of the top five fields of engagement with the examined spaces (p.24). The importance of learning in Making becomes equally obvious in literature written on Making as a new tool for education (Thompson, 2014; Halverson & Sheridan, 2014; Martinez & Stager, 2014). Collected data from the present study shows similar views among participants and, thus, confirms previous literature on this aspect. Learning and knowledge expansions plays an important role when devising a morphology for the movement (see Chapter 5).

2.1.2   Democratisation of Information

Hand in hand with learning and acquiring knowledge comes the sharing of that knowledge, or the democratisation of information. This aspect is crucial in the MM as communities – online and offline – form around making knowledge available. Especially the new modes of organisation and sharing of information in an online environment allow not just Makers but anyone with internet access to share and use design files, blueprints and teaching tutorials from anywhere in the world, often for free. A few prominent examples of websites that were distinctly created to form and assist Maker communities include the already mentioned https://www.instructables.com/ and https://www.thingiverse.com. Thousands of Makers post their projects, instructions and design files here to share ideas and engage with others. The processes of invention and personalisation are completely transformed by ease of access and affordability of blueprints and designs on the internet. The sharing of knowledge, online distribution of creativity and the collaboration that comes with it, have major impacts on projects and their production:

> […] digital files can be shared and copied limitlessly at virtually no cost and with no loss of quality. But what's more important is that they can be modified just as easily. We live in a 'remix' culture: everything is inspired by something that came before, and creativity is shown as much in the reinterpretation of existing works as in original ones (Anderson, 2012, p. 74).

This remixing of information and ideas, especially through online means connects the global with the local. Neil Gershenfeld, professor at the Massachusetts Institute of Technology and director of its Center for Bits and Atoms, explains that "The designs can be made anywhere in the world. […] So you're shipping data, instead of shipping products" (2011, p. 59).

This so-called democratisation of information online is neither a new phenomenon nor one constrained to the MM. However, one of the novel features of the movement is that it pairs the possibilities the online world offers with the increased ease of access to digital fabrication

tools (Nascimento & Pólvora, 2018; Grimme et al., 2014; Unterfrauner & Voigt, 2017). Ele Carpenter (2011, p.49), researcher in politicised art and social networks of making, takes it one step further and raises the sharing of information to a political level:

> Within contemporary creative culture there is a critical mass of makers organizing in response to the multiple crises of de-skilling, proprietary licensing and outsourced production. This eclectic mix of unlikely bedfellows is rapidly reshaping older patterns of 'Do It Yourself' production through both old and new technologies and 'Do It Together' networks, both online and in located spaces. The makers are committed to open transparency and access to ideas and information. They use any tools or materials necessary.

She emphasises the importance of the social and open source sharing component of Making things which is especially empowered by the internet and digital networking. Open networking and sharing of ideas are a key aspect of today's Maker culture, not least because of its interwoven connections to the hacker scene of the last 50 years (Nascimento & Pólvora, 2018, p.931). These point to the political background of exploitation and hierarchies that are motivating Makers to make stuff by themselves. These political aspects are given more consideration in later sections (see 2.2.2; 5.2.6). But their connection to the free sharing of information appears crucial aspect to the MM.

Even though democratising information appears to be one of the main aspects for Makers, this is not an uncontested assertion. Inclusiveness issues play a role here, especially when the communities that form around Making are rather exclusive and homogenous, as we will see later. This study shows that a lack of skills and/or confidence, for example, can be a considerable obstacle for someone to participate in Making and thus in getting access to this information. The morphology developed in Chapter 5 looks at these tensions more specifically. Due to these new sharing mechanisms also being based on digital technologies, they are combined under one heading with the democratisation of technology (see 5.2.4).

2.1.3   Conceptual Approaches

Already, we can detect some tensions in how a Maker and the movement are defined. Some Makers identify the act of Making as something that is inherent to a human being. Three prominent Makers make this case:

> Making is fundamental to what it means to be human. We must make, create, and express ourselves to feel whole (Hatch, 2014, p.11).

> We are all Makers. We are born Makers. […] If you love to plant, you're a garden Maker (Anderson, 2012, p.13).

> 'Maker' […] describes each one of us, no matter how we live our lives or what our goals might be. We all are makers: as cooks preparing food for our families, as gardeners, as knitters (Dougherty, 2012, p.11).

All three promote the movement, not just as a hobbyist activity, but as something that can transform the world, and everyone should join. They themselves and their respective companies have contributed enormously in spreading the movement – and were profiting from its growth. This raises a question over the extent to which the MM is led by its users and amateurs. No doubt, there are numerous bottom-up, non-commercial hacker- and Makerspaces. But are they the same as the corporate MM? Could the term just be a softer, more acceptable term for establishing a branding strategy that is easier to promote than that of the hacker movement which is often used interchangeably? Jonathan Bean, researcher of technology, and Daniela Rosner, researcher of cultural histories, define a movement as "typically understood to be a bottom-up phenomenon, brands usually originate from the top down" (p.26) and conclude that Dougherty's *Make:* magazine and other related products have fostered the movement which, in fact, "may be better understood as a brand. […] a brand that is mobilizing a broader ideological shift, positing that individual consumer/makers […] have the power to perfect the world through production" (p.27). Maybe it is not a question of whether or, but an overlap of a variety of push/pull factors that make Makers into a unique group of people. While this dissertation cannot fully scrutinise this question, its morphology could greatly help in devising different Making constellations and, therefore, also those that potentially differentiate a grassroots movement from a brand.

Academic literature has not engaged much with actually defining what the movement is. Is everyone a Maker or is there a difference between *m*akers and *M*akers? Sustainable design scholar David Roedl and his team (2015) are among the few who have looked at the terminology. Through their discourse analysis of 191 relevant publications, they identify "two distinct but related definitions of 'making'" (p.15:8). One "sees making as a near universal human activity; a practical, everyday means of making-do and making-sense in the world" (p.15:8), the other "examines particular practices of making that are enthusiastically approached as hobbies and/or and [*sic*] come to represent subcultural identities and lifestyles" (p.15:8). The present study concerns itself more with the latter definition by trying to identify distinct features of Making. It therefore supports the view that there is indeed a difference between the two and that everyday making is not the same as Making practices in the MM.

Some researchers emphasise that there is no one way to define Makers and the movement as a whole (Nascimento & Pólvora, 2018; Lindtner, 2015; Ames et al., 2018). They criticise that much of the terminology that is used to describe it is Western-centric. Lindtner (2015) has conducted extensive ethnographic research with Chinese Maker communities and demonstrates "how China's makers challenged any direct mapping of a globalized narrative of innovation and Western histories of hacking onto China" (p.872). Susana Nascimento and Alexandre Pólvora (2018, p.943), both science and technology scholars and working for the European Commission – Joint Research Centre, further generalise Lindtner's findings by stating "makers [*sic*] cultures seen as a group are always based on a wide diversity of settings, territories, networks, people, artefacts and more importantly of different levels of awareness and commitment to a broader transformative power." In a collaborative article by nine researchers (Ames et al., 2018) who examine Making cultures within Bangladesh, Taiwan, Vietnam, Paraguay and China, the term 'making do' is promoted as incorporating more diverse Making practices around the world instead of only focusing on one "that portrays technological know-how and craftiness as crucial in liberating individuals from corporate monopolies and bureaucratic state structures" (2018, p.1). The authors, all having conducted extensive anthropological research in sites of Making and hacking in the aforementioned countries, show how

> making (and hacking before it) emerges within specific contexts and with particular characteristics that embed it in its locale. Making/hacking, as a practice, responds to local needs, is adapted to local topographies of materials and practices, and yet unfolds in relation to global imaginaries. It makes use of local physical, economic, and human resources. It is embedded in local circuits of people, objects, capital, and skill, and it takes on a particular character within a local landscape of production forms. […] our point is that we need to see this [contemporary Western making hype] itself as a local and contingent account of making. Our examination of other makings highlights the historical, political, and economic specificities of those Western accounts (2018, p.16).

Their rich data and views on Making profoundly challenge conceptions of Making that merely include Western values and notions of empowerment. The morphology in the present study accounts for these findings and also understands the Maker movement as a plurality of practices with a plurality of constellations. Freeden's morphology of ideologies is ideally suited for this purpose as it allows for flexibility while also providing a stable umbrella for all MM activities.

With this in mind, we shall now proceed to assess conceptualisations of the movement that have already been attempted. Three concepts are considered: Wehr's approach of

differentiating between three groups of people within the DIY movement (2012); Voigt et al.'s empirically informed taxonomy of the Maker movement (2016); and Millard et al.'s conceptual framework written for the European Commission's *MAKE IT* initiative (2017). Sociologist Kevin Wehr defines three groups of 'do-it-yourselfers': DIY individualists, DIY coordinators and DIY lifestylers (2012, p.2). Even though he talks about DIY and not Making, the two overlap and the structural approach of one can potentially inform the other. *DIY individualists,* for Wehr, are individuals acting in isolation. He stresses that through purchasing equipment and requiring related services, they are still "enmeshed in the larger capitalist system, even if they desire to break away from paying professionals" (p.3). *DIY coordinators* are "people who consciously embrace a DIY mentality and coordinate with a larger group" (p.3). He deems them at the core of the DIY movement. This group of people consciously identifies with a DIY mentality and is "proud of it" (p.4). Lastly, *DIY lifestylers* are those that have internalised a DIY approach to life where DIY becomes political. They "live and breathe the DIY lifestyle" (p.4). Wehr explains that people of this group can come from all walks of life – punks in an anarchist squat, hippies on a collective farm or from "the culture of 'good ol' boys'" (p.4). What unites them is their commitment to more complex and intensive DIY projects than the average person might embark upon (e.g. building your own house) without relying on experts. All three taken together constitute a DIY movement that is not necessarily a traditional social movement (like for example environmentalism or feminism), but a movement of expressive action that "does not seek broad social change, but rather offers personal fulfilment for members" (p.4). Activist notions as well as ideas of self-actualisation play an important role when the morphology is devised.

To some extent, Wehr's categorization aligns with Roedl et al.'s (2015) idea of makers and Makers being part of the same activities, just on a different intensity level. Like them, Wehr attributes similar activities to all groups but with a different level of enthusiasm and intensity. However, this is also where Wehr's concept raises questions. For example, he relates the intensity of someone's DIY commitment to that person's political motivations. DIY individualists who do not engage with a group of other DIYers do not appear to be motivated by political opinions which seems to be a generalisation without proof. In fact, his categories do not appear empirically informed and no references are given to sources that might support his ideas. On a different note, for the MM a classification along these lines might be lacking in its analysis of important themes, such as the role of technology or the different nuances of political motivations. Thus, while Wehr's conceptualisation offers a first approach to conceptualise the movement, it does have too many gaps.

Christian Voigt et al.'s taxonomy (2016) of the MM, which was devised by a group of researchers from Finland, Spain and Austria, not only offers a perspective directly referring to the object of discussion but also a very different approach. These researchers base their results heavily on social media and online data mining, such as Tweets and Google trends analysis. The four main categories they devise as being defining of the movement are 3D-printing, kids learning in Makerspaces, supporting students in Makerspaces, and schools and libraries as Makerspaces. Whereas the approach of looking at a large amount of empirical data might be a good start, the methodology appears flawed. A lot of their tweets are mined while two educational Making conferences are taking place, thus skewing the results heavily towards education, libraries and schools. One of their initial terms to search for is 'maker_education' which appears random since others, for example relating to entrepreneurship, are not included. Equally, they assume that a social media representation of Making is a real representation of the movement. But how many Makers will post about a small trial and error project? Do all Makers use their chosen hashtags? And how many Makers post in English? The four main strands they identify are not being connected with each other or in any way organised in a structural way. Consequently, whereas the paper offers an interesting approach, it is not sufficient enough to capture nuances and the breadth of the movement.

The conceptual framework that approaches a comprehensive picture more fully is that of Jeremy Millard and eleven other European researchers (2017). The framework was devised for the *MAKE IT* project of the European Commission. However, it is necessary to mention that it does not set out to be comprehensive but, instead, focuses on the areas outlined below due to its funding which is specifically geared towards Community Awareness Platforms (CAPs). These are the focus of the European Commission in "designing and piloting online platforms that create awareness of sustainability problems and offer collaborative solutions" (p.23). Within their MM framework, the researchers focus on (1) digital fabrication, (2) CAPs, (3) Crafts and DIY and (4) creative industries (see Figure 2-3).
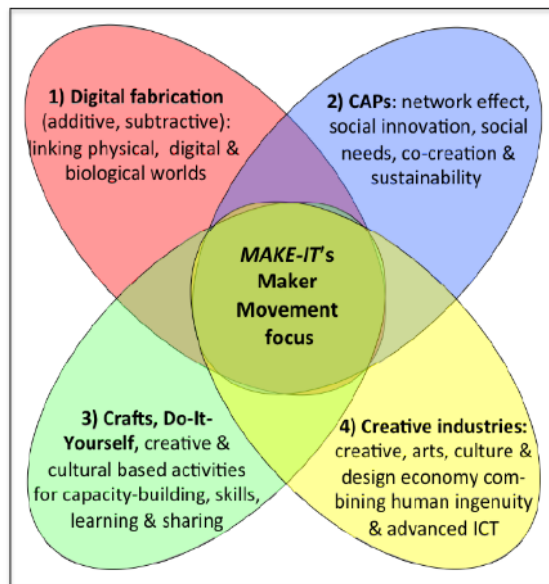
Figure 2-3 Research focus of MAKE IT.

The first category, digital fabrication, refers to technologies like 3D printing and laser-cutting. The authors are interested in local and inexpensive production which is enabled by 3D-printers, software or computer-aided design. CAPs as a project focuses on networks of people, ideas and sensors which enable "new forms of social innovation that aim to support behavioural change, reputational processes and self-regulation to the maximum degree so that these are trustable and effective" (p.23). Makerspaces and communities are viewed in this business- and government-focused way and looked at due to their potential to encourage sustainable and smart growth. Crafts and DIY as a third category refer to "the process of manufacturing by hand with or without the aid of advanced or power tools and [to it being] part of the informal economy" (p.24). These activities are driven either by marketplace motivations (e.g. need for customisation, lack of product availability, etc.) and identity enhancement (empowerment, craftsmanship, etc.) (p.24). The authors point out that even though Makerspaces can be of many different types, they are generally characterised by a creative DIY spirit (p.25). Lastly, the creative industries (category 4) have been chosen due to "many makers [today] overlapping and working with the so-called creative industries as creative, arts and culture-based economic activities."

Their framework, like Wehr's, does not offer much in terms of evidence or discussion of how they have decided on these four categories. Nevertheless, they seem to capture quite a big group of Makers. Unfortunately, some elements are missing. Even though they do speak of Makers establishing new ways of production with potential for environmental and social change, they do not explicitly mention a notion of activism and political action. This might be due to this framework being established within a report that is funded by the EU. Additionally, the framework focuses on Makers within networks and who are, ideally, working towards social and environmental goals. Whereas that might be the case for some, it does not apply to all. Again, their conceptualisation is a helpful start and brings fruitful ideas into the discussion, but it does not allow for every Maker to find their place in it.

There is clearly a need for conceptualising what the MM is about. Doing so helps solve various tensions and allow for research that is tailored towards specific Maker groups. Instead of focusing on infrastructure or intensity of engagement, this study has devised a morphology that is based on themes and strands that shape and inform Makers and their movement (see Chapter 5).

2.2   Community and Politics

This dissertation mainly considers inclusiveness and environmental sustainability aspects of Making, which is why this section reviews literature related to community (2.2.1) and political dynamics (2.2.2). Both identify gaps and show where this research project fits in.

2.2.1   Community

Literature provides strong evidence that community among Makers is very important. However, upon closer examination many different kinds of communities come to light. This section explores the different types of community within Making and its importance, as well as open tensions which raise questions for future research. Firstly, however, the basic infrastructure and set up of community spaces needs to be explained. The local base for Makers is usually a Maker- or hackerspace. This is where machines, tools and workspaces are installed. These spaces can be organised differently. A report on Makerspaces in South Africa (Kraemer-Mbula & Armstrong, 2017) differentiates between the following: community-based collectives, university-based collectives, government-based collectives and hybrid collectives (p.11f). The present study adds the category of commercial spaces and expands the university-based category to 'educational collectives' in order to include schools.

Grassroots bottom-up collectives: Grassroots spaces are typically set up and run by its members on a volunteer, unpaid basis. Financing is often enabled through membership fees and/or fundraising activities (i.e. workshops or grants).

Educational collectives: These spaces are linked to schools or universities in order to provide Making space for students and staff. Often at least one officially employed staff person is responsible for the space. Depending on the institution, access restrictions can be in place, e.g. only students can access the space and not the public.

Governmental collectives: Spaces in this category are sponsored by the government. In Kraemer-Mbula and Armstrong's report, the government is a regional one which is not to say that other levels of government cannot be involved in Makerspaces. To the knowledge of the researcher, however, not many of these spaces exist.

Commercial collectives: Commercial spaces are for-profit spaces that are run by paid staff and charge fees for using the space in order to pay wages, financial upkeep of machines and investment in new machines. A prime example is the former TechShop which was the biggest commercial Makerspace chain until it declared bankruptcy in 2018.

Hybrid collectives: Hybrid forms portray a mix of different aspects from the aforementioned set-ups. A Makerspace in a library as an educational institution could fall into this category, for example, if it was funded by the government.

On a more public level, Maker communities are mainly found in online spaces, e.g. websites, or events during which Makers exhibit what they have been working on. Events also often include workshops that provide the opportunity for visitors to start learning a new skill, and spaces where suppliers might sell Making related tools and materials. The most prominent example is that of Maker Faires which are part of Make Community, LLC. The Faires started in 2006 and have grown to more than 200 Faires worldwide, ranging from flagship Faires with more than 100,000 visitors (Make:, 2013) to smaller local Mini Maker Faires. Non-branded events take place as well, e.g. the annual Liverpool MakeFest.

As elaborated on previously, sharing information online is a significant component of the MM and can be considered the second main way through which Makers connect beyond their local spaces. Hatch in his manifesto (2014) lists nine crucial behaviours that make a good Maker. Four of these have to do with communicating with fellow human beings: share, give, participate and support (p.1f). Similarly, academic authors seem to agree on that basic notion. Sociologist David Gauntlett (2011, p.2), who researches creative processes and self-initiated everyday creativity, springs to mind. He is adamant in promoting the idea that Making is, automatically, connecting and forms community:

- Making is connecting because you have to connect things together (materials, ideas, or both) to make something new;
- Making is connecting because acts of creativity usually involve, at some point, a social dimension and connect us with other people;

- And making is connecting because through making things and sharing them in the world, we increase our engagement and connection with our social and physical environments.

Even though Making connects, Gauntlett's description does not necessarily imply that these connections are enjoyed. Davies (2017) has interviewed more than 30 Makers of 12 different US hackerspaces and found that, indeed, community is essential to the hacker spirit and very much enjoyed by Makers. Interviewees noted how it was great to make cool stuff, but even better and more productive to make cool things together (p.69). Human computer interaction design scholar Austin Toombs and his colleagues (2014) have undertaken a 15-month ethnographic study in a hackerspace and list community as one of the three main concepts which emerge as priorities when defining ones' own Maker identity:

> the space has more to do with providing a social atmosphere for its members, operating as a third space, one that is neither home nor the office, for members to relax and visit with each other, where members can work on projects that fail without fear of judgment, where members learn to engage with their materials and tools on a deep level, both through hours of practice and through learning experiences set up by more experienced makers.

The authors paint the picture of a local Maker community and its rooms as being a safe space that sits separately from home and work environments. Whereas the present study acknowledges the importance of community within Making activities, it does not define it as an essential criterion for being a Maker. In Chapter 5, community is located among the adjacent concepts of the Maker morphology, thus attributing it with important functions within the movement, but not as an essential requirement for someone to call themselves a Maker. In particular, the notion of a safe space was brought up by study participants and is important later on when considering issues around inclusiveness and accessibility in Chapter 6.

Where Davies examines face-to-face communities, Gauntlett's theories (2011) specifically consider online communities. He notes how online communities provide a platform for people to feel recognized in a community of like-minded interesting people, especially if access to a local, face-to-face community with similar interests might be lacking (p.101). Stacey Kuznetsov and Eric Paulos (2010), both scholars of human-computer interactions, have had a closer look at online DIY communities and conducted a detailed online survey among six selected platforms, which provided data from more than 2600 respondents. Their findings suggest that "community togetherness complements the predominantly solitary

practice of doing DIY work" (p.302). This paints a picture of individual DIYers and Makers sitting in their homes and occasionally checking in online to share.

Davies (2017) paints the opposite picture. The results of her in-depth interviews have led her to conclude that face-to-face community is one of the most important aspects of being a Maker. Individualism is important in American culture, and evidenced by people withdrawing into the digital world. Here, Makerspaces offer trustworthy and deep face-to-face connections that extend beyond the space. In fact, she goes so far as to claim that striving to be part of a face-to-face community is one of the main motivators for people to participate in Making activities and one of the two main reasons for the expansion of the movement:

> Public discussion of hacking and making often mentions community. […] But none of these accounts view community as what is driving the growth of the maker movement. […] This […] is the wrong way around. It's not the technology that drives community, but the communities that happen to involve technology (p.158f).

This sharp contradiction to the two commonly accepted drivers for the movement as presented above turns technology-based accounts on their heads and provides a whole new view on the movement, including different main motivations, political implications and goals. Toombs et al. (2015) similarly explore Makerspaces and their face-to-face communities while putting special emphasis on the notion of care and care ethics. While categorizing three different kinds of care within their studied Makerspace, they point out one aspect that differentiates Makers' communities from other communities of practice: "[…] what makes the study of care in Maker communities particularly interesting is how the tension between the espoused libertarian hacker ideology and the need for community maintenance and interdependent care plays out on an everyday basis" (p.636). This point leads the authors as well as Davies to the second main driver of the movement: a neoliberal zeitgeist which emphasises the power of the individual and self-actualization (2017, p.162). (Self-actualization and its different forms are explored further on in section 5.3.2.)

Both studies acknowledge the contradictions raised by a combination of neoliberal individual ethics and a desire to build small-scale local community; a perspective which is further explored in the upcoming section on political dimensions. Additionally, like many others these studies were conducted in grassroots Makerspaces in the USA, and neither spaces of different nature, i.e. corporate ones, nor communities outside the country were considered. To the knowledge of the researcher, no comparative studies have been conducted so far. Apart from these notions, other questions become prevalent when considering the

different emphasis on different communities. Is the movement, simultaneously, affirming and countering the digitalisation of our lives in the last two decades? What about Makers who are neither connected online nor in a face-to-face community? Is community important to them? Are they part of the movement? Much remains to be discovered in these areas. The importance of the present study lies in devising a morphology that allows for a variety of dynamics within community and tensions with other aspects, such as the previously mentioned neoliberal zeitgeist.

2.2.1.1 Inclusiveness and Accessibility

Many authors have acknowledged that despite the social and political power communities can have, they can also, almost inevitably, have a darker side to them (Putnam, 2000; Gauntlett, 2011; Davies, 2017). Sociologist Gerard Delanty (2018) engages at length with the contested term. Within sociology and anthropology "community is seen as the search for belonging and the emphasis is on the cultural construction of identity. In this approach, the emphasis is on community as Self versus Other" (p.5). The 'other' of the MM is the object of this section. Statements that claim that everyone is a Maker appear to include every person in the activity. However, it is not as inclusive as suggested.

Study	Location	Gender balance	Age	Other
Toombs et al., 2014	US	2 women 28 men	19-50	
Charter & Keiller, 2014	18 countries (top 5 UK, USA, Australia, Netherlands, GER)	Men 90:10 Women	Most (40%) 25-34	70% higher education degree
Kwon & Lee, 2017	Korea	3 women 90 men	25 in their 20s, 21 in their 30s 24 in their 40s	71% higher education degree (86% of those in engineering)
Voigt, Unterfrauner & Stelzer, 2017	Austria	~300 women ~1300 men	Men median age 32, women median age 29	
Grimme et al., 2014	US	1 woman 9 men	between 20-40 years of age)	all white
Moilanen, 2012	19 countries	25 women 223 men (2 'no answer')	mean age = 31 years, range: 13-62 years	85% higher than high school degree

Table 2-1 Collection of demographic data from some studies on the MM.

An initial look at overall demographics is helpful. Table 2-1 provides an overview of demographic data from different studies. Even though these handful of studies are not enough to make general statements about overall demographics, they do show tendencies in gender (predominantly male), age (between the ages 20-40) and educational background (well-educated). These studies are spread out across the globe and the last decade, thus

showing a movement that is potentially not as inclusive as portrayed. Toombs et al. (2015) put their finger on it:

> [T]he ethos that 'anyone can be a maker' obscures the fact that *not* everyone can be a maker. A single mother with three part-time jobs and no car probably cannot be a maker—not, at least, in the sense that 'being a maker' is specifically understood in this and other hackerspaces. Such an individual becomes literally invisible in the maker ethos, thus redefining 'everybody' down to a certain social class; it is presumably not a coincidence that the majority of dues-paying members are men in their thirties with professional careers, many of which are in IT (p.636). [emphasis by authors]

Before the gender-aspect of this data is given more attention, a brief overview is provided of more overall inclusiveness issues. Looking at membership processes in local Makerspaces offers more insight. Davies (2017, p.105f) notes the dangers of tight-knit communities. Her interviewees are mainly individuals from grassroots Makerspaces. As such, they often do not welcome everybody into their group, but follow a selection procedure in order to decide who fits in and who does not. Davies recounts several such processes and recalls one space that went so far as to have a "formalized period of 'stalking'" (p.54) of a potential new member before their membership was decided upon. She sums up all the different membership processes by noting that there was a strong sense within the different spaces that being part of their community was a privilege, not something to be taken for granted (p.54). Toombs et al. (2015) discover something similar when conducting their ethnographic study of a Makerspace. Entry into Making communities, to them, has not so much to do with skill and interest, but with the ability to fit into these communities on a sociological basis (p.637). Toombs (2017) himself analyses the most important tropes of a Makerspace discussion list, one being the vetting of new members (p.1083). From requiring a background check of new members to giving them unquestioned 24/7 access to the space, all kinds of ideas are voiced when deciding on an ideal process. He summarises the discussion stating: "it foregrounds how community members are often prioritized over outsiders, and 'fitting in with the community,' is emphasized" (p.1083).

Davies' interviewees even take this one step further and do not entitle more corporate spaces, such as TechShop, with the right to call themselves a hacker- or Makerspace due to their lack of a tight-knit community. This is problematic as these corporate spaces or more organized not-for-profit spaces, e.g. in libraries or universities, are not included in her study, even though she notes at the start that all of them belong to the movement. As remarked

before, Davies names a longing for community as one of the two main reasons for the development of the movement. In this instance, top-down spaces no longer seem to count as part of it. If they do belong, what then are the features that unite all Makers – whether corporate space, bottom-up group or private individual at home? Again, it becomes obvious why a morphology of the movement is necessary and relevant.

Figure 2-4 EU28 Makerspaces' average monthly fee and national average hourly wage.

Another aspect of not being part of a community encompasses practical issues. There appear to be few, if any, studies that address this centrally. However, it can be assumed with high certainty that some people who would like to be part of a Maker community simply do not have the time, money, nor physical access to do so. Some studies' participants, for example, can be considered fairly young (Davies, 2017; Toombs et al., 2015). Even though this could

have multiple reasons, one hypothesis might be that people in their 20s and 30s might simply have more time due to less immediate family commitments.

Similarly, proximity will be an issue. Face-to-face community might seem important to Makers who can access a Makerspace, but those without access might have different views. An issue that could arise despite having a Makerspace close by is that of affordability. Most spaces run on a membership basis (Davies, 2017, p.53) and require members to pay a regular fee in order to be given access to the space itself and its tools. Fees vary from space to space. The average for European countries is just about 20€ per month (see Figure 2-4). The figure also portrays the quite significant differences between Makerspace fees and hourly wages in the respective countries. Only in a few is one hour of work or less enough to pay for membership (i.e. Luxembourg). In most countries, membership costs more than this, in some considerably, i.e. in Lithuania an average of around 10 hours need to be worked to be able to afford Makerspace membership. This figure, then, illustrates different financial levels of exclusion in different European countries. Currently, these aspects are, if at all, mentioned only in side notes. They have not been studied, yet. While this study has not focused on them exclusively, it incorporates some of them later in Chapter 6 when examining how gendered pay-gaps create increased hurdles for women to join a Makerspace.

Gender imbalances are given priority in the present study. When thinking back on Table 2-1, this balance was heavily leaning towards men in every study. A similar picture is given in Table 2-2 which lists four of the most prominent (Western) Makers. All four are men, white, of a similar age and rather well-off. A UK Makerspace list (Stokes, 2015) finds only 11 out of 97 spaces that list a female membership of 50% or more and 28 spaces report a percentage below 20%.

Chris Anderson

Editor in Chief of *WIRED* magazine 2001-2012

Author:
- *The Long Tail: Why the Future of Business Is Selling Less of More* (2006)
- *Makers. The New Industrial Revolution* (2012)

Neil Gershenfeld

Director of MIT's Center for Bits and Atoms

Founder of a global network of over 1000 Fab Labs, chairs the Fab Foundation, and leads the Fab Academy

"He's been called the intellectual father of the maker movement."
(Gershenfeld, 2019)

Dale Dougherty

Former CEO of Maker Media, Inc. President of Make Community, LLC

Launched *Make:* magazine in 2005 and Maker Faire in 2006

Regularly considered the founder of the Movement (e.g. Corcoran, 2015; Delkic, 2018)

Mark Hatch

TechShop CEO (declared bankruptcy in 2018)

Author:
- *The Maker Movement Manifesto* (2014)
- *The Maker Revolution* (2017)

Table 2-2 Prominent Makers.

That women do not feel welcome in Makerspaces has been a topic within the communities for a few years now. In January 2013, an infamous thread on the wiki.hackerspaces.org email-list about women's involvement in spaces outraged many. The most quoted extract from it is this:

> If a hackerspace has one female and she wants more females in the hackerspace then she should start a campaign to find more females. It could be that she host a class about e-textiles or whatever it is females like to talk about (Powell, 2013).

Liz Henry (2014), a Maker in San Francisco, reflects on the thread and how she and other non-male Makers set up a feminist Makerspace not long after this discussion:

> That month there were many truly appalling, misogynist, sexist posts to the hackerspaces.org list. Guys kept saying that women don't come to hackerspaces and aren't hackers. The whole thing brought our alienation to a head. If we aren't at hackerspaces, it isn't because we don't make things, don't code, or aren't technical enough. It's because men act like the space is theirs. Women face harassment ranging from assault to much milder, but more constant, come-ons and innuendos.

Over the past few years, various studies have more generally looked at women's involvement in DIY/hacking practices in different countries and settings (Richards, 2016; Potot, 2013; Cox, 2016; Heim LaFrombois, 2017; Tanczer, 2016). In their qualitative inquiry and literature-based study, Nascimento and Pólvora (2018) paint a picture of the MM that falls short of its ideal to be open and empower individuals, grapples with white and male predominance, and faces many discussions around visible discriminatory practices against non-male Makers (p.14f). While deliberating on the distinction between Maker brand and movement, Bean and Rosner (2014) acknowledge "making as a process by dudes, for dudes" (p.27). Statistician Jen Lewis (2015) has specifically looked at Makerspaces and barriers for women's involvement in them. Many of them mirror Henry's writing. Through interviewing Makers and consulting informal research and media, Lewis (2015) has identified many constraining aspects for women, such as spaces being too intimidating and not pleasant to be in, having no specific goal, no easy way to get in and join, and women just being less interested – for now (p.12f). She concludes with noting that the biggest hurdle might still be for existing users of Maker- and hackerspaces to see the benefits of making a change. Often, they are concerned about "maintaining the ethos, purposes and focus" of their spaces (p.18). Henry appears to agree with most of that assessment and adamantly points out that women are just as much hackers and Makers as men are, they just do not feel as welcome as men in the dedicated spaces. The present study analyses very similar reasons for women's exclusion

from Makerspaces, starting from physical aspects of a space to the very masculine culture in them that makes it difficult for women to join (see Chapter 6).

The last years have, in fact, seen a wave of feminist Makerspaces set up. Davies (2017) and others (Rosner & Fox, 2016; SSL Nagbot, 2016; Toupin, 2014; Fox et al., 2015) have started looking at these spaces and their practices. According to Davies (2017. P.100), feminist hackerspaces are usually founded out of a desire to have a space where women feel part of a community, too, and not like 'the unicorn' in a crowd – the exotic representative of a different gender, or culture, or sexuality, who has nevertheless managed to find their way into hacking. Upon drawing her conclusions, she deliberately excludes spaces which are diverse on purpose, knowing that their aspirations are much more political than the average Making community.

> Other than in the diversity-oriented space we visited, which took social change as part of its mission, hackers and makers generally saw collective action and change as relevant solely in the sphere of their space and its members. Hacker and makerspaces were not about social change. They were about building strong community (p.172).

Apart from the fact that building strong community in times when individualism is prized and supported and that this in itself can be understood as social change, she here draws a clear distinction between spaces that are political beyond their own walls and those that are not. There appears to be a stark difference between internal politics and external politics in the explored spaces. Her conclusions are, thus, only partially valid and she, like her studied Makerspaces, excludes 'the other' to some extent.

Daniela Rosner and Sarah Fox (2016), SSL Nagbot (2016), Fox et al. (2015) and Sophie Toupin (2014) are much more focused on feminist Makerspaces in particular. All four publications directly challenge hacking and Making as a hegemonic masculine concept and posit feminist Making/hacking as hacking hacker culture itself:

> Ultimately, these spaces attempt to hack the concept of the hackerspace — reshaping the meaning of hacking itself as a way to hack life in all its forms so as to (re)gain autonomy. […] I have shown that for feminist hackers, makers and geeks the open space concept enshrined as the core of the standard hackerspace model is largely undesirable. They envisage a different role for their hackerspace, one in which boundaries offer both safety and a platform for political resistance. In doing so they counter the myth that open spaces are necessarily inclusive and egalitarian, revealing the issues of privilege which lurk behind such platitudes (Toupin, 2014).

Thus, as Davies already pointed out, they automatically have an added political dimension to them that regular spaces might not possess. Exploring feminist Maker- and hackerspaces, and particularly the reasons why they have developed, provides highly fruitful insight in the analysis chapters.

Even though studies have taken a closer look at women in feminist Makerspaces, only that by Lewis (2015) has been identified which speaks to women who are active within 'regular' Makerspaces and examines their situation. Equally, apart from Lewis's paper, empirical studies are generally conducted in the USA. This present research project has spoken to women and men of Makerspaces in the UK, Austria and Germany to find out what views on inclusiveness are and how non-male Makers are treated in those countries.

2.2.1.2 Women and Technology

Given the focus on women within the movement, a brief overview shall be given of feminist studies of technology. Since the 1980s researchers have studied the construction of gender through technology and the construction of technology through gender. Prominent writers in the field are Harriet Bradley, Cynthia Cockburn, Judy Wajcman, Sadie Plant and Donna Haraway. Their works are based on the understanding that technological capabilities and competence is still seen as something masculine:

> In contemporary Western society, the hegemonic form of masculinity is still strongly associated with technical prowess and power [and has led to] 'the construction of men as strong, manually able and technologically endowed, and women as physically and technically incompetent' (Cockburn, 1983, p.203). Entering technical domains therefore requires women to sacrifice major aspects of their feminine identity (Wajcman, 2010, p.145).

Looking at some recent data on women in science underlines Wajcman's and Cockburn's point. The UNESCO Institute for Statistics regularly publishes reports on women's worldwide involvement in sciences. Their latest publications on this from June 2018 indicates a worldwide imbalance of women involved at the research and experimental development stage in science. Figure 2-5 provides a visual overview. Few countries reach percentages of above 45% and most remain below 30%. Thus, the worldwide average is at 28.8% (UNESCO Institute for Statistics, 2018, p.2).

The gender gap in science
Women as a share of total researchers, 2016 or latest year available

70.1%-100%   55.1%-70%   45.1%-55%   30.1%-45%   0%-30%   No data
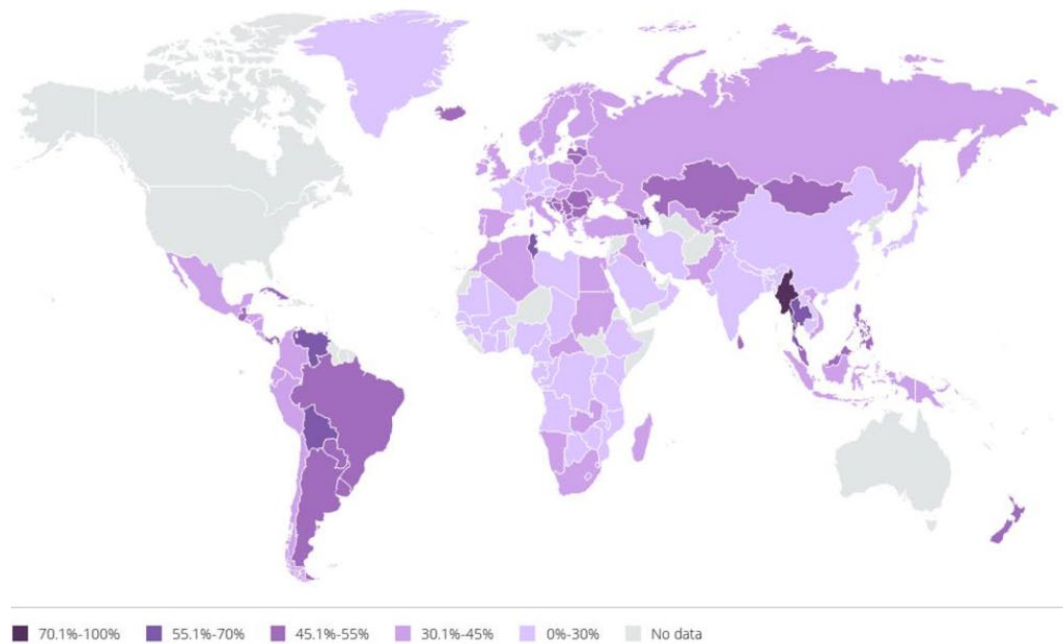
Figure 2-5 The gender gap in science.

Even the women who do work in science and technology fields might struggle to fit in. Based on a case study analysis, Wajcman (1998) analyses how women fare in a male-dominated environment and concludes:

> […] to achieve positions of power, women must accommodate themselves to the organization, not the other way around. Women managers therefore pay a high price for venturing into male-dominated territory. For most women the price is too high – requiring them to sacrifice major elements of their gender identity. No equivalent sacrifice has been expected of men (p. 160).

Even though Wajcman is talking about management and not technology, the latter is just as much a male-dominated territory as the former, as we have seen in the previous paragraph. Thus, these results might apply to women in technology, too. The present study examines the culture in Makerspaces through a gender lens in order to determine if similar dynamics exist (see Chapter 6). In fact, the data chapter reveals that some women in Makerspaces do adopt masculine characteristics to fit in. Wajcman's findings are problematic in the way that they neglect various forms of masculinity and the pressure for men to fit in as well, but this does not negate the pressures that exist for women. Wajcman's findings have motivated the present study by showing how a male-dominated culture can quickly turn into a masculine culture that excludes other genders. To study women's exclusion in Makerspaces,

Wajcman's focus on an organisations' culture has been adopted as it appears to be crucial in analysing gender exclusion.

A closer look at women's involvement in IT and the hacker scene does not paint a more promising picture. Steve Matthewman (2011), who examines technology and social theory, states that

> in the world of computing men accrue symbolic and material rewards. Women are heavily underrepresented in the IT industry (Bartol and Aspray, 2006; Zarrett et al., 2006), and they are concentrated in 'softer' service areas like administration, communication, customer relations and marketing. Men monopolize the technical hard core of programming (Whitehouse and Diamond, 2006) (p.134).

Faulkner (2001) partly correlates this gender imbalance with the nerd image that is associated with computing: "It seems that for a woman to opt to work so closely with technology is potentially to reject any meaningful engagement in the social world and so face 'gender inauthenticity'" (p.85). She continues later saying it is "commonplace to find at least some engineers and computer specialists who seek refuge from human relationships in technology" (p.89), thus strengthening the image of the computer-interested person escaping from the 'real' world. This, she states, does not align with feminine identity. Especially referring to hackers, she talks about a loss of control and power that they aim to negate through their activities (p.88f). Faulkner (2001, p.89) concludes that

> it is hardly surprising that women engineers tend to drop out or to lose out in career terms: they never really 'belong to the club' and it is hardly surprising that the entry of women is (still) greeted with hostility by many engineers: it challenges what it means to be a man (Murray, 1993) and, perhaps, it threatens to spoil their fun.

Leonie Maria Tanczer (2016), scholar of international security and emerging technologies, explores a similar realm when interviewing a gender-equal sample of 10 hacktivists. She comes across a variety of discourses in which male hacktivists either justify gender imbalances (p.1608f) or ignore them completely (p.1602f), and female hacktivists either resist those imbalances from within communities or feel separated from the community and struggle with their hacktivist identity (p.1604f). The present study, in fact, not only partly follows a similar approach to data collection, but equally comes across similar themes, as the analysis chapters show.

Digital cultures scholar Tim Jordan, who writes about *Hacking* (2008), agrees that there are "many women who can programme and some […] have played roles within hacking, but it remains the case that across all the different types of hacking that have been examined so far there is a strong male bias in membership" (p.125). Nevertheless, he calls for caution to not equate hacking with sexism and higher rates of misogynistic practices than in other male-dominated communities (p. 125f). Even though the present study does not do so, it has found discriminatory practices among the studied Makerspaces and finds itself aligning closer to Faulkner's and Tanczer's discussions around gender identity and computer technology.

However, with the onset of digital technologies the potential for using them to liberate non-male genders also gained momentum. Sadie Plant's *Cyberfeminism* and Donna Haraway's *Cyborg Manifesto* are both prime examples for ideas about how women could break out of their constricting shell. Plant praises the spread of the internet which "has been taken to epitomize the shape of this new distributed nonlinear world. With no limit to the number of names which can be used, one individual can become a population explosion on the Net: many sexes, many species" (1998, p.46). The internet cannot be controlled and is unpredictable; a medium where women should excel as they thrive in fluid systems and processes (Wajcman, 2004, p.64). The de-centralised organisation and power beyond man's control (Plant, 1998, p.49) destroys "his identity, digitalization is mapping his soul and, at the peak of his triumph, […] man confronts the system he built for his own protection and finds it is female and dangerous" (Plant, 2000, p.335). Despite these promising effects of the internet that it no doubt has, more recent top-down counterforces of attempting to control content and social media platforms need to be kept in mind and might challenge Plant's assumptions.

Haraway's *A Manifesto for Cyborgs* (2000), around the same time, describes how current technologies have turned us all into cyborgs – cybernetic organisms. "Late twentieth century machines have made thoroughly ambiguous the difference between natural and artificial, mind and body, self-developing and eternally designed, and many other distinctions that used to apply to organisms and machines" (p.52). She shows how we have broken down three binary oppositions: human – animal, animal-human (organism) – machine, and the physical – nonphysical. This she views as an opportunity. Especially communication technologies and biotechnologies are crucial tools that can enforce new social relations for women everywhere:

> Cyborg imagery can suggest a way out of the maze of dualisms in which we
> have explained our bodies and our tools to ourselves. This […] means both
> building and destroying machines, identities, categories, relationships, spaces,
> stories. Though both are bound in the spiral dance, I would rather be a cyborg
> than a goddess (2016, p.67f).

Despite these theories being two decades old and providing rather deterministic and transformative views of technology, both might be able to assist us later in fleshing out notions of women in a male-dominated technology scene such as the MM.

The development of feminism and technology within research has gone many ways and is now at a point where gender and technologies are understood to shape each other mutually. This social construction of both takes into account "that technology as such is neither inherently patriarchal nor unambiguously liberating" (Wajcman, 2010, p. 148). This understanding and the theories presented here assists us later in exploring and refining women's participation and engagement in the MM.

2.2.2   Political Dimensions

When considering the MM through a political lens, distinct perspectives and aspects become apparent. The discussion ranges from notions of anarchist Making practices to entrepreneurial and commercial practices. This section explores these notions and Makers' political identities. The first few paragraphs look at more general and economic ideas, whereas the second section closer considers at environmental aspects.

2.2.2.1 General

Before starting to look at those different notions, it is important to distinguish between political values inherent to the MM and those that are held by individual Makers. This is not to say that one cannot influence the other or be affected by it, but many authors generalise from personal values of individual Makers to values determining the whole movement. Davies, for example, concludes that Makers are driven by a neoliberal individual striving for self-actualization and, at the same time, by a need for communities. This might be true for the Makers she interviewed in the 12 Makerspaces in the US with predominantly male, highly educated and middle-class participants. But it might not be true for users of online communities, women, or Makers on other continents. Thus, she takes stock of only one part of the movement and arrives at a conclusion that, as she herself admits, is contradictory in itself, especially because she excludes diversity-oriented spaces from that final conclusion

(2017, p.171). More consideration is necessary when determining movement inherent and individual values.

Equally, it is necessary to point out that some Makers might not identify with any political motivations or actions within their Making practice, seeing it solely as a hobby and nothing political. Davies (2017) and others (Kuznetsov & Paulos, 2010) state that for some the movement is a hobby and nothing else: "Hacking and making are personal rather than political" (Davies, 2017, p.132). This dissertation, however, follows academic understandings of all of life being interwoven with politics and that everything we do has political aspects to it. As political scientist Andrew Heywood (2017, p.1), author of *Political Ideologies: An Introduction*, states: "All people are political thinkers. Whether they know it or not, people use political ideas and concepts whenever they express their opinions or speak their mind". Makers' choices in the way they interact with each other and how they approach their activities is, thus, also inherently political. Choosing to concentrate on Making as a hobby instead of, for example, as a climate activist activity is in itself a political decision. However, the popular understanding of politics, which mostly refers to party and state politics, prevents many people from realising just how political their everyday lives are. With that in mind, we shall now look at the literature discussing the dominant political notions of Making.

Two main trends can be observed: that of the opponent to current economic structures, and that of the entrepreneur who, also, partly disagrees with current modes of production, but is still very much embedded in neoliberal thinking. The first is supported by notions such as the (re-)learning of skills, empowerment of the individual and communities, and, as stated above, the notion of free online sharing. De-skilling in all circles of life, according to Carpenter (2011), has been taking place over the last decades, mainly motivated by a prevalent care for profit making: "Makers […] recognize that de-skilling is not simply the result of digitization, but an effect of the geo-political exploitation of technologies for profit over social or environmental sustainability" (p.51). This call for re-skilling can be found in the mainstream and academic Maker discourse (Dougherty, 2012; Sivek, 2011). The discussed skill-set includes repair and fixing skills (Sivek, 2011, p.195), creation and innovation skills (Dougherty, 2012, p.11), and traditional as well as modern skills (Gershenfeld, 2011, p.62). The way all of these are learned is mostly through online sharing and community support.

These authors argue that newly learned skills will be the basic tools with which to empower oneself and seek self-actualization. Empowerment is important in the MM and the emphasis on these values has to be understood in relation to the hegemonic power and determination of big businesses and companies. Human-computer interaction scholar Theresa Jean Tanenbaum and her colleagues (2013), for example, discuss the implications of Maker culture as a democratizing movement: "We contend that DIY practice is a form of nonviolent resistance: a collection of personal revolts against the hegemonic structures of mass production in the industrialized world" (p. 2609). Cyberpunk author Bruce Sterling (2011) notes a similar sentiment: "Making is a folk aspect of a great, unfolding struggle over humanity's means for information, production and distribution. This is a bigger struggle than the atelier of arts and crafts" (p. 70). An additional nuance comes from Maker Faire Africa's[4] *Maker Manifesto* (2012, Figure 2-6). Its ten tenets include "1. We will wait for no one", "6. We will hunt down new skills, unmask locally made materials, keep our work sustainable and be kind to the environments in which we make" and "10. We will remake Africa with our own hands." It speaks of the utmost empowerment through Making, not just for its Makers but for the whole continent. How this sits with more Western notions of empowerment within a Maker context, is further examined in the morphology in Chapter 5.

The move from passive consumer to active consumer represents a further aspect of political importance and has been raised by a few authors (Dougherty, 2013; Kohtala, 2015). Makers as producers might not initially strike one as being opposed to the dominant economic system. Indeed, the word producer seems tightly knit to capitalist economic processes. Some Makers, as covered further on (see section 5.2.6), do not wish to overthrow or challenge the current economic system, but they want to be part of it and produce their own products for profit-maximisation. However, there are also those who become producers of their own technologies and livelihoods exactly because they want to get away from a capitalist way of living. Again, a spectrum of nuances and tensions can be identified within just one aspect of the movement. These tensions are not scrutinised in detail in this dissertation, but they assist in devising a morphology which can, in turn, be employed to flesh out nuances further.

Through becoming producers, some Makers aim to challenge inbuilt obsolescence.

> Part of the power of hacking and making was the ability to fix or make your
> own tools and technologies, and thus not only to tweak them to suit your
> preferences but to escape the cycles of consumption and obsolescence that

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[4] Maker Faire Africa is not connected to Make Community, LLC's Maker Faire brand.

manufacturers have handed to us. Hacking and making, we were told, were about independence (Davies, 2017, p.169f).

The literature on Making finds Makers here whose activities criticise production processes on a deeper level. This includes the wastefulness of inbuilt obsolescence and the way many products are designed and made. According to Roedl et al. (2015, p.15:10) and their discourse analysis of 191 studies on Maker culture, Making is not just about creating something new but also about repairing, repurposing and reusing. Makers counter the wasting of resources and the exploitation of the environment. These criticisms of current widespread production processes go beyond small, re-affirming changes and challenge structures and manufacturing processes on a more general level. The wasting of resources and environmental aspects is examined separately in the next section.

Figure 2-6 Maker Manifesto by Maker Faire Africa.

The second trend of the entrepreneur, however, is just as noticeable. Mainstream literature in particular seems to support this view which might have to do with the fact that – as mentioned before – it is written by US-based Makers who are CEOs and founders of Making related businesses and in need of selling their vision and products. An activist stance against neoliberalism seems counter-intuitive to their purposes. Anderson (2012) is observant of the two different trends himself. On the one hand, he sees the "Commercial Web model, defined by low barriers to entry, rapid innovation, and intense entrepreneurship" (p.225); on the other hand, he acknowledges the idea of a MM which is "more about self-sufficiency […] than it is about building businesses. […] The idea [is] not to create big companies, but rather to *free ourselves from big companies"* (p.225f) [italics in original]. Even though he acknowledges this motivation, he puts his money on the first model (p.226). A report by the Deloitte Center for the Edge (Hagel et al., 2013), similarly, announces huge impacts even if only a few Makers pursue market opportunities (p.8). About one fourth of the report focuses on how already existing businesses can take advantage of the opportunities the MM presents (p.2, pp.13-17). Profit-making by and through Makers appears to be a main consideration. Davies, as mentioned previously, also reaches the conclusion that neoliberal values have much more bearing among participants than counter-cultural activist ones (2017, p.162).

Depending on which text is read and which approach is taken, the movement can be seen as having many different values and purposes. As mentioned before, individual values are mixed up with inherent ones. In terms of individual motivations and beliefs, it does not seem to be a question of either or, but more one of where on the continuum the Maker, group of Makers, or Makerspace sees itself; a view which goes hand in hand with the difficulty of defining exactly what the movement is about. All these tensions and contradictions show the clear need for a conceptualisation of the movement that allows for a variety of overlapping understandings and constellations. That is why the present study is a unique and important contribution to existing literature.

2.2.2.2 Environment

Within political dimensions, in the present research special consideration is given to environmental sustainability. The movement has regularly been praised as offering a chance for sustainable technology production (Fairware, 2016; Lockton, 2013). What does academic literature say? In what follows research supporting positive environmental effects of the MM is introduced, followed by studies that state more neutral or even negative

environmental effects. Furthermore, gender within environmental sustainability discussions is introduced.

Many of the studies examining sustainability within the movement stem from the European Commission funded Horizon2020 project MAKE IT and are, thus, based on the (almost) exact same data sets. Almost all of the five studies (Unterfrauner et al., 2019; Millard et al., 2018; Unterfrauner et al, 2017a; Unterfrauner et al, 2017b) interview the four Makers (manager + three Makers picked by manager, one female, one commercial, one socially ambitious) from the same ten Maker initiatives across Europe. The only study that diverts slightly by including an initiative from the UK is that by Unterfrauner and Voigt (2017). They do not list the specific initiatives, but one can assume that the second German initiative (listed in the other studies) was exchanged for a UK-based one. Equally, their study does not seem to interview the managers of these initiatives but only the three regular Makers. Even though we cannot say for sure that those Makers and initiatives are the same, considering that the study is also part of the MAKE-IT project, methodologies align with the others and the authors were both part of a few of the other studies, it seems likely. Thus, we have five studies all claiming positive environmental effects through Making and the MM, but actually they are based on the same data and should be considered to have less impact than five independent studies would grant.

Nevertheless, their data and findings are valuable and shall be considered here. All three studies from 2017 (Unterfrauner et al., 2017a; Unterfrauner & Voigt, 2017; Unterfrauner et al., 2017b) conclude that there is great potential for positive environmental sustainability action through Makers, however it remains on the micro-level and has room for expansion.

> Even though the environmental impact of makers' processes or their recycling and upcycling approach might remain on a micro-level due to a rather small community, there is a great potential when it comes to products and materials which are developed within this community having great potential to reach impact on meta and macro-level (Unterfrauner et al., 2017b, p.128).

Additionally, in later studies technology and knowledge researcher Elisabeth Unterfrauner and some of her colleagues (2019) examine the idea that some Makers are concerned with care for the environment whereas others are not, and that the latter "seem to represent the minority in the maker community as most interviewees showed a high interest in environmental issues" (p.12). Problematic in their assessment is their description of a singular Maker community to which this finding applies instead of differentiating between multiple constellations of Making, as the study at hand shows through developing a

morphology. For Unterfrauner et al. areas of sustainable action are, for example, repairing, recycling and upcycling, environmentally friendly materials and products, environmentally friendly production processes and impact of local production (2017b, p.123f). Unterfrauner et al. (2019, p.12) continue to define two crucial factors which lead to higher environmental awareness in a community: "(a) whether or not there are other makers with similar environmental interests in the local maker space and (b) whether or not the manager or facilitator of the space is keen on promoting environmental awareness". The community a Maker is part of seems to be decisive in that Maker's environmental concern and, thus, the impact their Maker practice will have on the natural surroundings.

Millard et al. (2018) largely agree with this assessment (which is not surprising considering that all authors were part of the previously mentioned studies), but add a more critical component, namely that "there remains a significant gap between 'making', […] and social and sustainable innovation […]. Making is often still dominated by the latest gadgets, technical prowess and playful experimentation which are of strategic importance for innovation" (p.27). In the course of their study, they analyse various aspects of Makerspaces, including social sustainability (e.g. education/research, quality of life, social inclusion) and economic sustainability (e.g. innovation for economy, work and employment). The very first thing they point out when considering environmental sustainability is that "compared with both social and economic sustainability achievements, environmental sustainability achievements are overall somewhat less impressive, […] indicating both the overall lack of ambition in this regard as well as perhaps the difficulty for makers in undertaking environmental evaluations" (p.19f). Among the most high-ranking environmental successes they find are sustainable consumption and circular economy. Lowest are scores for decreased greenhouse gas emissions, decreased pollution and bio-diversity (p.20). The authors also offer a gender component which is picked up further towards the end of this chapter. For now, we continue to look at other studies which seem to be more critical on the subject of environmental sustainability within Making.

Two main aspects seem to dominate: (a) interest within the movement to be environmentally sustainable is rather low and (b) the impacts of Making on the environment are potentially worse than often portrayed. In terms of interest in these issues, three studies can be cited. The first is a technical report of the Joint Research Centre of the European Union by Paulo Rosa et al. (2017), this time outwith the *MAKE-IT* initiative. The authors examined and scrutinized 826 Makerspaces across the 28 EU countries to achieve an overview of the importance of certain topics to Makers. They employed a desk-based approach during which

they used text-mining techniques for information gathered from the spaces' websites and social media pages. Among other aspects, they establish thematic interests of Makerspaces. Out of the 826 spaces, a total of 18 appear to be interested in environmental aspects (2.18%) (see Figure 2-7). Topics such as digital fabrication, programming or entrepreneurship all rank higher. Despite being among the top 10 interests, the environment does not appear to play a big role according to this data. Nascimento and Pólvora (2018) second this finding. When exploring exhibitors' projects at the Maker Faire Rome they remark on a variety of projects concerned with sustainability. However, they also point out that it clearly is not a dominant strand in the projects they encountered (p.15f). The methodology of these studies, however, is problematic as they do not speak to a single Maker and define the movement by online presentations and observations rather than by data collected through exploring Makers' actual motivations, values and goals.

Charter and Keiller (2014), in contrast, distributed an online survey to 45 hackerspaces in 18 countries, inquiring about motivations, activities and future ambitions. The 95 responses they received covered more than 20 different motivations as important to participants. Two of those relate directly to environmental sustainability, namely "To help reduce society's impact on the environment" and "To encourage others to live more sustainably" (p.10). Both rank among the least chosen options with just a few more than 20% of participants (strongly) agreeing to the claim. Science and technology scholars Cindy Kohtala and Hyysalo Sampsa (2015) take it one step further and actually talk to Makers directly. They have set up a workshop for 13 Finnish Makers with whom they discuss "the future of makerspaces for the year 2020" (p.5). They asked participants what trends and issues they foresaw for 2020, and for potential solutions. They did not prompt specifically for environmental trends to receive reliable data. "The majority of the expressed issues did not have a clear environmental implication. Environmental sustainability thus does not appear to be an overarching aspect of all or even the majority of issues the makers consider relevant in future makerspaces" (p.20). The authors observed three participants who were very outspoken about environmental issues; the remaining group did raise environmental issues as well, but not as strongly as the first three. Again, environmental issues do not seem to occupy a considerable amount of importance for many Makers. Nevertheless, for some they might be crucial, thus emphasising different constellations and a need for a morphology that accounts for a variety of forms.

EU28 Makerspaces' Top 10 Thematic Interests (Rose et al., 2017, p.25)
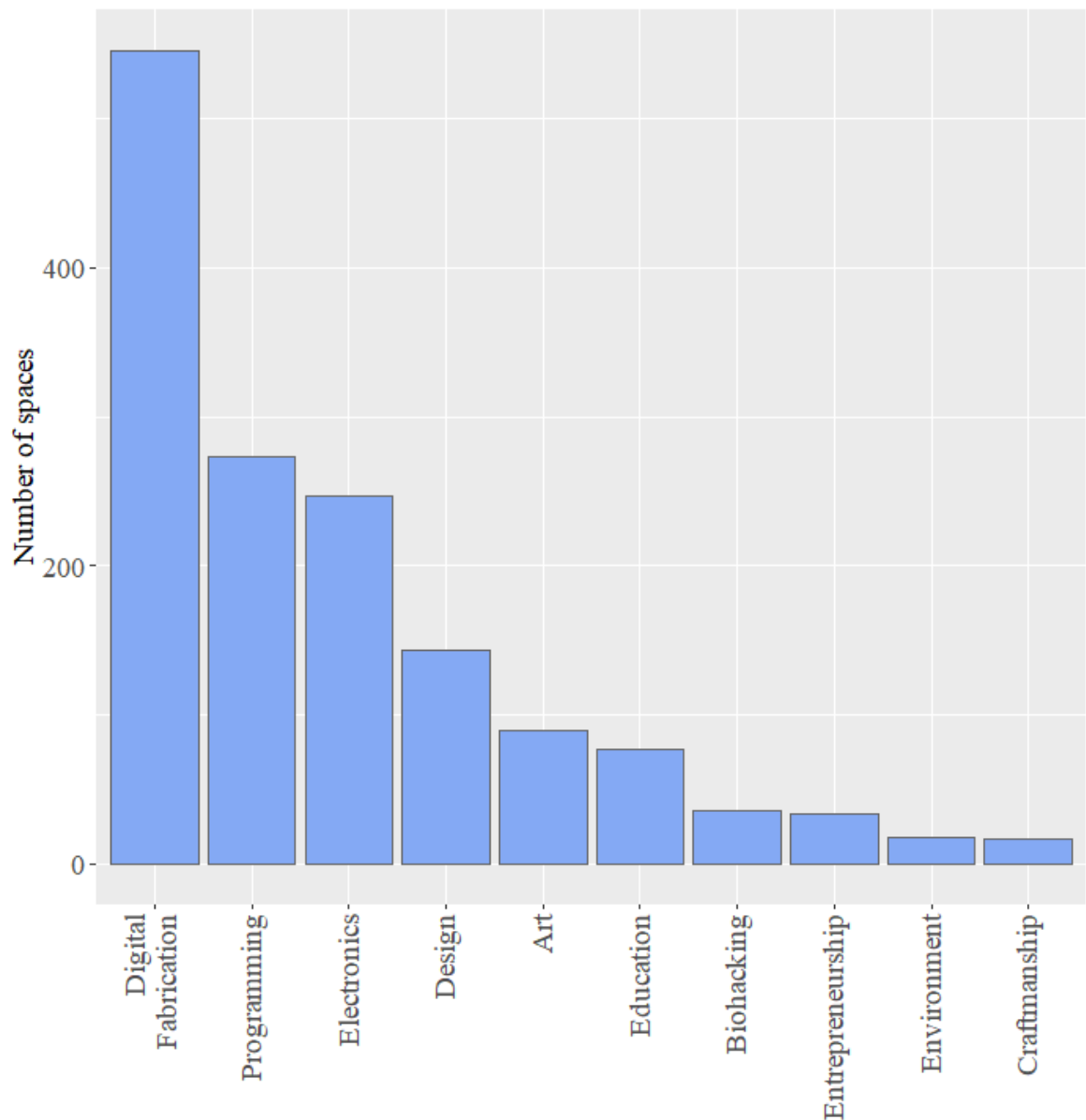
Figure 2-7 EU28 Makerspaces' Top Thematic Interest.

The second aspect that supports a view of the movement as not very sustainable is that of the impacts of Making on the environment potentially being worse than often portrayed. Kohtala has addressed sustainability in research on distributed production and summarised her findings in an integrated literature review (2015). She describes distributed production as

> a shift in consumption and production patterns away from conventional mass production, […]. The boundary between consumers' and producers' roles blurs […]. Distributed production thus includes a range of current and emerging practices where private citizens have increased capacity to affect what is produced, from product personalization to personal fabrication (2015, p.654).

Kohtala remarks that not a lot of research has been done, and of the papers written most are conceptual and not empirically proven. She questions some of the sustainability themes she comes across, e.g. that customised products might be harder to recycle and only add to the mass production material flow rather than replace it (p. 30). Equally, "Research in rapid prototyping confirms that a fabbed[5] artefact may have relatively high environmental impacts per unit, but at this personal scale overall volumes remain very low" (p.661). Researcher of open source technology Catarina Mota (2011) worries about similar issues, for example: "precisely the fact that products can be made at the push of a button may lead us to regard them as disposable and easily replaceable, thus decreasing the product's life cycle and greatly increasing the amount of waste" (p.285). An online article that examines whether digital fabrication technology is sustainable, mirrors these sentiments more pessimistically:

> This consumer-driven digital maker revolution is just as unsustainable as the digital fabrication revolution in large factories. We've been able to produce everything locally for decades using hand-controlled machine tools. Digital tools only allow us to produce more and faster. And this happens […] at the expense of higher energy consumption. [Equally,] if consumers can use fast manufacturing machines, total material production will likely increase […]. When billions of people are just a click away from getting factories to work for them, whether in the cloud or on their desktops, this does not bode well for sustainability. We'll create even more stuff, and each product will cost much more energy than if produced with conventional methods (Decker, 2014).

Clearly, many aspects of the movement and Maker practices could have positive but equally negative impacts on the environment. Roedl et al. (2015) have considered academic literature on the ability of Makers to act environmentally friendly and are critical of the fact that the majority of papers celebrate Maker culture as "an individual and apolitical form of empowerment" (p.22) which obscures challenges Makers face. These included legal, aesthetic and socio-economic constraints and are often neglected. Thus, the conversation is directed in "a way that is counterproductive to the goal of subverting obsolescence, […] understood not merely as bad for the environment but also as antithetical to purported values of makers […]" (p.22). The authors emphasise the role of the research community in supporting Makers and their environmental goals, which are not easily reached. Determining definitive answers as to whether the MM is, overall, environmentally friendly or not appears almost impossible and cannot be assessed here. But what can be achieved is speaking to

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[5] *Fabbed* here refers to personal fabrication.

everyday Makers scrutinizing their practices and exploring their environmental motivations. What is clear is that there is likely to be room for improvement.

As mentioned previously, we shall briefly revisit Millard et al.'s (2018) research on whether the MM is contributing to sustainability. The authors throughout their analysis come to acknowledge a gender component within concerns for environmental sustainability:

> Overall, females have a higher focus on social and educational issues, on openness and sharing, skills and quality of life, whilst males focus more on technology, industry/economy innovation and changing regulations, norms, etc. […] In the environmental sustainability impact context, females are also more successful than males in relation to sustainable consumption and the circular economy. However, females are marginally less successful than males in terms of decreased pollution, the latter perhaps being a more technically specialist issue (p.23).

There is a lot to unpack here, but the connection between environmental concern and gender is given particular consideration within this study. Unfortunately, apart from Millard et al.'s study, no other research project has looked at the connection within the MM context.

As a result, more general studies about gender and environmental concern are necessary. Research from the past decades has found "that women express slightly greater concern than men" (Xiao & McCright, 2017, p. 169). Less agreement exists as to why that is, however it appears that some reasons are emerging. Environmental sociologists Chenyang Xiao and Aaron McCright analyse data from a US-wide telephone survey from six different years and found support for the hypothesis that women are more concerned with safety and risk than men and that this risk is linked to environmental concern: "We found weak but somewhat consistent support for the safety concerns hypothesis. While there is virtually no gender difference in worry about global environmental problems, women are indeed slightly more worried […] about health-related environmental problems" (p.182). A hypothesis they negate is that of men's and women's social roles being important. The authors have found that neither employment status nor parenthood influence environmental concern (p.182) which confirms a claim already made in 1997 by Paul Mohai, namely that gender differences in environmental concern are most likely due to "the differing socialization experiences of men and women […], rather than the roles they occupy or other structural factors" (p.167).

Social psychologists Taciano Milfont and Chris Sibley (2016), who analysed a New Zealand-wide survey from one year along similar lines, connect the different socialization experiences of both genders to different levels of empathy and social-dominance orientation

(SDO) which both influence environmental concern. They explain that women are socialised to be more empathetic and, thus, care more for their natural surroundings, e.g. animals and the biosphere (p.87). Equally, men are socialised to a higher degree to "desire and support group-based hierarchy and the domination of 'inferior' groups by 'superior' groups" (Sidanius & Pratto, 2001, p. 48). SDO is, according to research, intrinsically linked to empathy (Milfont & Sibley, 2016, p.85) and predicts a lower concern for environmental issues than empathy. They write:

> Part of the reason why women endorse more environmental values is because women tend to have higher levels of empathy and lower levels of social dominance orientation, whereas men value the environment less partly because they tend to have lower empathy and higher social dominance orientation (p.86f).

Again, not social roles, but socialisation and gender roles determine concern for the environment. A study by social psychologist Lynette Zelezny and her colleagues (2000) examines three studies to explore gender differences and environmentalism as well and also reaches the conclusion that socialisation is most likely to explain women's higher concern.

Two further studies shall be briefly considered before moving on. Both are from 2002 and from a similar authoring team. Both teams pin heightened environmental concern by women to increased socialisation in altruism socialisation and life experiences (Dietz et al., 2002, p.361; Kalof et al., 2002, p.124). However, they also include racial issues in their discussion. In more detail, they claim that minorities in general are more altruistic than white people, especially white men: "The same theoretical arguments that posit women as more altruistic than men suggest that minorities may also face socialization and life experiences that encourage altruism" (p.362). Sociologist Linda Kalof and her colleagues (2002) explored this further by comparing environmental concern of six distinct groups as exhibited in a US-wide survey: Black women and men, Hispanic women and men, and White women and men. They found that "values and beliefs of White men were substantially different than those of the other 5 subgroups […] White men endorsed fewer pro-environmental beliefs and placed significantly less importance on altruism, openness to change, traditionalism, and self-interest" (p.124). The authors conclude that they suspect the key variable associated with environmental concern to be membership in the most advantaged social group in society. This group does not feel constrained by survival concerns and, thus, not as much threatened by environmental pressures (p.124). Unfortunately, race has not been part of this studies' focuses. However, the idea behind their observation resurfaces later in Chapter 7.

The literature review has shown that the MM struggles with a variety of issues, such as gender inclusiveness and environmental sustainability. Tackling either of those issues in itself, let alone both, appears to be a rather enormous endeavour. Makerspaces, especially grassroots ones, are often run by volunteers and do not have a vast amount of resources at their disposal. This study, then, asks whether the two issues are potentially connected and whether tackling one of them might help tackle the other by extension. Specifically, it asks:

> Does increased female participation in Makerspaces in the United Kingdom, Germany and Austria contribute to an improvement of positive environmental impacts of Making practices in those spaces, or vice versa, might an increased focus on positive environmental impact by those spaces encourage more women to join into their communities?

Whereas none of the literature argues against or for this, yet, this dissertation considers the question in order that it might develop practical implications for Makerspaces in what they can do to tackle gender-inclusiveness issues and processes detrimental to the environment together. Establishing a connecting link between both would suggest that by tackling one of the two would support improving the other.

The following objectives are accomplished in order to reach a conclusion: firstly, devise main features and a morphology of the movement. As we have seen, prior studies have revealed no clear idea or consensus as to how the MM can be conceptualised in an inclusive yet flexible way. It is important to know different aspects, potential groupings and defining features. This objective is undertaken with the help of Freeden's theory of the morphology of ideologies. In order to assess inclusiveness and environmental sustainability in Makerspaces in the UK, Germany and Austria a specific morphological constellation for those spaces is necessary. Only then can the research question be addressed in its context. Secondly, on the basis of this specific constellation, the dissertation assesses how women are included in Makerspaces in the UK, Germany and Austria, and what potential issues are. Even though women and their exclusion have been addressed within literature, very little research has engaged with women in regular Makerspaces and explored their experiences. Equally, no study has been found that considers male Makers' perspective on gender inclusiveness. To establish a link between gender inclusiveness and environmental sustainability the study, thirdly, identifies environmental behaviours and motivations within the movement, and compares gender-related differences. The aim then has been to explore the connection between amateur technology Making, gender inclusiveness and

environmental sustainability, specifically in German, British and Austrian Makerspaces. This is hoped to assist Makers and their communities in not only improving in one of the challenging areas but in both simultaneously.

Chapter 3   Research Design

"Your questions are social science social democratic shit. […]

What's the point of the gender question?"

(B301, gender unknown, country unknown, 101)

Now that the main literature surrounding the MM has been assessed and gaps have been identified, the present chapter expands on the scope and objectives of this study 3.1), and develops a research design to achieve these objectives, and thus answers the overall research question. The following sections introduce the research strategy (3.2), methodology (3.3) and a short section on reflexivity (3.4). Throughout, references to ethical issues and potential faults within the design are made. Figure 3-3 provides a visual overview of the final research design, which, on the one side, starts data collection with a quantitative survey (self-administered questionnaire) and leads its qualitative inquiry on from that through semi-structured in-depth interviews and, on the other, employs short interviews to triangulate findings.

3.1   Scope and Objectives

This section provides more detail on the scope (3.1.1) and objectives (3.1.2). The focus is on self-identifying female Makers in Maker- and hackerspaces in the United Kingdom, Germany and Austria. The following paragraphs briefly deal with each of those foci and justify why they have been chosen for this project.

3.1.1   Scope

This study aims to explore the MM from a non-male perspective. Self-identifying female Makers are, therefore, at the heart of research. Gender itself is a socially constructed concept, including specific behaviour, activities and attitudes allocated to each end of the spectrum (men/women) and, thus, not necessarily connected to the sex of a person. Consequently, research participants are those who self-identify as women, not those who society deems female according to their assigned gender at birth.

The focus of Germany, Austria and the United Kingdom has been chosen for academic as well as practical reasons. Many studies and inquiries centre around Makers and Makerspaces in the USA. More studies from other countries and cultures are necessary to provide a broader, more comprehensive picture. A few studies already look at other countries, such as China (Lindtner, 2015) and South-Africa (Kraemer-Mbula & Armstrong, 2017) but the bulk of research is still focused on the US. Therefore, this study explores the English- and German-speaking Maker cultures in the three mentioned European countries.

They have been chosen due to their rich traditions of amateur Making and their similarly industrialised nature. The United Kingdom has a strong political DIY history that was prominent in the 1990s and manifested itself through direct action (The Trapese Collective, 2007, p.xii). Germany and Austria both provide deep-rooted traditions in hacking and subversive DIY activities. The German Chaos Computer Club, founded in the early 1980s in West Berlin, in particular is not only still a large hacking grassroots-organisation but also seen as *the* inspiration for the first hacker- and Makerspaces in the US (Davies, 2017, p. 31). The industrialised nature of all three countries provides a similar background to studying their Maker cultures and, potentially, extracting specific differences in those DIY practices. The focus on different countries instead of only one has been chosen to compare potentially different developments and features.

The focus on Maker- and hackerspaces has been chosen due to their centrality for the MM. As elaborated in the literature review, they are key as this is where many Makers meet locally on a day-to-day basis. We have already seen that the two terms Makerspace and hackerspace are difficult to distinguish and often used interchangeably. This research project, similarly, approaches the two terms in the same way, while appreciating that differences might arise while research is conducted. For the purpose of data collection, the wiki.hackerspaces.org list was employed. It lists self-identifying Maker- and hackerspaces worldwide, defining them as "community-operated physical places, where people can meet and work on their projects" (Wiki.hackerspaces.org, 2020a). At the start of data collection in May 2018 the following numbers were obtained: Germany – 205 spaces, United Kingdom – 96 spaces, Austria – 18 spaces. It is difficult to provide a reliable overview of how many spaces there are in each category as listed in the literature review (2.2.1). Consulting NESTA's UK Makerspace data set (Stokes et al., 2015) which lists legal structures of a space (Table 3-1) shows that grassroots bottom-up spaces are in the majority. As we can see later, this balance is mirrored in the data collected through this study.

Grassroots bottom-up	46
Educational	2
Government	1
Commercial	21

Table 3-1 UK Makerspaces categorized by type,
according to NESTA data set.

3.1.2 Objectives

The first objective of the study is to devise a morphology of the movement. Such a morphology has, to the knowledge of the researcher, not been established. Often studies have claimed to define the movement when, in reality, they have defined one part of it (i.e. MM in the USA). When studying the MM, it is important to know its different aspects, potential groupings and defining features. This objective has been undertaken with the help of Freeden's theory of the morphology of ideologies (see section 3.2.2). Specifically, after a general morphology is developed, a specific constellation for Makerspaces in Germany, the UK and Austria is presented to support subsequent analysis. The literature review has shown that findings of other studies are often attributed to the whole movement without consideration of the findings' specific contexts. The present study avoids this by embedding its explorations into a specific Makerspace constellation of the developed morphology.

The second objective of the study is to assess how women are included in those Makerspaces, and what potential challenges are. As previously mentioned, studies have stated that women are not very well included (Bean & Rosner, 2014; Lewis, 2015; Rosner & Fox, 2016; SSL Nagbot, 2016). But it appears as though only Lewis (2015) has spoken to female Makers who see themselves as part of a regular Maker community. The present study follows this approach and adds an equal amount of interviews with male Makers in order to explore potentially different views on inclusiveness and environmental sustainability issues.

The third objective goes into more depth regarding environmental aspects. The study identifies environmental behaviours and motivations within the movement, and compares gender-related differences. Environmental motivations are crucial to this study. Whereas the environment has been mentioned in other studies as a factor in the movement, no prior study has specifically looked at environmental attitudes, behaviours and motivations, and explored

gender-related differences. In achieving this objective, a link between gender and environmental practices can be established and, thus, the research question can be answered.

3.2 Research Strategy

This section incorporates the basic set up of the research project, including its underlying ontological view (3.2.1), an explanation of how the morphology for the movement has been devised (3.2.2) and how a mixed methods design shaped data collection (3.2.3).

3.2.1 Social Constructivism

Social Constructivism as an ontological position builds the foundation of this study. It starkly contrasts fixed, universalistic understandings of reality and discourages the establishing of universal truth. Instead, it understands reality as a fluidly perceived idea that can reach some kind of stability if agreed upon by many. The approach allows for a variety of conceptions of reality, including structures and power relationships. This study considers that concepts are understood as socially constructed as this is the ontological and epistemological basis of Freeden's morphological analysis of ideology (Freeden 1996, 47-136), which is then applied to the study of gender and technology. This idea was first broadly explored by Peter Berger and Thomas Luckmann in 1967. The basic idea of their book *The Social Construction of Reality* was this: people construct their own realities which shapes the way we live and, thus, people themselves. In their own words:

> Man is biologically predestined to construct and to inhabit a world with others. This world becomes for him the dominant and definite reality. Its limits are set by nature, but, once constructed, this world acts back upon nature. In the dialectic between nature and socially constructed world the human organism itself is transformed. In this same dialectic man produces reality and thereby produces himself (1967, p.204).

By showing how identity is constructed and how people together set up rules and institutions through their understandings of reality, they explain how everyone's reality is continuously negotiated and shaped. The above quotation is an example: when writing the book, in their reality and that of their society it was acceptable to use the masculine gender form in order to refer to all people. Nowadays, these rules have changed in academia and their writing would present itself differently if written today.

When Berger and Peter's book was first published, it set off a wave of interpretations and applications. To some academics, their theory was highly applicable (Simpson 1967; Maquet

1968); to some it represented political indifference (Light 1967; Simpson 1967) as the authors, for example, engage little in "careful explication of conflict and change" in the shaping of identity and institutions (Light, 1967, p.56). In many fields, *The Social Construction of Reality* was employed and scrutinised throughout the following decades which led to an "impressive diffusion of social construction" (Knoblauch & Wilke, 2016, p.61). Multiple strands emerged, for example constructivism, social constructivism or social constructionism whereby constructionist approaches have been applied "to more socially centred usage, as in anthropology, sociology, and some branches of psychology" (Gubrium & Holstein, 2008, p.8) and constructivism "has considerable currency in science, mathematics and, technology studies" (Gubrium & Holstein, 2008, p.8). Samra-Fredericks distinguishes the two as follows:

> within *social constructivism* […] the concern is 'with how individuals mentally construct their worlds with categories,' and hence it 'privileges individual, subjective knowing' (Fletcher, 2006, pp. 426, 431). […] In contrast, *social constructionist* efforts […] centralize the 'interplay between agency and structure linking individual constructions of sense-making and enactment to the societal level through processes of structuration' (Fletcher, 2006, pp. 426–427) (2008, p.131).

As shown by Samra-Fredericks, separating factors emerged around views on what exactly is constructed and how, e.g. institutions, language, or social roles. This led to some, for example philosopher of science Ian Hacking (1999, p.1f), criticising social construction as too wide and arbitrary as it includes everything from authorship, emotions, population statistics and technical systems. The topics listed here are merely an excerpt of a much longer list of alphabetically ordered topics he found as related to social construction. However, just because something applies to many aspects of life, does not make it unusable or invalid. Rather, it has the potential to help analyse the way humans live together and construct their reality more thoroughly. Returning to Berger's and Luckman's book then, sociologists Hubert Knoblauch and René Wilke (2016) define it as "a common denominator in that it allows one to relate these various approaches theoretically" (p.66) but not a standard which explains all forms of social construction. In practice, the social construction of reality mainly refers to social realities (Sismondo, 1993, p.518). There is also an "objective reality, or that which cannot be wished away" (Sismondo, 1993, p.518), for example a tree or a mountain. How these are perceived, can be socially constructed, but their actual existence cannot. Despite this, the social construction of reality has proven contentious within the field of sociology of scientific knowledge.

Nevertheless, Berger's and Peter's book remains relevant and highly suitable for the project at hand because the latter considers social dynamics within the *co-production* of technology and user groups, an attention crucial in social construction: "the *social construction* […] is […] constructed by processes which are specifically social, such as social actions, social interactions, and institutions" (Knoblauch & Wilke, 2016, 64). This understanding of people's reality is crucial for the topic at hand as the latter examines people's/Makers' behaviour and social interactions, how those shape and are shaped by understandings of gender, technology production/impacts, their tools and own creations and how those, in turn, shape understandings of reality. Some researchers who have already started looking at the Maker movement through a socially constructed lens are Lindtner (2015) and Ames et al. (2018) both of whom emphasise the different issues and factors that shape Maker cultures in various countries. Especially the objective of the present study to establish a MM morphology appears to fit in well with social construction approaches. As the next section will show, Freeden emphasises the different constellations of his morphological concept which varies across different social groups and cultures as the essential concepts and practices of being a Maker are differently configured by different social groups and cultures. He explicitly states that ideologies and their morphological structure are constructed and not universal truths: "Ideological morphology is neither fixed nor permanent apart from the decontesting nature of the core-adjacency-periphery nexus itself" (Freeden, 1998, p.95). Two of the fields who have heavily adopted a social construction approach are, in fact, science & technology studies and gender studies (Knoblauch & Wilke, 2016, 57). Thus, this approach is more applicable in this regard as well. Despite both social constructionism and social constructivism potentially being suitable for this project, priority is given to social constructivism. Firstly, the latter is important in discussions around science and technology studies in general, as the following paragraph will highlight. Secondly, when recalling Samra-Fredericks' differentiation in previous paragraphs, social constructivism appears more applicable, as the research project considers specifically how individuals construct their Maker practice, and gender and environmental impacts within it. Even though a morphology is established which could be argued to represent a broader structure and thus suit social constructionism approaches better, this structure is not institutionalised or based on official structures by Makers. Individual viewpoints are more central and, hence, social constructivism appears more suitable.

Social constructivism has had a major impact on science and technology studies. In 1984, Trevor Pinch and Wiebe Bijker devised an understanding of the social construction of technology (SCOT). Their main point: a technological artefact is "an alternation of variation

and selection" (1984, p.411). Many social groups are involved in the design, production and interpretation of a technological artefact. It will continuously be re-interpreted and, thus, reshaped. Therefore, "[…] the 'successful' stages in the development [of an artefact] are not the only possible ones" (Pinch & Bijker, 1984, p.411). When analysing an artefact, both authors call for a detailed understanding and description of the social groups involved (unfortunately, they do not mention those groups that are excluded) and how these groups perceive and make use of the artefact. Even though artefacts are constructed and viewed differently from different groups, there will be an overall development of a technology from idea to stabilization. The latter refers to a state in which a social group has developed and interpreted the artefact to a point that it is not much contested anymore. It has become stable. This can be equated with a socially constructed truth that is agreed upon by many.

However, the degree of stabilization might vary between different social groups (Pinch & Bijker, 1984, p. 416). Kline and Pinch, in 1999, explain that this "'interpretative flexibility' distinguishes SCOT from other social constructivist approaches in the history of technology" (p. 114). Technology is not only embedded differently in different social groups, it also informs and shapes these social groups differently; a two-way shaping of each other. Sheila Jasanoff terms it co-production of technology with which she means: "the proposition that the ways in which we know and represent the world (both nature and society) are inseparable from the ways in which we choose to live in it" (Jasanoff, 2004, p.2). As per technology definition employed in this project, the MM can be seen as a socio-technical system that has taken a variety of forms and, thus, provides a good example: the overall movement has spread across the globe and whereas in some cultures high-end technology and innovation might have priority, in others political motivations or traditional technologies might be much more valued. Just as Kline and Pinch state, there is interpretative flexibility present which the development of a general morphology and specific constellations will highlight.

Gender studies, indeed, have also been strongly intertwined with and fuelled by social constructivist views of society. Women's studies scholars Kathy Davis, Mary Evans and Judith Lorber (2006) explain how gender and feminism are constructed in two senses: firstly, they note "the division of people into two differentiated groups, 'men' and 'women,' and the organization of the major aspects of society along those binaries. The binary divisions override individual differences […]" (p.2). Secondly, they explain how these constructed differences together with other socially constructed differences (e.g. race) "interact to produce a complex hierarchical system of dominance and subordination" (p.2). Thus, not

only gender itself is constructed but also the political and hierarchical dynamics between the categories:

> Gender is a system of power in that it privileges some men and disadvantages most women. Gender is constructed and maintained by both the dominants and the oppressed because both ascribe to its values in personality and identity formation and in appropriate masculine and feminine behaviour (Davies et al., 2006, p.2).

Only through seeing gender roles and their power relationships to each other as socially constructed can these categories be challenged and altered. Hence, social constructivism is highly appropriate to describing how gender, its interplay with technology and the arising problems of inclusiveness are viewed within the MM.

Before moving on, a brief overview shall be given in regard to the methods used and their fit of social constructivist worldviews. According to Creswell and Clark, a constructivist worldview aims at understanding multiple participant meanings, the social and historical construction of the studied phenomenon and theory generation (2018, p.36). All of these criteria are fulfilled by this project. The authors continue to name qualitative research methods as the ones more likely and more suited to a constructivist mixed methods study (p.42). However, as we will see, the study at hand employs quantitative (online survey) as well as qualitative methods (interviews). Interviews that aim to explore understandings are inductive, online surveys are deductive. Adopting a social constructivist worldview clearly asks for an inductive methods approach during which the social realities that are formed within and outside the MM are explored. Including quantitative methods, such as a survey, does not have to be detrimental or contradictory, however. Firstly, the focus of the study is the qualitative data (see 3.2.3 Mixed Methods Design). Exploring understandings and interpretations of Making has priority, not testing an overall theory of the MM. Secondly, the survey is used as a tool for exploration, not hypothesis testing. It explores a wide variety of aspects and includes diverse answer possibilities with multiple instances of open-ended questions for individualised answers.

3.2.2   Devising a Morphology

In order to define the MM, an approach that can encompass different understandings and beliefs about Making while simultaneously allowing for an overall MM umbrella is needed. We need a morphology of the movement. Morphology, commonly used within biology and

linguistics, generally refers to "The study of the forms of things" (Lexico, 2020a). In the present case, an understanding is formed which includes different concepts and aspects that relate to each other and mutually define the movement as a social configuration. This approach is based on Freeden's conceptual approach of ideologies. In his seminal work *Ideologies and Political Theory: A Conceptual Approach,* Freeden (1998) meticulously develops an understanding of political ideologies that simultaneously provides a flexible conception of large ideological families while not neglecting their internal variability and different manifestations. His conception is gaining increased currency as a method for identifying and examining ideologies and has been widely applied by himself and others (Freeden & Stears, 2013; Franks et al., 2018). This section provides an overview of his theory to lay the groundwork for developing such a morphology for Making.

In its essence, Freeden's work describes how individual political concepts shape and contest each other and, thus, mutually generate meanings. These meanings, in certain constellations, form an ideology. Before starting to show how ideologies are composed, he emphasises that, just like individual concepts, ideologies and their morphologies are "underwritten by culture and history" (1998, p.77). For example, being a conservative in the United Kingdom might differ significantly from being a conservative in the USA. Both can be included under the umbrella of conservativism, but their morphological constellations look differently to some extent. Following on from this point, Freeden states his central understanding of ideologies: "they are characterized by a morphology that displays core, adjacent, and peripheral concepts" (p.77).

Core concepts are similar to the ineliminable features of single political concepts. Without these core concepts, an ideology might be altered considerably. For example, conservativism without a core of traditionalism would struggle to still call itself conservative. The core of an ideology is a cluster of concepts whereas the same family of ideologies might present variants of core clusters within its respective sub-ideologies (p.84). These core concepts are further defined by concepts that are adjacent to them. In the case of tradition within conservativism, these might evolve around historical understandings, religion and self-identity (Heywood, 2017, p.65f). According to Freeden, adjacent concepts are fundamental:

> The existence of concepts adjacent to the ideological core is essential to the formation of an ideology. The notions of logical and cultural adjacency […] are equally vital to the articulation of an entire ideology (1998, p.77f).

The adjacent concepts that flesh out and shape the core concepts are closely linked to ideas of cultural and logical adjacency. Freeden here describes an interconnected web of single individual concepts and their ineliminable features which through logical and cultural adjacencies shape the core and adjacent concepts which, in turn, react back on the individual concepts (p.78). This helps to understand why political concepts and ideologies are subject to constant change and never finished.

Lastly, peripheral concepts "add a vital gloss to its core concepts" (p.78), as Freeden states eloquently. They are not as defining as core and adjacent ones but can still have relevance in shaping and defining those. Additionally, the concepts may "gravitate from a more central to a marginal position, or vice versa" (p.78). Thus, even if not being important at a certain time in a certain location, concepts may change according to different cultures and through the years.

A point Freeden emphasises and that is, in fact, also important for us to keep in mind, is that ideological morphologies have no absolute boundaries (p.88f). The challenge and simultaneously beauty of these morphologies is their fluid yet stable state which, for example, can let them morph into hybrid forms with other ideologies, such as conservative liberalism. Fluidity is important in the context of the MM. As we have already seen in the literature review, terminologies surrounding the movement are various and concepts such as hacking or DIY are regularly used interchangeably when talking about Making. Freeden's fluid approach gives us the chance to understand these practices and their cultures as having different, overlapping morphological set-ups but, equally, a rather stable uniting core.

These are the basic tenants of Freeden's theory. His views of how society and ideology is constituted resonate well with our underlying theory of Social Constructivism. He regularly stresses that the internal formation of ideologies and their concepts is "shaped by what is referred to here as culture: temporally and spatially bounded social practices, institutional patterns, ethical systems, technologies, influential theories, discourses, and beliefs" (p.69f). The patterns of ideologies are not universal but socially constructed understandings of how humans should live together. Ideological practices and their justifications experience continuous internal as well as external change to which they adapt and adjust.

The underlying structure of an ideology is crucial in understanding its essence. The same point is made by this study about the MM: it cannot be understood if its underlying morphology is not understood. Therefore, in Chapter 5 the first analytical undertaking of this

dissertation is to apply Freeden's morphology to it in order to define the movement's core, adjacent and peripheral concepts. The chapter starts out by justifying why a theory of political ideologies can be applied to a cultural movement and continues to outline the most important concepts.

3.2.3   Mixed Methods Design

The aims and objectives of this study require literature studies as well as primary data collection. Literature is the starting point. Serving to provide a general overview, this material offers insights from which an initial morphology of the movement is devised. The categories and variables used for primary data collection are based on this overview. Equally, after having completed data collection, literature assisted in embedding the findings in the academic field. Primary research provided rich original data which expands already existing literature. This section briefly justifies why a mixed methods approach was deemed necessary for primary data collection in this study. Specifically, 3.2.3.1 provides a more detailed account of which mixed methods design is used, and 3.2.3.2 engages with appropriate sampling methods.

3.2.3.1 Convergent Multi-Level Mixed Methods Research Design

According to mixed methods specialist John Creswell (2014, p.4)

> Mixed methods research is an approach to inquiry involving collecting both quantitative and qualitative data, integrating the two forms of data, and using distinct designs that may involve philosophical assumptions and theoretical frameworks. The core assumption of this form of inquiry is that the combination of qualitative and quantitative approaches provides a more complete understanding of a research problem than either approach alone.

This research project draws general conclusions about various motivations and values within the movement, but also explores their underlying findings in-depth and ensures an analysis and interpretation closely linked to what Makers accept to be their truths. Therefore, an approach encompassing both qualitative as well as quantitative methods is employed. Additionally, employing both approaches provides a method for triangulating findings.

This research approach fits well with a social constructivist worldview. According to Creswell and Plano Clark (2018, p.36), a constructivist worldview aims at understanding multiple participant meanings, the social and historical construction of the studied phenomenon and theory generation. All of these criteria are fulfilled by this project. They

continue to name qualitative research methods as the ones more likely and more suited to a constructivist mixed methods study (p.42). The present study employs quantitative (online survey) as well as qualitative methods (interviews). Contrary to usual usage, the survey is used as a tool for exploration, not hypothesis testing. It compares a wide variety of aspects and includes diverse answer possibilities.

Within a mixed methods approach, several designs can be employed to achieve the desired outcome. This research project collected data on two levels and, therefore, used a convergent mixed methods approach (Creswell & Plano Clark, 2018, p.65). Level 1 is made up of an explanatory sequential design which starts with quantitative data collection (self-administered questionnaire) and moves on to qualitative methods (in-depth interviews) in order to explain the quantitative data (Creswell & Plano Clark, 2018, p.65ff). Creswell and Plano Clark (2018) have devised a notation system in which capital letters signify which data is emphasised and lower-case letters show which is not. Here, qualitative data (QUAL) is emphasised whereas quantitative data provides support and a framework to work in (quan). Level 2, characterised by a qualitative approach as well, is a mode of triangulation and ran simultaneously to level 1. It was, thus, constant help to inform level 1. It consisted of short interviews conducted at Maker Faires throughout the data collection period. Figure 3-1 gives a visual overview of the research design. Throughout this chapter, it is further defined, i.e. with sampling (Figure 3-2) and analysis (Figure 3-3).

This convergent multi-level mixed methods research design with its explanatory sequential component and an emphasis on qualitative data collection has been chosen for several reasons. The main goal of the study is to assess and understand female motivations for participating in the MM with a special focus on potential environmental attitudes. Qualitative, inductive inquiry is more appropriate for this purpose. Nevertheless, a quantitative, more representative overview of the topic at hand is desirable as well in order to understand developments and issues more fully. This quantitative data was not only helpful in underpinning the qualitative data, but also expanded it on a broader scale and facilitated its inquiry. At no time, however, was this quantitative data taken at face-value and as determining of all Makers. Rather, it opened up the more in-depth inquires of the qualitative inquiries. Last but not least, short interviews made up level 2 of data collection which was conducted simultaneously to level 1. This level is mostly employed as an additional supportive component that allows triangulation of findings.

Despite this approach being well-suited to the study's objectives, a range of limitations remain. Firstly, and probably most importantly, this study prioritises qualitative data which is absolutely crucial in fleshing out nuances and ideas. Nevertheless, it is not ideal in devising more general claims. The findings presented here apply only to a careful sample of a few Makers in Germany, the UK and Austria. Secondly, as with every overt study, participants' answers might have been influenced and positively skewed by knowing about the topics of research and by wanting to appear in a good light. Of course, these things are difficult to examine and decide, but nevertheless it is important to be aware of and mention them. Other limitations are raised throughout the study and summarised at the end.
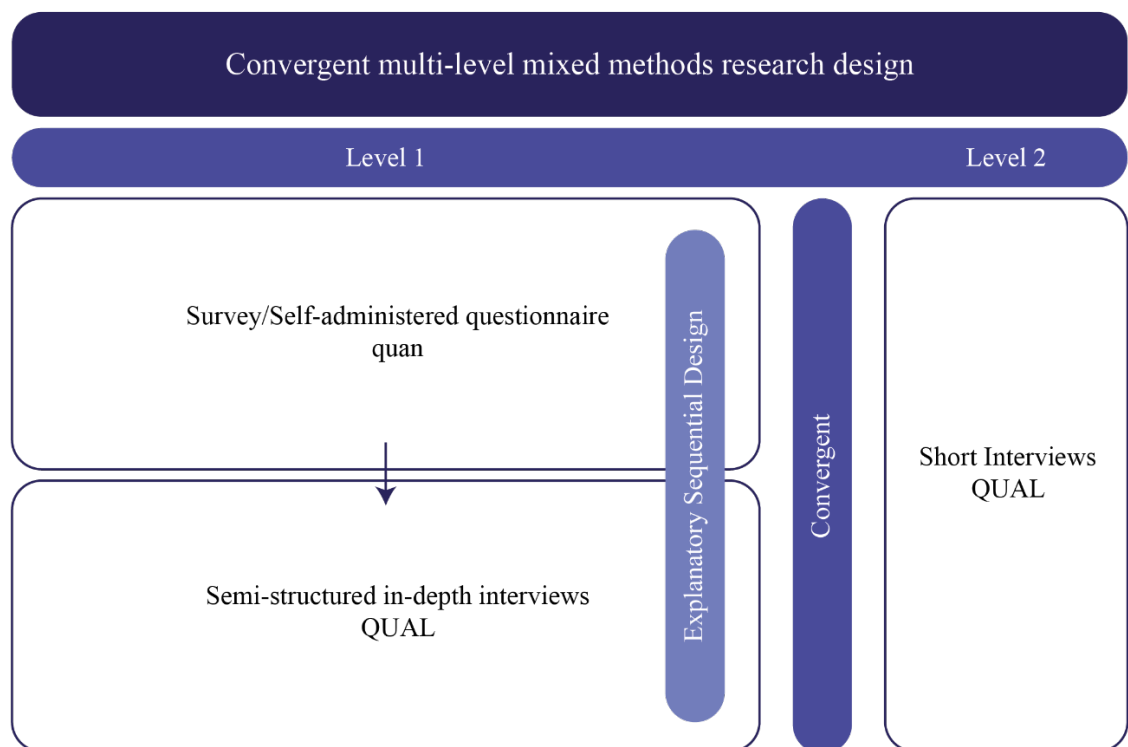
Figure 3-1 Mixed Methods Research Design.

Before moving on, two main criticisms of mixed methods approaches shall be addressed. Firstly, a major criticism evolves around supposedly combining two research paradigms (positivist and postpositivist) that are opposed to each other (Doyle, 2009, p.183). Even though some challenge such a dichotomy (Doyle, 2009, p.183), mixing paradigms can actually be effective where one methodology is in the service of another (Giddings & Grant, 2007, p.57). This is the case in the present study. The underlying paradigm is clearly postpositivist with an ontology that builds on Social Constructivism. One might argue that employing a survey contradicts this approach, however it is employed in the service of it, not in its contradiction. The survey is used in order to explore beliefs and Maker themes, not

to test a hypothesis. It, thus, complements the exploratory nature of the in-depth interviews instead of contradicting it.

The aim of the study is to, firstly, explore themes shared in Making in Germany, the UK and Austria and to discover similarities and differences of the weighing of these themes, for both of which qualitative methods are not necessarily suitable. However, these themes are not taken at face-value and as defining all Makers everywhere. Instead, they are treated as indicators for different constellations and emphases within a variety of Making practices and, thus, support a postpositivist socially constructed worldview. That this is the case can also be seen by the only sparse use of statistical analysis and emphasis on it throughout the project. The survey is, thus, employed in service of the more qualitative methods and used in order to explore the socially constructed worldviews of participant Makers. More generally, the overall criticism of dichotomous paradigms hinders broader research, a wide variety of data collection and the rich description of phenomena. Or as Giddings and Grant (2007, p.58) state: this "way of thinking about paradigm […] disagreement [is] neither cause for war nor requiring reconciliation but […] itself a virtue."

Nevertheless, and this is the second main cause for concern, mixed methods approaches are more likely to bring up inconsistencies between collected data and some researchers disagree with the way these inconsistencies are often handled. For example, Dawn Freshwater (2007, p.138) posits: "This sense of incompleteness is often what is missing in research texts and it *could* be that the incompleteness of mixed methods research texts is related to its overemphasis on completeness." In other words, she finds that mixed methods studies are often employed in order to reach a more complete picture and that in the course of that pursuit incompleteness or inconsistencies might be undervalued and potentially neglected. Firstly, the project at hand does not see striving for completeness as a problem, while, however, acknowledging that a fully complete picture is almost certainly impossible to gain of any social phenomenon. Secondly, the undermining of inconsistencies and overemphasis of completeness is not done in this study.

While of course the research tries to capture the studied phenomena as best as possible, it does not deny that there are inconsistencies in its data, as for example seen in Chapter 7 when quantitative data and qualitative data indicate different answers to the same question. Doyle et al. (2016, p.632), while recognising that inconsistencies need to be addressed, also point out that these inconsistencies "can uncover new theories and insights". This has happened in the present study where inconsistencies in the data (again, see Chapter 7) have

led to further inquiry into the collected data and reinterpretation with new insights. How this new data set was devised is explained in section 3.3.2.3 and its methodological justification in section 7.2. Just as Freshwater states herself (2007, p.143), contradictions are not seen as a problem in this study, but rather as an enriching factor that adds to the complexity of the studied phenomenon.

3.2.3.2   Sampling

Sampling methods within mixed methods research designs do not follow a generally accepted categorisation (Teddlie & Yu, 2007, p.88). Nevertheless, the widely accepted existing sampling methods within qualitative and quantitative methods are sufficient to devise appropriate approaches.

Level 1: Sequential Sampling

The explanatory sequential design employed sequential sampling. That is, the sample of the semi-structured in-depth interviews were based on the sample of survey participants. Survey participation was sampled through probability sampling, specifically cluster sampling. The self-administered online questionnaire was not sent to all Makers but specifically those Making and socialising in Maker- and hackerspaces which are registered on https://wiki.hackerspaces.org/. This is an online wiki which connects Makers and hackers worldwide and provides comprehensive data on where Makers are active. At the time of survey distribution in April 2018, the following spaces were recorded on the list:

	Active	Planned	Building	Closed	Unknown	Reformatting	Total
UK	60	9	10	10	7	0	96
Germany	151	25	12	9	3	5	205
Austria	15	1	1	1	0	0	18
Total	226	35	23	20	10	5	319

Table 3-2 Registered Maker- and hackerspaces on Wiki.hackerspaces.org in 2017.

This list is community run. Anyone can register a new space or update information on an existing one. It is therefore impossible to ensure that all the given details are correct. However, there is evidence that community members are active and regularly updating

spaces and the list itself. As of January 2020, 190 spaces have updated their profile within the last 12 months[6] (Wiki.hackerspaces.org, 2020b). By following the list, 299 spaces (out of 319 registered ones including 20 marked as closed) were contacted and asked to distribute the questionnaire to their members. As well as contacting spaces directly, Makers were also contacted through several email-lists provided by wiki.hackerspace.org, through a call for participation on Twitter/Facebook and a call for participation in the German-speaking *Make:* magazine and the British *HackSpace* magazine (screenshots in Appendix C). Even though the survey is mainly targeting Makers in Maker-/hackerspaces, participants who are not part of those spaces were not excluded. If the latter came across the call for participation online or in a magazine, they were free to participate.

The sample for the interviews was sequentially devised from the survey participants. At the end of the survey, participants were given the option to provide their contact details to potentially participate in interviews. The time of reflection between participating in the survey and, at a later stage, in an interview was hoped to be beneficial to the study as participants had the chance to reflect on issues raised in the survey. Originally, a purposive criterion sampling strategy was to be applied which would have chosen a variety of female and male Makers according to specific criteria (Bryman, 2016, p.409). However, considering that only 36 women participated out of which only 12 left contact details to be contacted for further research, all those female participants were contacted without limitations regarding certain criteria. Not all 10 female interview participants were reached that way. Only five of the 12 initially contacted women ended up volunteering to be interviewed. The other five women were found through calls for participation on Twitter and snowball sampling. These women were asked to complete the survey beforehand in order to attune them to the research topic and encourage reflection. After this change in sampling method, male Makers could also not be contacted based on certain criteria anymore. They were now chosen at random through a random number generator (https://www.random.org/) to ensure a sample as random as that of the women. In total, 30 male survey participants were contacted and 10 agreed to be interviewed. Unfortunately, no interviews were carried out with Austrian participants. No female Maker from Austria left her contact details to be interviewed, and

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[6] This marks a decline in numbers since the first drafting of this study (January 2018) when 299 spaces were recorded as having updated their profiles. What the updates were and the reasons for the decline cannot be assessed here. However, the future and development of Makerspaces and the MM appear to offer intriguing data for further studies.

the random number generator did not return a number allocated to an Austrian Maker. Therefore, all in-depth interviews are with British and German Makers.

Level 2: Short Interview Sampling

As pointed out before, level 1 and level 2 of data collection happened concurrently and, thus, their sampling took place independently of each other. Their sampling method was stratified random within a specific cluster of Makers. These interviews were conducted at Maker Faires within Germany, Austria and the United Kingdom which constituted the three clusters. Within those, the sampling technique that was employed was that of disproportionate stratified random sampling.

Stratified random sampling describes a procedure whereby participants are chosen by certain criteria, e.g. gender. The population is divided into strata and within those sampling occurs randomly. This was chosen to ensure a variety of Makers were interviewed. Firstly, the present study sought to ensure a balance in gender (women/men). Furthermore, it sampled a wide variety of projects and types of Making from electronics and coding to felting and baking. This ensured a broad coverage of activities and people involved in them. Thirdly, it aimed at always including all the Maker-/hackerspaces who exhibited at a Faire. Considering that the research focuses on those spaces, this was a good way of contacting some and getting detailed data on them. Fourthly, projects that seemed to have an environmental component were chosen more frequently in order to get insights on environmental practices. The researcher, nevertheless, ensured to not only approach those projects but also included Makers who exhibit projects which did not seem to be concerned with the environment. Finally, practical issues were decisive, e.g. how busy a stall was or how many people were staffing a stall. This way ensured that data collection did not distract people too much from their stalls and their visitors.
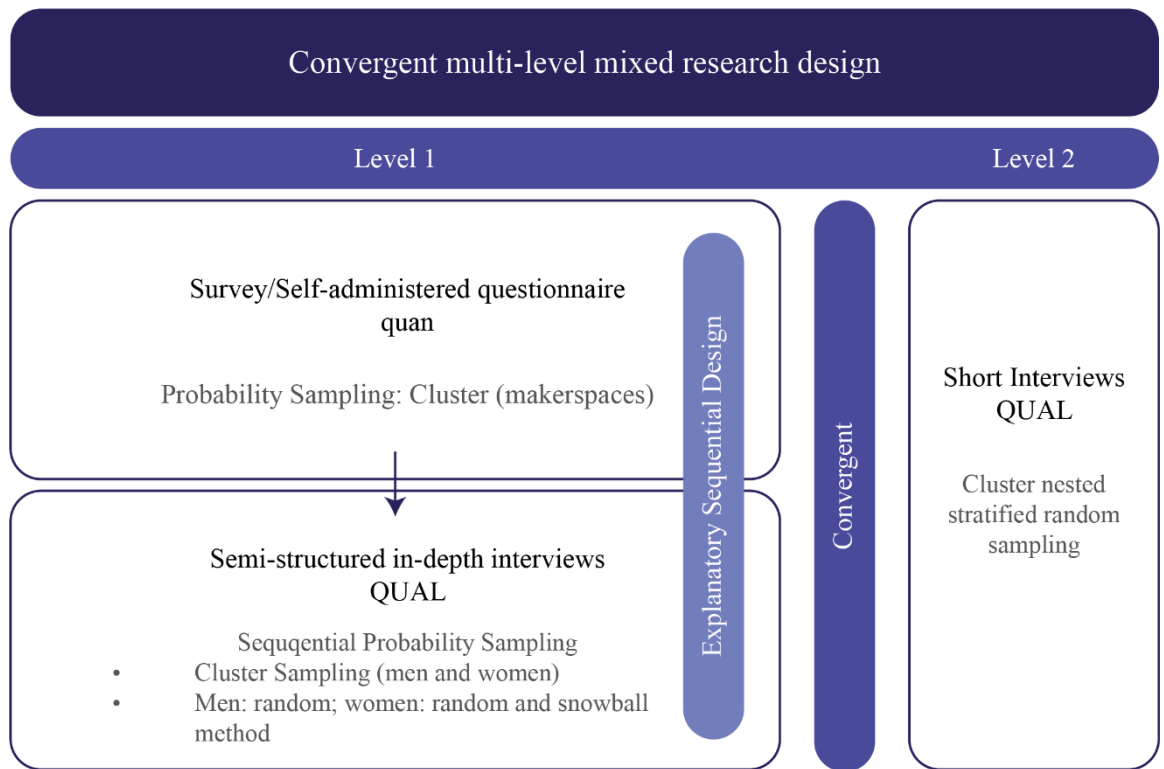
Figure 3-2 Mixed Methods Research Design including Sampling.

Makers of all directions and manifestations participate in these events. A broad variety were approached. Therefore, the stratified sampling here was not done proportionately. That is, the data reflects a broad variety of Makers and projects that does not necessarily align with the actual proportions of those criteria in the Maker population or at the Faires. For example, a huge variety of projects was captured even though a majority of stalls engaged with modern computer technology. This balance does not reflect in the sample. It is, thus, disproportionate stratified random sampling. It needs to be mentioned that the strata were not substantiated with data. For example, the researcher did not know ahead of time how many women and men would exhibit at the Faires. She decided on site whom she would speak to without having clear data on the balances in the different criteria. This is not common but deemed acceptable as the goal of these short interviews was to get a broad overview of Makers' motivations and capture a broad variety of projects. Figure 3-2 provides a visual overview of the research design including the sampling strategies.

3.3   Methods

This section explores primary data collection in depth, including advantages and disadvantages of the individual methods, their content and analysis approaches.

3.3.1   Primary Data Collection

This section presents a detailed overview of these methods, how they were employed, and what practical and ethical issues were encountered (see Appendix A for ethic approvals).

3.3.1.1 Survey

The survey was distributed in form of a self-administered online questionnaire. Its content surrounded four key themes: Making practice including motivations, environmental values and attitudes, inclusiveness, and political beliefs. Participants were also asked demographic questions which included their gender, age and place of residence. The full survey can be found in Appendix B. It was designed in a way that would not take more than 20min, excluding reading the invitation letter and confidentiality information. It ran for 10 weeks. During that time, it was intensively distributed around Maker-/hackerspaces. However, when having to find female participants through other channels as previously described, the survey was re-opened to receive their answers, attune them to the types of questions and encourage reflection before the interview. A note is necessary on the section on political beliefs and standpoints which aimed to get an overview of what political direction Makers identify with. This data was supposed to help analyse movement inherent political implications and connections with environmental beliefs and values. However, it soon transpired that many participants did not feel comfortable with the general nature of these statements and how their political beliefs were relevant in the survey. Many did not answer this section and it was, thus, left out of the analysis.

As with every research method, there are limitations and potential ethical issues. Firstly, a survey is likely to give rather broad data which can potentially be interpreted in different ways and participants do not have a chance to influence questions or covered topics at all. Unfortunately, this is a top-down approach which, in this instance, cannot be avoided without significantly lowering participating numbers. Misinterpretation of data is countered with the interviews within the second step of data collection which allowed participants to go deeper into issues and raise their own topics and concerns.

Secondly, the survey itself, its questions and the way and order they are asked, can heavily influence participants' answers. It was designed to be as un-biased as possible through including open-ended questions, however, equally, being aware that a fully un-biased survey design is not possible and unconscious steering of participants through choice of words is almost inevitable. Thirdly, due to the survey mainly being conducted online, it could

exacerbate inequalities relating to people who do not own a computer or have access to internet. However, the very basic equipment of Maker- and hackerspaces includes computers and internet access. The spaces are often organised and communicate by email and other means of online communication. It can then safely be assumed that the target group of the study has access to the necessary requirements of participation.

3.3.1.2 Semi-Structured In-Depth Interviews

Semi-structured in-depth interviews were the main method for qualitative data collection and, thus, for exploring Maker motivations and beliefs, especially in regard to environmental practices and inclusiveness. These interviews were sequential to the self-administered questionnaire and, therefore, only started once the questionnaire was finished. Through their inductive nature, the interviews provided room for exploration and in-depth understanding of the survey results. The content of the interviews aligned closely to that of the survey: motivations, environmental values and attitudes, and inclusiveness. Participants were asked to further reflect on those questions, state whether they have gained new insight since taking the survey and consider alternative answers, and what these could mean for the movement.

In total, 20 Makers were interviewed in-depth: 10 female and 10 male. This lies at the lower end of the spectrum when consulting how many Makers other studies with similar approaches have interviewed. Whereas Shannon Grimme et al. (2014) have only interviewed 10 Makers in one Makerspace and Tanczer (2016) has interviewed a gender-equal sample of 10 hacktivists, most other studies have interviewed a minimum of 30 Makers, i.e. Davies and her research partner (2017), and Unterfrauner et al. (2017b). Unfortunately, it was not possible to interview more Makers for this study as female Makers were hard to recruit and the balance between men and women was important to uphold. Nevertheless, a total of 20 interviews is deemed acceptable within the spectrum of studies that have been conducted before. In conjunction with the survey data, some more general statements can be made about gender and the environment within Makerspaces in the United Kingdom, Austria and Germany.

The interviews themselves were considered low-risk and as not inflicting any harm on the interviewees. Data collection adhered to all ethical standards. Participants were fully informed about the study and how their data would be used. Regulations of confidentiality were always strictly adhered to. For one interview which was conducted face-to-face, a confidential and safe space within the university was found. All other 19 interviews were

conducted online through means chosen by the research participant. This approach ensured that they would be comfortable with the way data was collected. Online communication software Skype, Mumble and TeamSpeak were used most often. The researcher asked all participants for their permission to potentially contact them after the interview for follow-up questions.

3.3.1.3 Short Interviews

The short interviews utilized tools from both quantitative and qualitative approaches. Their semi-structured nature, not strictly defined questions and answers suit qualitative understandings. The main questions interviewees were asked were always the same, thus more aligning with a quantitative approach. Questions evolved around motivations, values and attitudes. Standard questions that all of the interviewees were asked are the following:

- What is it that you are Making?
- Why do you enjoy Making?
- Do you think the movement has effects on society, and if so, which ones?

Sometimes it was possible to also include aspects of environmental sustainability or inclusiveness. Leading on from these questions and the participants' answers, the following topics were explored in more detail:

- Environmental components in their creation
- Economic feasibility of being a Maker
- Values and motivations of the MM
- Potential for the movement in the future

Before the interview started, participants were provided with an information sheet and the chance to ask questions. Consent was then audio recorded. Despite trying to keep interviews confidential, it was almost impossible to find spaces during the Faires that provided quietness and were far away from other people for them not to overhear. Only in a few cases was this possible. Most Makers answered the questions while next to friends, other unknown Makers and members of the public. Even though the content of the interviews is not considered high risk, this is still problematic. It is, nevertheless, considered acceptable due

to participants being aware from the start that their environment would be noisy and busy and, thus, could have declined participation.

3.3.2   Data Analysis

The following paragraphs provide a brief overview of analysis methods that were used for quantitative data, qualitative data and how the two were combined. Additionally, conducting research in multiple cultures is addressed.

3.3.2.1   Quantitative Analysis

The majority of the collected survey data was analysed using the programme *R* for statistical analysis. This relates to all closed questions which provide the respondent with a set of pre-defined answers and, thus, can be measured and compared in a statistical manner. Mainly, this involved summary statistics in order to summarise certain variables and show their distribution, bivariate statistics for comparing two variables with each other and exploring potential correlations between them and hypothesis tests that are able to calculate dependencies more reliably.

3.3.2.2   Qualitative Analysis

Similar to the open-ended questions within the survey, all interviews were analysed through *Nvivo* using thematic analysis (TA). This analysis strategy has become more popular over the last two decades but is not uncontroversial. One of its main benefits is its flexibility which is also a point of criticism. TA is not grounded in any specific research paradigm or academic heritage. While this might be seen as a weakness, it is considered as an advantage for this research project. Victoria Clarke and Virginia Braun (2017) who are among those academics who have started looking at TA in more detail remark how this method "can be applied across a range of theoretical frameworks and indeed research paradigms" (p.297), is able to tackle "virtually any data type" (p.298) and "can be used for both inductive […] and deductive […] analyses […]" (p.289). These characteristics of TA seem ideal for a mixed methods approach which will work both deductively and inductively, with qualitative and quantitative data and under the framework of social constructivism.

On first inspection, TA works quite straightforwardly: small data units (codes) are developed to bigger data units until overarching themes are found. Problematic is the arbitrariness with which codes and themes can be devised. As Gery Ryan and Russell Bernard (2003), two

other academics joining the early discourse about TA, comment, often researchers do not describe or explain how they have discovered their themes (p.86), even though it has been shown that different approaches can yield very different results (p.103). It is, then, crucial to clearly state how codes and themes have been derived in order to guarantee reliability, validity and build trust not only with other researchers but also research participants who are most likely to value transparency in data analysis.

Within the research project, a theme is defined by the following qualifiers as listed by Bryman (2016):

> By and large, we can say that a theme is:
> - a category identified by the analyst through his/her data;
> - that relates to his/her research focus (and quite possibly the research questions);
> - that builds on codes identified in transcripts and/or field notes;
> - and that provides the researcher with the basis for a theoretical understanding of his or her data that can make a theoretical contribution to the literature relating to the research focus (p. 584).

This is indeed how themes have been found within the present study. Firstly, all transcript interviews were annotated. Secondly, the annotations were grouped into codes which provided a first overview over the content in a more structured way. Lastly, those codes were grouped into overarching themes. Due to the focus of this study, data was analysed according to three main categories: Maker practice, inclusiveness, and environmental sustainability. Within each, themes were devised as described.

All of these modes of analysis have been incorporated in the already displayed illustration which provides a visual overview of the research approach undertaken in this study. Figure 3-3 displays the fully developed research design, including sampling and analysis approaches.
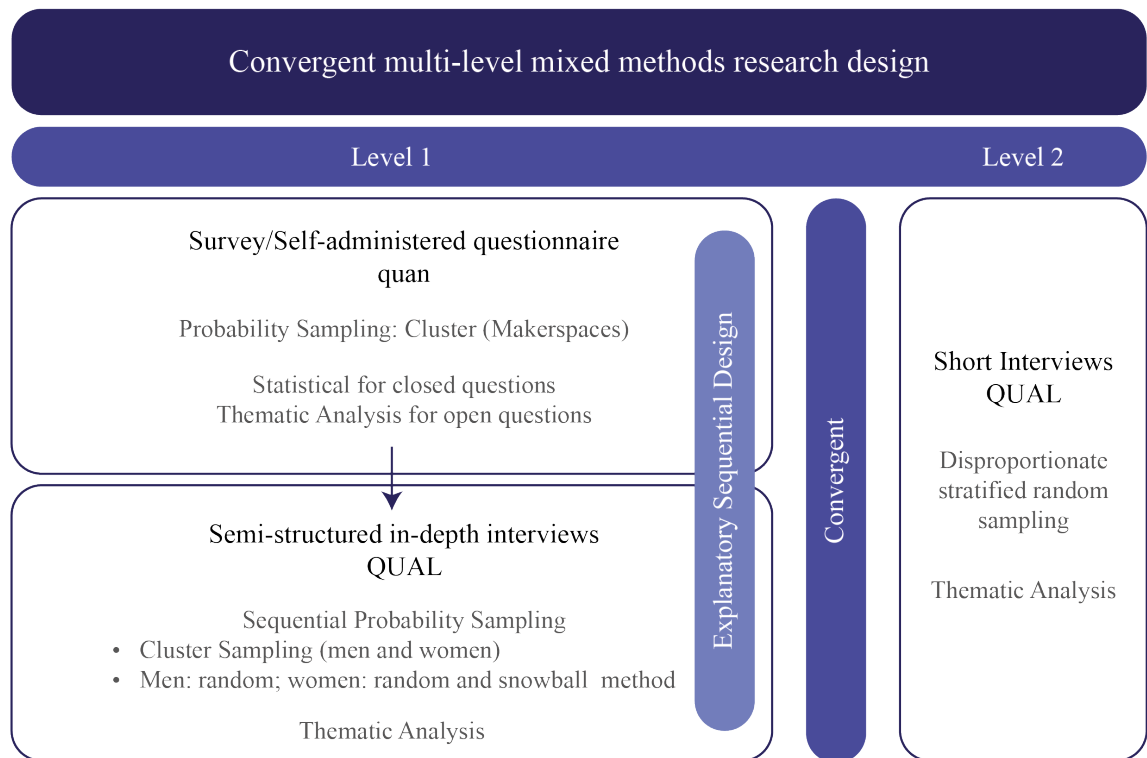
Figure 3-3 Mixed Methods Research Design including Sampling and Analysis.

3.3.2.3 Bringing the two together

Combining research findings of both quantitative and qualitative methods might at first seem counter-intuitive and challenging. However, results fit in with and supplement each other. Both analysis methods aimed to find correlations, causations and emerging themes which, in the end, provided a better overview of female Makers in the UK, Austria and Germany and their environmental motivation and explored those motivations and surrounding structures in more detail.

Different methods have been devised around analysis of mixed methods approaches. Among them are processes such as *data transformation* (qualitising quantitative data or quantising qualitative data), *data consolidation* (combining both data types to create new variables or data sets), *data comparison* (comparing data from different data sources) or *data integration* (integrating all data into a coherent whole, or separate quantitative and qualitative coherent wholes) (Robson, 2011, p. 493). For this study, data comparison and integration were most important. Considering that all three methods explored similar themes and questions, the resulting data lent itself to being compared with each other. To devise and reach conclusions, data was then also integrated and considered as a whole.

Data consolidation was important when devising environmental profiles of all in-depth participants in Chapter 7. Both qualitative and quantitative data were employed to create a total of ten categories, five qualitative and five quantitative. If a participant gave a pro-environmental answer in a category, they received one point. These points were added up and made up a final environmental score. Thus, a score of 10 signifies the highest possible number and, therefore, environmental attitudes and behaviour. Equally, a score of 0 would show a Maker practice that is not concerned with environmental aspects at all. There were no overt statements against the environment, hence no minus points have been given. The full chart can be found in Appendix D.

The quantitative categories were taken from participants' survey answers. Firstly, the questions whether someone considers themselves an environmental person and if they consider environmental aspects in their Maker practice were included. A positive answer received one point each, a negative answer or not answering did not receive a point. Critical voices might suggest that someone's general environmental attitude should not be important when considering their specific environmental Maker practices. However, the study is interested in an overall view of environmental attitudes and how those are reflected in someone's practice. Therefore, this category is included. The remaining three quantitative categories are made up by participants' answers to statements regarding environmental aspects in Making. In the survey, the environmental effects of a project in general, material usage and attitudes towards waste were each measured on a Likert scale by two statements, one positive, one negative. Participants had five answer options from 'Strongly Disagree' (=1) to 'Strongly Agree' (=5). The three categories now each included a value between one and five with everything above 3 (neutral) indicating a positive environmental attitude in the respective category. Therefore, every value above 3 added another point to a participant's overall score.

The qualitative categories were less easy to devise and score since all interviews were semi-structured and different topics were discussed with different interviewees. Nevertheless, some overall themes have been found: general environmental attitude, general environmental attitude in Making, priority of environmental concerns in Making, spreading of environmental awareness, and repair. The first two of these categories are identical to the first two survey categories in that they ask the same question, namely is someone, in general, an environmental person and do they consider the environment in their practice. Including these categories again in the qualitative section was important in order to give Makers a chance to expand on and verify their survey answers. Some participants, for example, did

not answer the question in the survey but exhibited pro-environmental attitudes in their interview. Equally, some interviewees gave positive environmental answers in their survey but not so in their interview. Thus, using both qualitative and quantitative data is important to balance out the picture.

Filling in all of the qualitative categories for each Maker was, as mentioned, not easy as some topics were not considered with each interviewee. Some categories' answers had to be educated guesses. For example, one participant spoke at length about the importance of repair within Making but never actually said whether they repair things themselves. Here, an educated guess was made for their repair practice and it is assumed that they do repair works. However, due to their uncertainty guesses only received 0.5 points if they were pro-environmental. In some cases, educated guesses were not possible as the provided data was too vague. In these cases, the category was left empty. Overall, the model is rather unpolished. However, it is enough to provide an overview of each participants' overall environmental attitudes and behaviours in their Making practice.

3.3.2.4   Cross-Cultural Research

A major consideration to be taken into account is that of the cross-cultural nature of this project. All primary data collection was undertaken in two different languages in three different countries. This has potential implications on how research is conducted and analysed. The languages to be used during this project are German and English since German is the researcher's native tongue. She is fluent in both languages, however, and can understand nuances and cultural implications contained within these. However, some aspects still need to be considered, such as translations and conceptions, dissemination of findings and equal conduct in both languages. All three methods described further up were conducted in both languages according to what the participant prefers. That means that translations need to be correct, not just linguistically but also functionally, culturally and metrically (Pena, 2007, p.1256).

Translation issues were easier to tackle in the survey and slightly more difficult to handle during the interviews which has mainly to do with the fact that they have to be dealt with in the moment without being able to consult dictionaries, other sources or native speakers. Whenever a translation issue occurred, the researcher and participant were always able to work out what was said. Equally, the short interviews continuously contributed to refining the way questions were asked in both languages, so that when the long interviews came

around, the researcher was attuned to potentially sensitive issues. She ensured that concepts and terms were thoroughly explored in interviews in order to ensure correct translation and analysis. In cases of doubt a second bilingual speaker was consulted. The only bigger issue around translation that occurred was in the survey and was, unfortunately, only noted after it was closed and in-depth interviews were conducted. The German translation used for 'empowerment' (*Stärkung*) was not ideal and confused quite a few German-speaking participants. The statistical data shows a stark discrepancy in numbers suggesting that British Makers seem to care for empowerment much more than German-speaking ones. After the interviews, however, it became clear that the German translation was poor and that the survey-generated numbers, thus, are not reliable. Participants spoke of the word *Selbstermächtigung* being more suitable.

In general, cross-cultural research requires cultural sensitivity for both researched countries/cultures. Cultural sensitivity is exhibited through "knowing key values and stakeholders, and exhibiting culturally appropriate communication and willingness to learn" (Eide & Allen, 2005, p.4). This includes extensive knowledge of a variety of cultural aspects, such as family, religion, history and politics (Liamputtong, 2008, p.4). Liamputtong, who has written extensively on cross-cultural research, asserts that only by immersion into a culture may a person gain in-depth and accurate understanding of that cultural group. The researcher of this study grew up in Germany and only expects subtle differences in comparison to Austrian culture. Both neighbouring countries are German speaking and share a rich and intertwined history. Even though the researcher has not lived in Austria for long periods of time, she does not expect this to be a problem. As for the UK, she was in her fourth year of living in the country when starting data collection and considered herself 'fluent' in understanding British culture at large. Where problems or questions arose, she consulted with supervisors and UK-nationals to ensure correct conduct.

3.4   Reflexivity

When employing a social constructivist framework, it needs to be acknowledged that researchers themselves construct their own biased reality just like everyone else and that this impacts their research. Thus, it is essential to reflect on one's own role and influence on a study to make it transparent, trustworthy and reliable.

As the researcher of this study, I consider myself a Maker, however others might not define me as such. I have been to one charity-organised Makerspace (irregular visits for about a year), participated in a local Maker and hacker group which mainly had participants present what they had made, set up a small university-based Makers group and have not engaged a lot in Making with digital technology. Rather, I enjoy Making with more traditionally employed technologies, such as sewing or cardboard prototyping. I have always enjoyed Making things myself instead of buying them. Nevertheless, I am fascinated by Makers who engage with more digital prototyping processes and aspire to use these increasingly as well. No matter what my involvement with the MM is, a critical account of the movement and its basic tenets was aimed for.

As discussed in the section on cross-cultural research, I grew up in Germany and have lived there for a total of 24 years. For another 7.5 years I have lived in the USA, mainland China, Hong Kong and Scotland. Whereas my primary socialisation took place completely in Germany, my secondary socialisation took place partly in Germany and partly in the aforementioned countries. Thus, through being well attuned and empathic to cultural differences, social circumstances and linguistic barriers, it was ensured that the research project was approached with cultural awareness.

Similarly, I am a woman and, thus, identify with the gender group I am studying further. This circumstance enabled me to better understand and grasp potential issues. However, being an insider can take away from more objective reflection and further probing of interviewees' versions of reality. As with other factors, I was aware of this challenge and ensured to question my own potential assumptions related to being a woman in a male-dominated movement like the MM.

Lastly, I have a substantial background in environmental social science and strong pro-environmental perceptions. One of the biggest challenges of this project was to not impose these values onto Makers and try to find pro-environmental meaning when there is potentially very little. Through detailed probing of potential environmental attitudes and motivations of research participants, and through making data analysis as transparent as possible, it was ensured this would not happen.

Chapter 4   Data

"What the hell do FabLabs/Maker have to do with gender and sexual
orientation??? Do you have no other problems?"
(B335, na, 30, Germany)

This chapter sets out to present general themes of all collected data. The first section provides a brief overview of participation statistics for each method. The remaining sections offer main findings grouped into the following themes: Maker practice, environment, and inclusiveness. For this purpose, data from all three methods shall be brought together and looked at collectively. Focus is on gender differences within the various aspects. National differences between the three countries were not found to be significant unless stated otherwise.

4.1 Participation Overview

Overall this study had 565 complete data contributions. At least 20 of those were made by the same participants because in-depth interviewees were recruited through their survey. Table 4-1 provides an overview of all participants. All participants have been assigned a code consisting of a letter and a number which is used to refer to them. The letter is derived from the employed method: short interviews – A, online survey – B, in-depth interviews – C. Numbers were added consecutively. In-depth interview participants, however, have been given pseudonyms to highlight the importance of this qualitative data and to ease flow of reading (see Table 4-4).

	Total	Women	Men	Non-binary	Other/ n.a.	UK	Germany	Austria	Other/ n.a.
Short Interviews	139	60	78	-	1	73	32	34	-
Survey	406	36	338	9	23	125	241	32	8
In-Depth Interviews	20	9	10	1	-	9	10	-	1
TOTAL	565	105	426	10	24	207	283	66	9

Table 4-1 Overall Participation.

4.1.1   Online Survey

In May 2018, the survey link was sent out to 131 German, 59 British and 12 Austrian Maker- and hackerspaces. Additionally, it was advertised by the British *HackSpace* magazine and the German *Make:* magazine. It is difficult to evaluate how many people were reached in total. In total, 406 complete answer sets were recorded within 10 weeks. As already seen in the opening quotation of Chapter 3, some participants were dissatisfied with gender being a focus:

> What the hell do FabLabs/Maker have to do with gender and sexual orientation??? Do you have no other problems? […] My dad likes to call your scene: 'filthy feminist-left-green'. (B335, na, 30, Germany)

> Picking to pieces by ideology driven by femnazis and SJWs [social justice warriors] which break up good communities to enslave them to their ideology. Cis-white male bashing will increase and lead to a separation in which the actual Makers set up their own cis-white male only spaces to continue their research and maker activities in peace without being hindered by the intolerance of these pseudo rebels. (B016, man, 100, Germany)

It is helpful that these few participants participated in the survey even though they do not agree with the topic. It can be assumed that most who have similar opinions have left the survey. Similarly, if someone does not consider themselves an environmentally concerned person, they might have closed the survey. Notably, resistance to gender issues was higher than to environmental questions. No survey participant voiced their dissatisfaction for the latter topic being a focus of the research project.

Table 4-1 provides an overview of participation per country and gender. Men make up an absolute majority of participants with 338 completed surveys. Women follow with 36 participants and non-binary people with 9 data sets. The remaining participants chose 'other' when noting their gender. Running a statistical summary on the cleaned-up age (Table 4-2) shows the first quarter of people falling below the age of 29 and the fourth quarter starting at the age of 47. The age most commonly given is 35 (mode). On average, participants of the survey are between 38 and 39 years of age. It is noteworthy that female Makers (median: 33.50 years) are 3.5 years younger on average than their male counterparts (median: 37 years).

Min	1st Qu.	Median	Mean	Mode	3rd Qu.	Max.	NA
16.00	29.00	36.00	38.71	35	47.00	100.00	6

Table 4-2 Survey: Summary of Age Distribution.

4.1.2   In-Depth Interviews

The main method of data collection was in-depth interviews, of which 20 have been conducted in total. Table 4-3 gives an overview of participants. The distribution of participants across genders and countries has been achieved fairly evenly. Unfortunately, no interviewees could be found for Austria. Additionally, one interviewee is a Maker in the USA. Despite not fitting the scope of the study, she had left her contact details to volunteer for further participation. Analysis focuses on the 19 interviews with Makers in Germany and the UK.

	UK	Germany	Austria	Other	Total
Women	4	4	/	1	9
Men	4	6	/	/	10
Non-Binary	1	/	/	/	1
TOTAL	9	10	/	1	20

Table 4-3 In-Depth Interviews: Participants.

In order to facilitate a better flow of reading and understanding of the in-depth interview findings, each of the participants has been given a pseudonym (see Table 4-4). German participants have been given common German names and British participants common British names. Due to gender being an important aspect in this study, the genders of the

names reflect the gender of the participants. The non-binary participant was given a name that can commonly been used for both, men and women. Important to note for the forthcoming analysis chapters is that Robin, despite being identified as non-binary, is often counted with the women. There are two reasons for this: when interviewing them, they remarked that some days they identify as woman, other days as non-binary. Also, they were raised as a woman.

	German	British
Women	Heidi Klara Lisa Anna	Nancy Jane Rose Megan
Men	Frank Hans Anton Karl Moritz Felix	Jack Ryan James Lewis
Non-Binary		Robin

Table 4-4 In-Depth Interviews: Pseudonyms according to Gender and Country.

4.1.3   Short Interviews

The first collected data was acquired through short interviews conducted at various Maker Faires in the UK, Germany and Austria. Table 4-5 provides an overview of participant distribution. Note that some participants did not provide their age or gave vague answers, e.g. "older than 18". They were excluded from the age mean. Despite attempts to interview an equal number of women and men, this proved difficult as an overwhelming amount of Maker Faire participants were men. Hence, no equal balance was achieved.

	No. Participants	Men	Age median	Women	Age median	n.a.	Age median
Mini Maker Faire Edinburgh 14+15/04/2018	32	13		19		/	/
Maker Faire UK Newcastle 27-29/04/2018	41	21	33	20	32	/	/
Maker Faire Austria Vienna 05+06/05/2018	34	23	35	11	33	/	/
Maker Faire Berlin 26+27/05/2018	32	21	33	10	32	1	n.a.
Total	139	78	35	60	32	1	-

Table 4-5 Short Interviews: Participants.

Most Makers who were approached agreed to participate in an interview. Only one person in Vienna did not wish to be interviewed. Additionally, two interviews from Edinburgh with a total of three participants were deemed unusable. The participants' knowledge of English was not sufficient to fully understand the questions and the nature of the interview.

4.2   Maker practice

Defining the MM is a difficult task and, some would argue, not possible due to the heterogenous understandings of different communities, countries and cultures. Certain themes and patterns can be picked up when exploring the data. As this is helpful later on to devise a morphology, these themes shall be presented here. Four main areas of focus have been identified: technology, intrinsic values, community, and politics. All four are complex and interlinked.

4.2.1   Technology

As defined in the literature review, this study understands technology as a very broad and comprehensive concept. However, this is not necessarily how Makers understand the term. The most common denominator seems to be the difference between newer and older technologies. Most participants seem to agree that new technologies, which they define as things such as 3D-printing, laser-cutting and electronics, were and still are the main driver of the MM. Short interview participant A091 (woman, Austria, 26) states: "The word Makers is new for something that people have always done. I think it developed because new technologies appeared which didn't exist before and which everyone can use. […] Because that's possible now, it's called Maker." A closer look at Makers' preferred activities supports this impression. In the survey, Makers were asked in an open-ended question to list their main areas of Making activities. Figure 4-1 shows the top 20 answers. The very top places are all occupied by these new technologies.

Some Makers, however, are not satisfied with such a limited focus on new technologies. In this study, most of them were women. Participant A066 does not want to be defined as Maker and reflects on the diversity of Making activities displayed at the UK Maker Faire:

> I'm very much afraid that if we don't include all sorts of techniques that will get lost as soon as old makers can't be here anymore. It's inspiring to watch them and learn. […] 'Maker' as we know it is trying to find its place right now, it's changing. I don't see a lot of community merging unless the community has already an interest in electronics and I find that quite limited.

Nancy in her in-depth interview agrees and says she's "a little bored of the whole maker movement. […] 3D printers and laser-cutters are not the be-all-and-end-all. […] makerspaces are a great way to get people into making but I find them very frustrating in how digital they are." Robin attributes this focus on digital Making to Western Making. They name Makerspaces in South Africa and Vietnam, which they have visited, and in which the focus was much more on traditional skills and/or Making and strengthening of community.

Consequently, some interviewees emphasise that anything that can be made by an amateur can and should be considered as Making activity. Heidi describes it as follows:

Survey: Top 20 Maker Activities

Which kind of Making activities do you usually engage in?
(e.g. coding, laser-cutting, woodwork, etc.)

[Freetext answer]
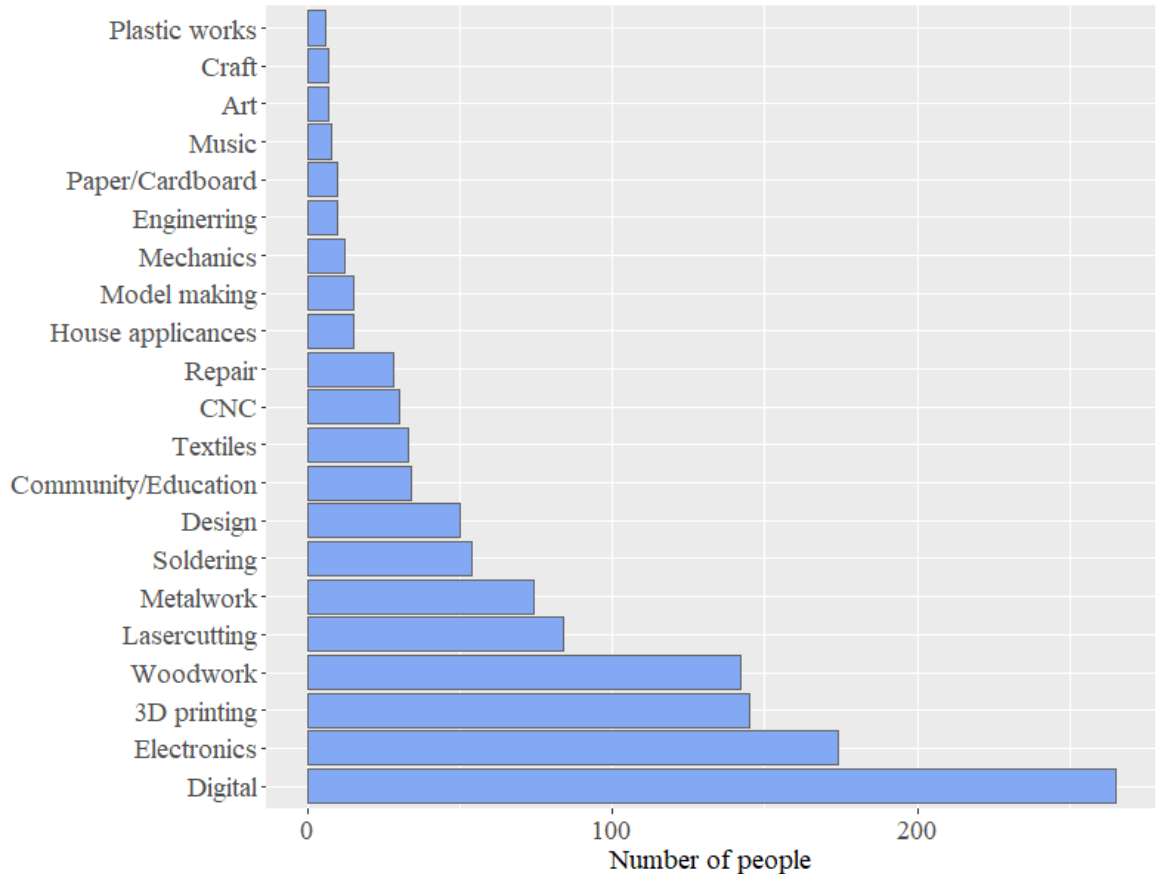
Figure 4-1 Survey: Top 20 Maker Activities.

> [Makers] are people who are mesmerized with a specific topic and who are keen to make things themselves…to optimise things and to really work hard on it. For example baking bread, that could be counted as making. […] It doesn't stop with the computer, it extends way beyond that.

Looking back at the Making activities mentioned in the survey (Figure 4-1), we can spot many non-electronic/digital Making activities which are, nevertheless, in the minority. There seems to be a tendency to include these 'a-typical' Making activities more and more into the movement. One short survey participant in Berlin has said they had attended the Faire for a few years and noticed that over the years more and more non-digital activities were included (A115, woman, GER, 36).

A further important aspect has more to do with the overall motivation for Making. The priority for many Makers is the understanding of technology and sharing of that knowledge. When the survey inquired if and why Making is important for us as a society, 160

participants stated accounts such as "Making leads people from merely consuming to understanding technology again" (B027, man, GER, 32), "We all need to know how things are made!" (B102, man, UK, 35) and "If you know how things are made and created, then you can change the world" (B252, man, GER, 42). This, in fact, appears to be one of the key aspects of the movement: tinkering with and understanding artefacts (see Figure 4-2). Study participants name a variety of positive effects and reasons for why this is important: challenge big corporations and their production processes, challenging inbuilt obsolescence, and environmental degradation.

4.2.2   Intrinsic values

The second main field crystallising in the data is that of benefits for the individual Maker. Main themes here are imagination/creativity, the joy of Making, personalisation, empowerment, and well-being. These are interlinked and inform each other.

When asked what motivates survey participants to engage in Making activities, almost 300 (75%) answer that they enjoy working creatively, making it one of the highest rating motivations. Many of the short interview participants agree and value Making because of how it makes you "use your imagination" (A001, woman, UK, 32), is a "creative outlet" (A019, woman, UK, 31) and how "It's not about building a robot or something like that, it's about being imaginative and tapping into your own ideas and not using pre-made kits" (A044, woman, UK, 47). A121, in fact, claims that if creativity is not used, "this can become destructive" (man, GER, 47). In-depth interviewees sometimes emphasise the importance creativity plays in their practice. Lisa, for example, talks about the environmental consequences of her Making activities and says: "Of course there will be waste, there'll be fumes or whatever. But it's not inherently bad because of that. It's an expression of creativity and creativity should never be underestimated, no matter what it is."

Survey: Motivations to Make

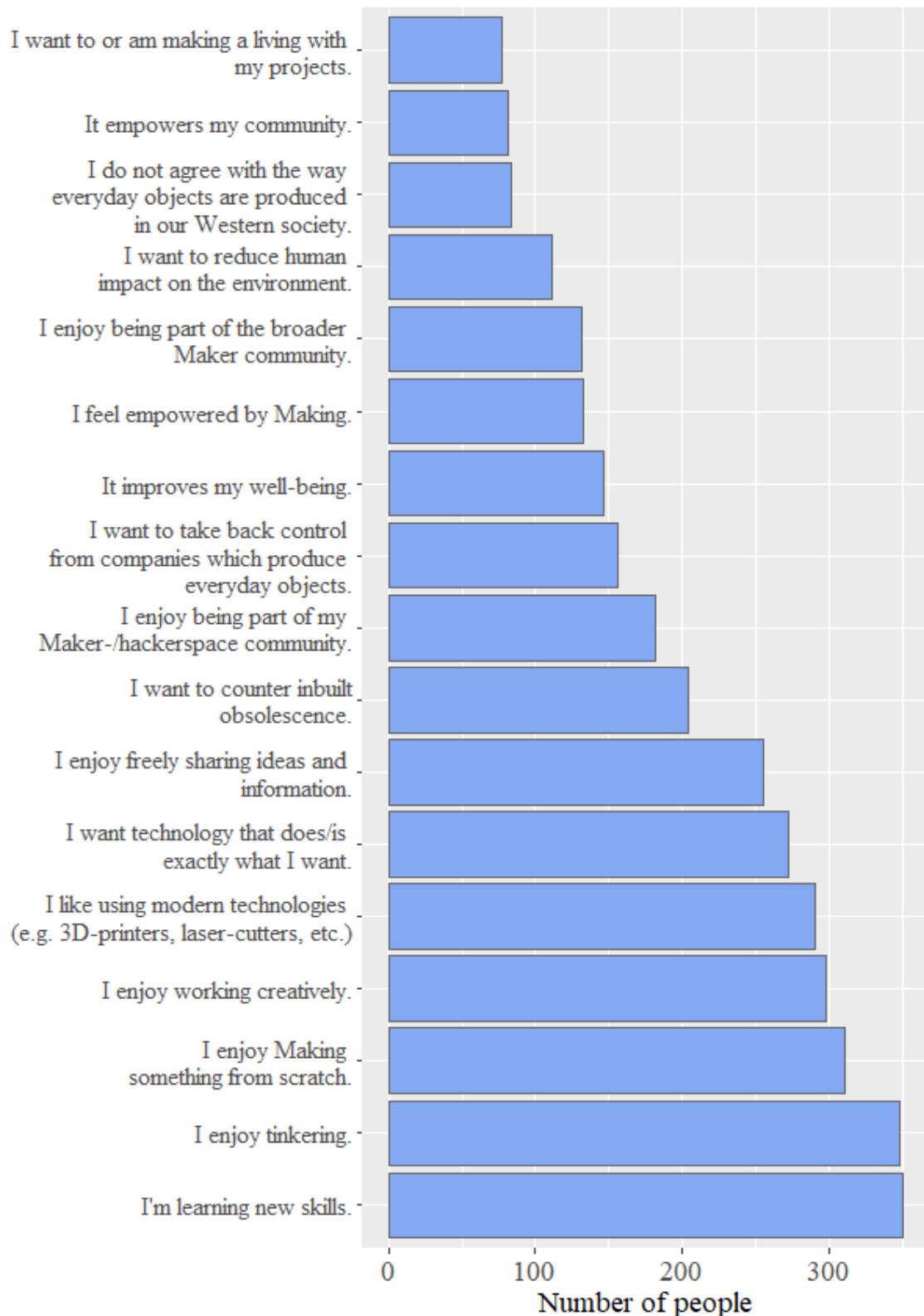*Why do you engage in Making activities?*

[Multiple answers possible.]

Figure 4-2 Survey: Motivations to Make.

Secondly, the joy of Making and tinkering appears to be a decisive factor for Makers. In fact, this motivation was one of the highest scoring in the survey with 87% of participants choosing this option. Only learning a new skill scored higher with 88%. We can recall Heidi saying that Makers "are people who are mesmerized with a specific topic and who are keen to make things themselves…to optimise things and to really work hard on it." The element of joy and fascination is evident. Given that Making is mostly a voluntary activity, it seems obvious that people would only engage in it if they enjoy it. However, this is a question of definition which shall be explored further in the morphology chapter.

An aspect that feeds into joy and creativity is personalisation. As already mentioned in the literature review, personalising your technology and aligning it to what you want, is seen as a common feature of Making. In the survey, 68% of Makers agreed that they are motivated by the wish to make technology that is exactly what they want it to be. Short interview participant A009 (woman, UK, 59) says:

> I like to have the control over what I have, I suppose, and I like to make it the way I want it to be. So even if I buy something, I almost certainly adapt it. Or I buy something from a charity shop and I hack it about a bit. […] yeah it just feels right.

Together with these aspects comes empowerment. Across all data collection methods, empowerment is a theme that is raised again and again. A045 (man, UK, 38) states: "I like the feeling of being able to do anything, Making tells me that I can. It's not just typical Making stuff but also decking a house or doing electrics, it's about being able to make things." This empowerment is linked to multiple factors, some of which have already been discussed, i.e. personalisation or understanding technology. Megan in her in-depth interviews connects this empowerment to political aspects:

> I like the fact that it's counter-culture. It's people taking matters into their own hands and creating their own networks, which is against the top-down political system that's so fucked at the moment [chuckles]. There's something about the empowerment and the connection that I really like.

Lastly, well-being is a major aspect of Making, not least because of the joy, creativity, personalisation and empowerment aspects. Of survey participants, 37% mention improvement of well-being as a motivation to engage in Making. Heidi, who is part of two Makerspaces and has attended bigger Maker gatherings, remarks:

> Often we do not cope well with the world out there [laughs]. No kidding, if you go to these congresses or hacker events, these are all basement children I'd say and I don't know of any other event where more therapy hours come together [laughs]. Because we don't really manage well with the outside world.

A good example of that is Lewis who suffers from poor mental health:

> I suffer from depression, and occasional anxiety, and I thought that by focusing in on one specific problem, and then taking that problem through to a successful solution, it's very good at breaking the negative thought cycles, because it is something tangible that you can look at and say, 'Well, so I've done this,' and so it breaks the negative thought patterns of, 'I'm not good at it, I can't do anything, I'm not succeeding in life.' It's something very tangible that you can say, 'Here was the problem, and I've created the solution.' It does give you a good feeling.

It is likely that while not all Makers are aware of this positive effect on their life, it might be a widely spread effect that is experienced by many. Again, if Making is defined as a voluntary activity, it seems only natural that it is something that is enjoyed by Makers and, thus, beneficial for their mental health. Well-being with Making is an aspect that has not been researched a lot yet and is something worth exploring further.

4.2.3   Community

For many participants their local Maker community appears to be a crucial factor in their Making practice. Two themes (which undeniably overlap) are paramount: sharing and socialising. Sharing relates to many different aspects. Mentioned mostly is sharing knowledge and skills. About half of in-depth interview participants hint towards this kind of sharing. Jane who has helped set up a space and is still involved in the running of that space says she likes:

> just being there and seeing what other people are doing and sort of picking up on things because I pick up on knowledge that way. I'm a bit of knowledge junky, I like to know how things work even if I'm not doing them myself.

This idea was not just prevalent in the in-depth interviews but as examined in Chapter 2 it is a main theme identified by the existing literature. In fact, sharing does not only happen within individual Makerspace communities but also in online communities and during Maker events. Short interview participant A066 (woman, UK, 24) recounts:

> there's a lot of sharing, like with the ladies here. On Tuesday I will go have an embroidery class with some of [them] and I'll bring conductive thread. She was totally into it. I think that's the best part.

Klara, being part of a very tight-knit community that spends a lot of time together, expands the communal sharing of knowledge and learning beyond Making aspects:

> I think there's always something to learn from other people, even if it's how they deal with problems or challenges or a job that they don't like doing. So we learn from each other to have non-violent communication as much as possible.

Even though not every Makerspace has such a close community, viewing emotional growth as part of learning and sharing experience might be beneficial to some. At least three Makers mention conflict situations in their spaces and that these are, partly, dealt with in an undesirable manner. Lisa remembers that one of the two reasons she is no longer attending a Makerspace is the tense atmosphere in the space: "everyone was bitchy to each other. There were different factions, which shouted at each other via the online mailing list and that just ruined the atmosphere for me." From being on various mailing lists of Maker- and hackerspaces, it can be said that this is not an isolated occurrence.

However, returning to the sharing of knowledge and skills, many participants are not only keen to learn from others, but also share their own knowledge and offer help to other community members and outsiders. James describes the situation in his space:

> We'd got a lot of people, especially students from university come along for some help with their projects. We were a bit of a knowledge kind of resource sort of thing. Word got around the university I'm sure, you got to go talk to those guys. It used to be quite good fun. We had lots of members as well. Lots of members who were new or less experience. It was always good fun, always really good, rewarding to help people out with their projects.

Important to consider when talking about helping people who are external to the Makerspace is the ambition to spread the ethos of trying things yourself and learning. Anton emphasises this point when talking about the open days at his space:

> We'll have visitors coming in […] who have a problem of some sort. […] 'Here's a broken computer', or 'Here, I've stolen this, how can I crack the password?' Those are the people we politely send away. […] Contrastingly, we had a woman there once. She […] said 'I have this old XP-computer, it doesn't work anymore. I have tried this and this, but I think it has this and that. Could you help me?' And that's always the start. If you say, 'I've tried things myself' and that was fairly intelligent, everyone will help you. That's what it's about.

> Helping yourself. That's the point of transferring knowledge. But we're not service providers.

The notion of being helped to help yourself comes up again when talking about repair in 4.3.2.1.

It is hard to imagine the free sharing of knowledge, skills and tangible objects outside of a fairly social and friendly community. It comes as no surprise then that socialising and hanging out with like-minded people is the second main theme that emerged when talking about community. Anna, when asked why she enjoys going to her Makerspace, says

> It's a kind of focal point that you have. For me it's totally about being social. […] It's fantastic to have a gang. I'd say it's a proper safe space. If you feel like everything is annoying you, then that's where you'll go and there'll be people who understand and who will catch you.

Ryan relates this especially to people who work in IT and software development and will "find it very therapeutic to [satisfy their] fundamental human craving to interact with other people." Five interview participants state that the socialising and learning of new things are the main reason they go to a Makerspace, not the working on a project. Hans explains:

> Well at home I make things about which I know I can make them and I need […] quietness. And that's just nuts in a makerspace. But in a makerspace you firstly get feedback, secondly you have the option to ask people questions and thirdly you are just not alone.

Anton calls most hackerspaces "pizza clubs with computer problems". He describes spaces as relatively small and not appropriate to actually do work in if many people are there and are loudly chatting. His space tackles this in that they have social meetings and separate working times. Felix, in fact, does not go to a Makerspace at all anymore because he knows enough people who have the tools he needs, i.e. 3D-printer, and because he is not so keen on social exchange.

Survey: Main Activity in Makerspace

What do you mainly do when you are in a Maker-/hackerspace?

[Only one answer possible.]
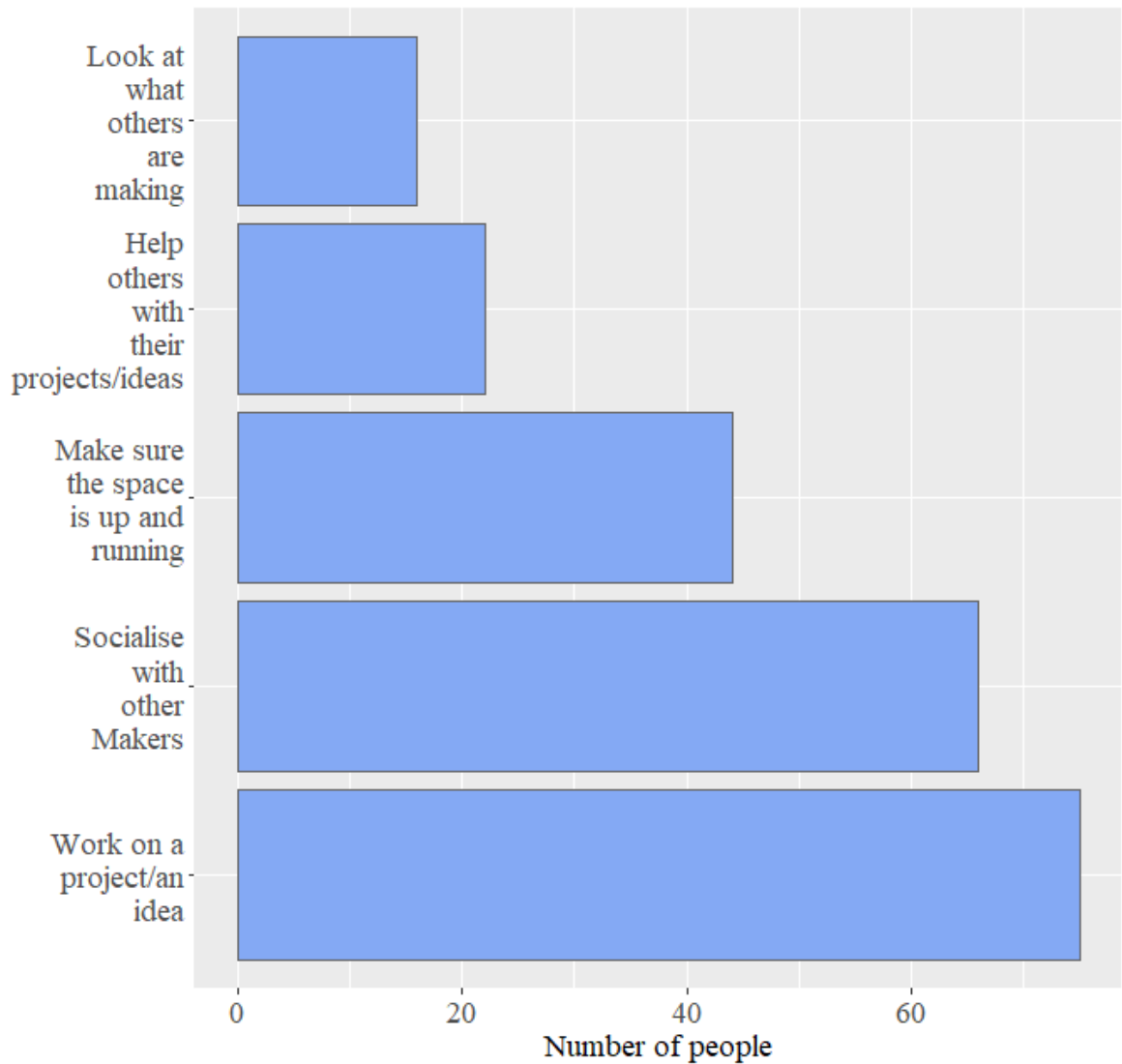
Figure 4-3 Survey: Main Activities when in a Makerspace.

Some of the survey data can shed more light on this notion that some Makers go to a Makerspace to socialise and not necessarily to work on a project. Out of the 223 who have answered the question what activity they mostly engage in when in a Makerspace, only 75 said "work on a project/an idea" (see Figure 4-3). Even though this is the most popular answer, it indicates that more than 150 Makers do something else, i.e. socialise with other Makers, help others, or look at what others are Making. In fact, when asked what a participant's favourite place to make was, 211 out of 363 said "home", only 144 chose "Maker-/Hackspace". Out of the 211 who prefer to make things at home, 85 still regularly attend a Makerspace (see Table 4-6).

Favourite place to make	Regularly attends Makerspace		
	Yes	No	NA
Home	211	85	97	29
Maker-/hackerspace	144	132	7	5
Work	8	4	3	1

Table 4-6 Survey: Favourite place to work and regularly attending a Makerspace.

The intensity of some of the connections that are made is noteworthy. Not only do participants talk about finding "good friends" (James) and being part of "a gang" (Anna), they also experience some of their Makerspace members as family. One woman said:

> There is a group of people where I'd say that goes towards family. They are the first ones we told that we were pregnant. Those are the people I would give my child to and say: 'Take care of it for a sec.' (woman, Germany, 33)

She goes on to explain her Makerspace as a safe space, even a refuge from the "world out there" with which Makers, according to her, often struggle. In this space at least, it seems as if its members construct themselves a reality separate from the one "out there". She later adds that most members of her space do not use their real name in this setting but use a nickname they have given themselves.

Her explanations seem to stand in stark contrast to spaces such as Lisa's who, as we remember, recalled quite a bit of conflict and tension in her space. As we will see a few times further on, Makerspaces appear to come in all shapes and sizes, including the way their community interacts and cares for each other. Robin who has worked with Makerspaces across the world has found that the focus in other cultures was much more on Making a community and empowering each other than it sometimes is in Western spaces.

4.2.4   Politics

A final theme is that of activism and political action. The way Makers (do not) identify with political aspects of their practice is worth considering and might be traced back to definitions of what political and politics means to people. In fact, some Makers clearly distance themselves from the notion of Making being a political activity, such as the following survey participants:

> The hacker/maker movement should define itself and not presume to have any further societal or political mandate (B188, man, GER, 24).

> Making is 'apolitical' (B270, woman, GER, 25).

> I'm afraid the Maker movement will become more political even though I'm of the opinion that that doesn't belong together (B386, man, GER, 38).

This might partly explain why some survey participants did not answer any questions in the section regarding political opinions. Others, as we have seen with Megan who talks about empowerment and political effects, identify and welcome a clear political connection "I like the fact that it's counter-culture. […] It's people taking matters into their own hands and creating their own networks, which is against the top-down political system that's so fucked at the moment." Anton is the only Maker who recalls developing an interest in Making through his political activities in a left-wing German political party and the people he met there. It seems as though there are two sides to the coin. Exploring this notion further would be recommendable as the MM has been called disruptive and political many times (see Chapter 2) but then, equally, is not seen as political by some Makers. Exploring this aspect and if Making activities are inherently political, i.e. with notions of empowerment, is something this study has neither set out do nor can achieve. These notions nevertheless play a big role in Chapter 5 when a morphology is developed. The chapter not only defines activism as a stand-alone concept within Making, but also reasons why, indeed, everything can be seen as political and, thus, Making as well. Equally, many political aspects are raised in conjunction with environmental aspects in the following section.

4.3 Environmental Views

Environmental considerations are considered to be a part of overall political aspects. Due to the former being one of the main foci of this study, they were emphasised and specifically explored in some depth. The online survey asked participants ten closed and two open questions regarding their general environmental values and their specific ideas and beliefs of how their Maker practices and that of the community in general engage with environmental impacts. The in-depth interviews were based on the individual participant's survey answers and, thus, explored similar questions. Additionally, more overall questions regarding the suitability of Making to deal with environmental issues and gender-related aspects were asked. This section focuses on environmental considerations and Maker

practices (4.3.1), environmental effects of Making (4.3.2), and gender-specific aspects (4.3.3).

4.3.1   Environmental Considerations: Level of Importance

Most Makers in this study care about the environment to some degree and somewhat include this concern in their practice. In the survey, almost 300 participants (74%) consider themselves environmentally concerned (Figure 4-4). In order to get a quick overview of whether these numbers diverge or align with environmental concern within the general population, analysis by the National Centre for Social Research of the European Social Survey was consulted. Unfortunately, the survey only inquired about people's concern regarding climate change, not general environmental concern. However, as climate change is one of the most commonly known environmental issues, we might expect a degree of correlation. According to the study, 69% of people in the UK, 77% in Austria and 86% in Germany are somewhat or very concerned about climate change (Barasi, 2017, p. 6). Important to note is that they have not included no-answer-values (n/a) in their graph. Thus, in order to get more comparable data, we need to omit those values from our clusters which leads to a dramatic increase in both participant clusters. Now, 91% of survey participants consider themselves an environmentally concerned person whereas interview participants reach a full 100%. The generally high percentages for concern in this study's survey might have to do with it especially attracting environmentally concerned Makers and, equally, because interviewees might not have wished to disagree with the researcher who through the focus of the study was likely seen as environmentally concerned herself. This assumption is merely hypothetical and cannot be proven as such but is worth mentioning.

Looking at answers to the question whether Makers consider the environment in their Maker practice provides a result of just about 200 participants (62%) affirming this question in the survey (Figure 4-4). Another question asked Makers to click all applicable answers that explain why they engage in Making activities (Figure 4-2). Just over 100 participants (~25%) note that they want to reduce human impact on the environment within their practice.

Survey: Environmentally Concerned Person and Practice

1. Do you consider yourself an environmentally concerned person?
2. Do environmental concerns (e.g. waste, material, purpose of project, etc.) play any part in your Making processes/projects?
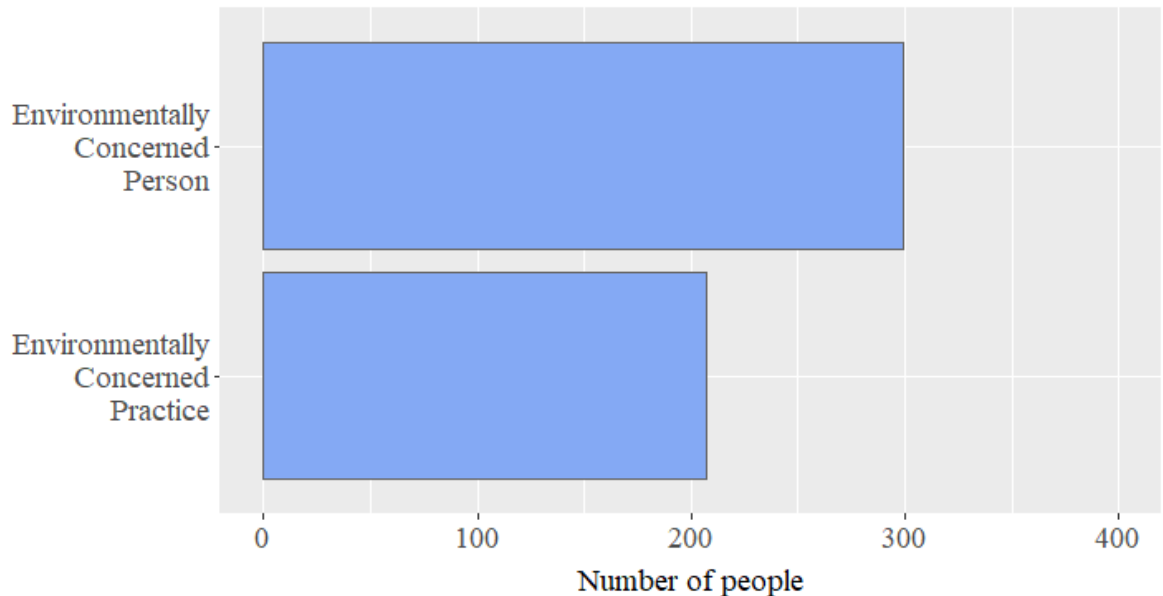
Figure 4-4 Survey: Environmentally Concerned Person and Environmental Making.

Taken together with the results from above, it can be inferred that many people consider themselves environmentally concerned and, to some extent, apply that concern to their Making practice, but that this concern is not necessarily a motivation to initially engage in Making activities for all of them. In-depth interview participant Lisa is a good example. She considers herself very environmentally aware and translates that concern in a lot of her everyday behaviour. However, the environment is not a motivating factor when it comes to Making. While reflecting on the fact that she incorporates the environment in her practice through reusing old material, she says: "I wouldn't say that the environment is my main reason for making things. It's more like when I make things, I will try to make my project out of material I already own." This reflects the numbers described above.

Survey: Environment & Project Statement #1

If the process of making a project or the final project itself
are likely to have negative environmental effects, it shouldn't be made.
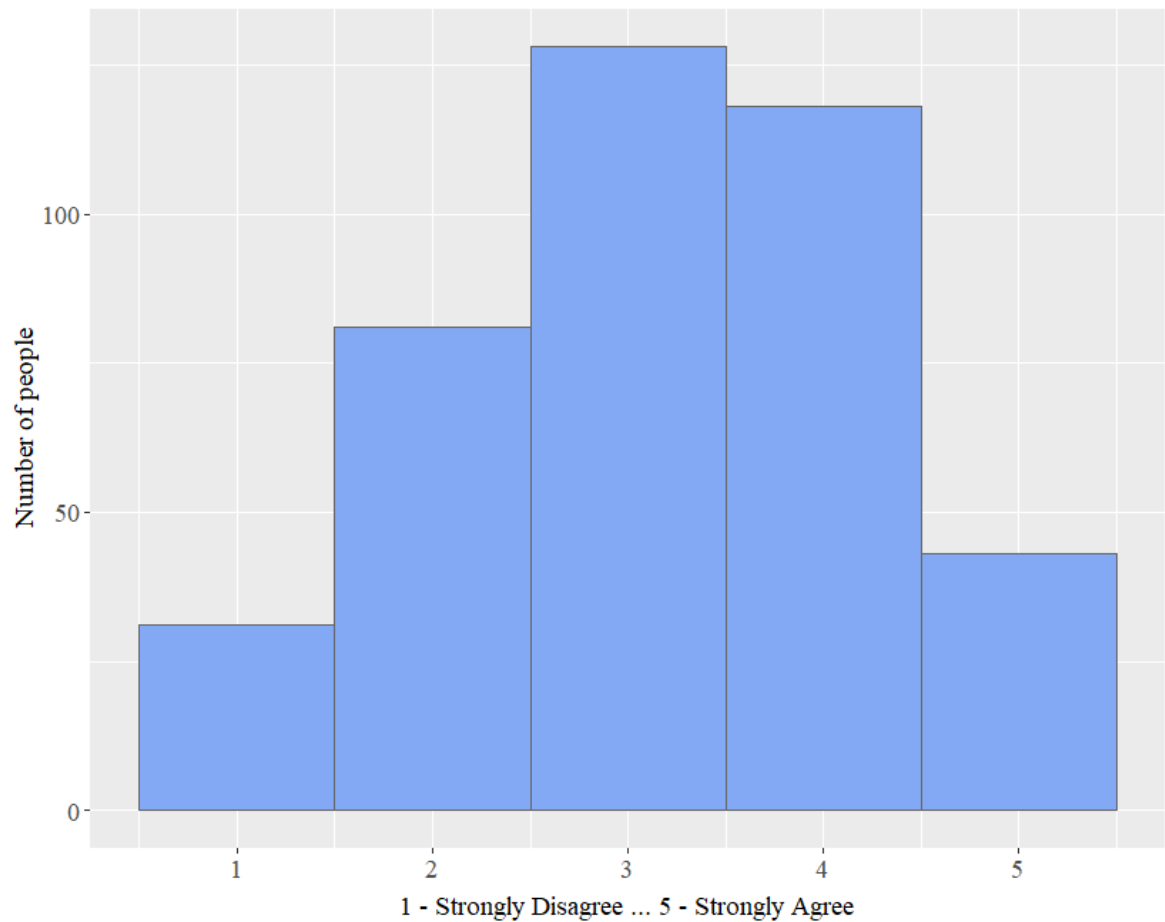
Figure 4-5 Survey: Environment & Project Statement #1.

When asked to rate their agreement to the following statement *If the process of making a project or the final project itself are likely to have negative environmental effects, it shouldn't be made.*, more than 160 of survey participants (~40%) agree to some extent whereas around 110 (~28%) do not (Figure 4-5). Upon turning that statement around to *A Maker's project should not concern itself with its environmental impact. That's not what making is about.*, we can see a bigger discrepancy between agree and disagree (Figure 4-6). More than 240 of participants (62%) disagree out of which 130 (33%) do so strongly. A majority of Makers arguably exercises some level of environmental concern when Making a project. Only about one fifth agree with this statement.

Survey: Environment & Project Statement #2

A Maker's project should not concern itself with its environmental impact.
That's not what making is about.
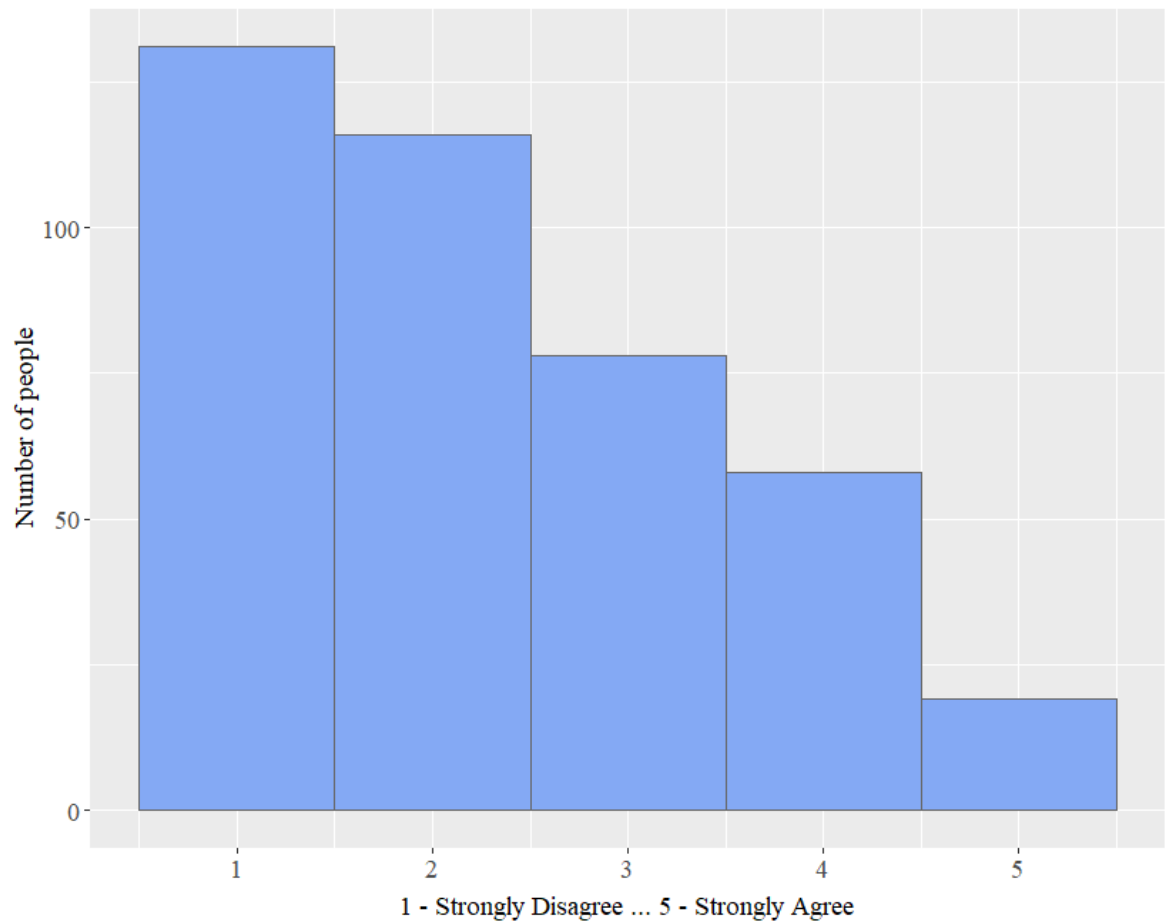
Figure 4-6 Survey: Environment and Project Statement #2.

The three following sections explore the different shades of concern in more depth and show how Makers apply that concern in their practice. This is based on in-depth interview data in which interviewees explained their answers to these above questions further.

Almost all interviewees agree that they are environmentally concerned people, however, only a handful seem to prioritise this concern. Hans and Felix, for example, both agree that a project should not be made if a Maker knows from the start that it will have very negative environmental effects. An example many interviewees mention when talking about very wasteful projects, is that of LED throwies, a small project in which an LED is taped together with a battery and a magnet and then thrown against a magnetic surface (Figure 4-7). According to participants, this project is often used outdoors, and the product often left there and forgotten which is environmentally harmful. Projects like these, according to Hans and Felix, should not even be started as their negative environmental effect is clear from the start.
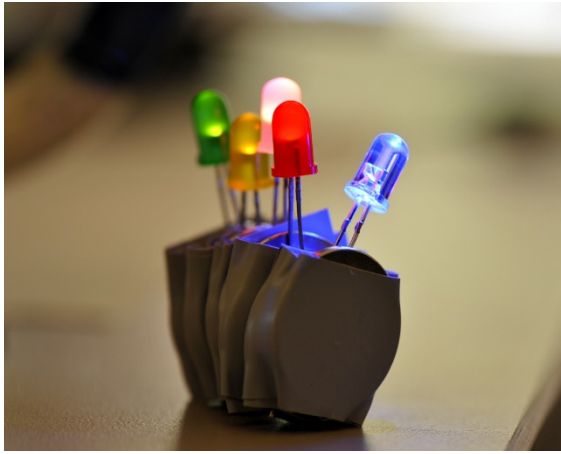
Figure 4-7 LED throwies.

Three in-depth interviewees go so far as to say that the environment is a main priority for them. Rose is one of the three and states that the movement needs to build environmentally ethically and that she would give people one chance to create something environmentally harmful but after that they should know better. Heidi, similarly, only allows for short-term environmental damage if the long-term effects of the project are environmentally positive. Klara goes further. She and her Maker community are especially committed to permaculture and appropriate technology. She states: "For us it's an integral part of our project, so the two things go together. They are inseparable. We wouldn't work on a project that is not environmentally friendly." She goes on to explain that every aspect of a project is considered, starting from energy source to final purpose of the project. Often, she and her community try to give a project multiple environmentally friendly purposes in order to increase its usefulness, e.g. a fence out of wood instead of metal which simultaneously provided nesting space for animals.

Klara, Heidi and Rose seem to be exceptions, though. The majority of Makers considers the environment in their practice but while simultaneously considering other aspects that might be equally or more important. Just like them, most Makers seem to realise that some or all their activities have negative environmental effects. Moritz and Jack both mention that everything that is made is bad for the environment as resources are being used and if the environment were the strongest and most important concern while Making, maybe nothing could be made. This contradicts Makers who actively repair and recycle to mitigate negative environmental impacts. Survey participant B357 (man, UK, 38) agrees: "I make stuff mostly for fun; strictly speaking anything I make is bad for the environment, because a factory in China can always work more efficiently than I can."

Megan agrees in so far that everything we do potentially has negative environmental effects and she is committed to raising awareness and teaching other Makers about the effects their projects might have. However, she also supports the view that sometimes other considerations are just more important. As long as a Maker has thought through their project and makes an informed decision about the effects of their project, it is acceptable if some of those effects are negative for the environment. Robin, Lisa and Lewis support similar views.

When explaining what those other considerations might be, Makers name aspects that can be grouped in three main categories: practical aspects, process considerations, and the purpose of the project. In terms of practical aspects, the one that is mostly mentioned is finances. A quarter of interviewees state that often being environmentally friendly in their projects would require them to spend more money, i.e. on more sustainable materials, and that that is money they either do not have or do not want to spend. James, who is an entrepreneur and aims to make a living with his projects, says:

> I don't feel that I've made a massively active effort to be environment-friendly, and I probably should. Then again, it's very small quantities and at the moment there's not much […] profit margin to mess around with, to maybe spend more on something to make it more friendly because I got to pay the bills [chuckles]. […] Probably there are things I could do that I'm not doing, although I think that it will be small because the quantity is small.

He hints at another aspect that is mentioned: scale. Because the quantity of how much Makers make and the size of their projects, some do not consider their environmental impact significant, e.g. Jack or Nancy.

Some aspects that relate to the process of Making are equally named as potentially more important than environmental effects. Having fun and promoting creativity are two of them. The ones that are mentioned most, however, are understanding technology and learning new skills. Nancy explains it as follows:

> I did aluminium casting when I was at university. Aluminium is really not a good material to be using. […] But it was a very beneficial process to do. […] the actual scale if you think about how much aluminium is being used commercially, why shouldn't some people get to learn aluminium casting to benefit themselves and to get an insight into the process and how much goes into actual production of valued minerals…really I'm not going to say 'you're not allowed to do that'.

Other Makers agree that sometimes learning a new skill and understanding the technology we use can be more important than negative environmental effects. This is sometimes supported by the view that the long-term effects of learning and understanding will lead to being a more environmentally aware Maker. Nancy is also hinting back at the aspect of scale between a Maker's project and that of main industry. This aspect resurfaces in the section on Makers who do not consider the environment in their practice.

A final element to consider in which other considerations play a role is that of the purpose of the project itself. The main argument here is that of positive social effects which might

outweigh negative environmental effects. Megan provides an example when talking about a modular wheelchair project:

> Let's say it had really amazing social impact. Let's say it was something that was going to have negative environmental impact. I think everything needs to be considered. You need rationale. […] There's nothing on the market for that. […] I've got to get the wheels made in China and they've got to be shipped over because, actually, I just can't get them made in the UK. I would say you really thought about that. You're really trying to make a difference. Go for it.

Jane, Rose and Lewis provide similar arguments in this regard. Other aspects that are mentioned are, for example, that the process of Making something can be environmentally negative but that the project itself might last longer than something that was purchased. Therefore, the negative effects might be acceptable. Equally, some Makers say as long as their project has a purpose and is useful, it is acceptable to them if it might have negative environmental effects. Both of these latter arguments could be brought back to a point made earlier, namely that the interviewees note that short-term negative effects can be accepted if the long-term environmental effects are positive.

Four interview participants hint at the fact that, actually, the environment does not play a huge role in their Maker practice. Some of the arguments that are brought forward are like the ones described above, i.e. the small scale of what people are doing has a negligible effect on the environment either positive or negative. James also adds an argument, especially for new Makers whose main concern it will be to get a project to work. Jack generalises this for all Makers:

> Some of my product is not necessarily about being environmentally friendly per se, but it's just about making products but then also wondering about how the process works and what processes you're using. Because if we're going to succeed in becoming more sustainable in our way of doing them then that has to happen for everything not just for stuff that's worthy or something.

Even though he does mention long-term sustainability effects here, he says later on in his interview that his environmental concern in Making does not extend beyond connecting people who are interested in sustainable Making. He also mentions that he struggles to decide which projects are ok to make under environmental scrutiny and which are not. But, in general, he does not include environmental effects in his practice. A final argument that is mentioned in this category was hinted at previously and is explained by Felix who is active in a political party in Germany. When asked why he noted in his survey that the environment

does not play a part in his Making practices even though it was important for him for a different question, he explained:

> For me personally, if I make something I need then it's not important if I do that to save CO_2. In my party, I'm always the one saying that it's all well and good for individuals to care about this but often that has the character of the sale of indulgences. If I want to improve something regarding the environment, then we need regulations from the state. That's its job.

Felix is the only one mentioning a political motivation to not engage with the environment in his Maker practice. However, quite a few Makers criticize current production processes and wish for better environmental standards.

4.3.2   Environmental Considerations: Effects

When it comes to specific environmental effects of Making, an overwhelming majority of in-depth interview participants agrees that effects are neither automatic nor inherent to Maker practices. Instead, Makers name aspects on which it is dependent whether someone's practice is environmentally friendly or not. One of these is the role a Makerspace and/or community around a Maker plays. Three Makers have given more detail on this, for example Robin:

> [I]t very much has to do with the community that you're within, and the setup of the makerspaces that you're interacting with. I think it's absolutely possible to have a makerspace where they're making whatever they want, with no considerations for their waste or their use of materials or anything like that. […] If you don't set up a community where you have these kinds of conversations, it's very possible for it to be missed.

Another aspect that is deemed important when reflecting on whether someone's practice is environmentally friendly or not is how Making activities are communicated. Jack and Ryan both mention 3D-printing in this regard and how it is important to not just encourage people to use it, but to use it in an environmentally friendly way. It is, thus, not inherent that Making things will have positive environmental effects but the way the community around someone communicates and teaches making seems to be important.

A few interviewees also reflected on the role of the individual in encouraging an environmentally friendly practice. Lisa, Rose and Megan all agree that environmental considerations during the Making process cannot be invoked automatically, but that Making

will reinforce someone's environmental concerns if they already have these in some form. Rose states: "I think it comes down to the person themselves and their driver and what they want and their own practice, because it's such a diverse community [and] everybody is in it for different personal reasons." Lisa adds: "It strengthens the tendencies that someone already has anyway." The following paragraphs explore ideas and beliefs of how the movement can have positive (4.3.2.1) and/or negative (4.3.2.2) environmental effects.

4.3.2.1 Positive Effects

Across all methods of data collection, an overwhelming majority of Makers agrees that the MM has positive environmental effects. Sixteen in-depth interviewees gave examples of how Making contribute to environmental sustainability. Eleven in-depth interview participants raised repair and reuse as an aspect in which Making can actively counter waste, environmental degradation and consumerist behaviour. They also claimed that through engaging with technology on the level of Making and hacking, a person gets to understand and value technology much more than if they were only a passive consumer of said technology. Through that newly gained understanding and valuing, a Maker would be more likely to repair items instead of throwing something out and buying a new item. Megan and Jack explain:

> I really hate throw-away culture. […] It feels like everyone's asleep and not realizing the stress the planet is in. One of the things that the maker movement does is when you get people back in touch with making, they on some level realize how much it took to make something, and therefore people value things more (Megan).

> […] if you've got more of an awareness of the processes and the labour involved in making your things, then maybe you'll treat it better, maybe you repair it more when it gets broken (Jack).

Similarly, the empowerment that comes with relearning skills and having technological choices were mentioned a few times as having positive environmental effects as well. Makers pointed towards the power of being in charge of producing their own technology and how reconnecting to those processes which are typically removed from us, changes their outlook on the world and increases their ability to make an informed decision when it comes to technology. "I do think that people want to do something about [throw-away culture] but I think they don't necessarily know how. Empowering them through making is a way of

doing that" (Robin). This active involvement in versus passive consumption of technology was mentioned by five participants in regard to positive environmental effects. Having a choice and being empowered to actively make that choice appears important to some Makers and relates to environmental considerations as well.

Another theme raised by some participants is local production. They remark that producing something locally instead of on a global market has various positive environmental effects. Firstly, it avoids transport of material and goods. Makers use spare material and parts in order to produce something new and, thus, avoid shipping new parts and material across the globe. Secondly, producing something locally and closer to the user of the final object aligns this object much more properly with the users' needs and requirements which, consequently, saves them having to purchase various technologies to adequately fulfil their needs. One Maker emphasises that this is an environmental effect achieved not just through repair but even through building something new:

> […] when you make something for yourself or make something for the person who's going to use it, you directly address their needs as opposed to if it's someone who's 1,000 miles away and a completely different culture and lifestyle. […] it's by keeping the end user more closely involved with the process, we fundamentally will make better use of the resources we have (Lewis).

Thirdly, a participant of the short interviews brings up a connection between local production and waste. When asked for the environmental protection potential of the MM he states: "We might actually be keeping more waste on our sides by making things ourselves than outsourcing the making and just keeping the products" (A045, man, UK, 38). Even though Making might have consumerist tendencies and produce waste, it prevents more waste being produced somewhere else which might potentially be much more damaging.

A last, more prominent aspect is that of community. Four interviewees have mentioned that environmental effects, to them, have to do with raising awareness for the environmental effects of Making and promote activities that focus on related issues. Often this is linked to repair and sharing with others the skills necessary to repair and fix objects. Along similar lines, sharing of materials, scrap pieces and information relates to making a positive environmental impact. Jane explains that in her Makerspace they "foster the idea of sharing things rather than just purchasing" and that this collective approach emphasises the idea of a sharing economy in which less waste is produced.

Due to repair being named as one of the most environmentally friendly practices within Making, it is necessary to give a brief examination of this activity and its relationship to Makers. Five main themes can be identified: environmental protection, understanding technology, control/empowerment, finances, and community. A majority of these seem to mirror the overall positive environmental effects that we have just looked at. But they shall be considered with the nuance of repair.

Environmental protection, as mentioned above, for Makers who repair is mainly achieved through preventing unnecessary waste. Not only many in-depth interview participants, but also survey and short interview participants agree with this. A045, for example, a male Maker interviewed at the Maker Faire UK in Newcastle in 2018, said:

> We've been led on a path of consumerism where we just throw away, and we can't go on doing that. […] When something breaks, rather than throwing it away, you can download an open-source file and fix it. […] If we want to reduce the amount of waste we produce, we need to craft more, we need to be able to fix our own things. […] It's not just being able to do it but also realise that you can.

Apart from many Makers raising the advantage of avoiding waste through repairing, a few compare it to Making an item from scratch. Nancy and Anna both point out that repair might balance out the negative environmental effects of Making something new. When discussing the wastefulness of prototyping and asking what she thinks the impact would be if everyone became a Maker and started prototyping, Nancy replies: "I don't think that that's how everyone would do it. […] everyone becoming a maker, that chain of thought often links to repairing things, so surely that's gonna cancel out any impact of people prototyping."

When it comes to understanding technology, repair mainly focuses on understanding the technology that already exists (in contrast to understanding how to make an item from scratch) and understanding the work and effort that go into producing an object. James uses the term of demystifying technology: "I think a lot of it is about just demystifying the whole thing. I think that's important because then maybe people should be a bit more switched on to the fact that things are repairable." Overall, the notion of understanding and valuing technology within repair does not show any considerable differences to the general notion within Making.

A theme that is brought up especially in connection with repair is that of taking back control from companies and empowering oneself. Frank calls it "an act of rebellion" to repair

something today when companies do not want people anymore to be able to fix their items. Megan gives the example of a garden fork:

> There's something about people getting frustrated with doing something like buying a garden fork. In the early days, you'd buy a garden fork, and it would last for 50 years. Now you buy a garden fork and if you're really lucky and you bought a really nice fork, it would last for 10 years. That's because of planned obsolescence. There's something about the whole fix and repair movement or maker movement that really ties in to people wanting to not buy into the IKEA cycle of, 'Good, it's so cheap, and so crappy. I moved house and the leg fell off. Oh well, I'll just go and buy another one.' There's something so soulless about that.

Planned or inbuilt obsolescence is mentioned – and criticised – frequently by Makers, especially in connection with consumerism and a quick turn-around of items that we use. Heidi strongly criticises our throw-away society in which everything is made to be consumed fast and things are built to have an expiration date. "That's not necessary. Why can't things last longer?" This is what Makers counter when they repair things and bring them back to life. To some, it is a process of empowerment. James says: "It's empowering, isn't it? […] Things that are actually really easy to do but it's all just like black magic. No one understands."

A positive aspect that is mentioned in relationship to repair is that of financial savings and monetary necessity. One short interview participant, for example, engages in repair "because I don't have a lot of money. Fixing things is a way of not spending a lot of money, although it takes time" (A018, man, UK, 36). The financial aspect of repair is mostly mentioned as an afterthought by participants which might be due to the focus on environment in the study. It would be valuable to explore more deeply how these motivations interact with each other and are prioritised.

Lastly, communal aspects are raised in connection with repair. Firstly, a Makerspace providing the tools and resources to repair is noted. Jane, for example, notes that having the tools around and having someone to show you how to use them is essential in order to fix something, and many people do not know anymore how to use certain tools. This leads into the second aspect that is raised: education and support. Quite a few study participants mention being involved in Repair Cafés that help and teach others to fix their broken items. In fact, Repair Cafés work on the premise that the attempt to fix something will only be made if the person whose item it is engages in the process and learns from it what they can. It is this involvement in the process that Repair Cafés and Makers in general seem to value when

fixing broken objects. It is not only repairing things for others, but simultaneously teaching them the skills to do so.

4.3.2.2 Negative Effects

Despite the majority of Makers in in-depth interviews naming positive effects of Making, quite a few simultaneously name negative environmental effects as well. Firstly, 3D-printing and laser-cutting are named specifically as being inefficient and wasteful technologies. Ryan emphasises his dislike of mindless 3D-printing with the example of someone printing a lampshade: "It took nearly like 20 hours to print on a heated print-bed so you use an absolute ton of energy to make the thing and it costs you a fortune and it was dead slow." Secondly, some Makers mention the environmental effects of modern technologies generally being detrimental and negative. Anna remarks that "I love tech, but it's just not the most environmentally friendly thing you can engage with." These remarks usually refer to electronics and 3D-printing as mentioned above.

Thirdly, the process of prototyping and a trial and error approach generally are considered wasteful practices. Three Makers mention this specifically, i.e. Anna: "Making, simply, includes an insane amount of waste. […] It's a lot of trial and error and, thus, per definition a process that requires a lot of material. It's just not a streamlined approach." When asked if an increase of participation in Making among the general population would have negative or positive environmental effects, James says "it'd probably make things worse" as it would mean more material waste through prototyping. Finally, other aspects that surfaced during the interviews are the long transport of materials and components, often from China, and some projects getting built but then not being used. The survey data provides some very similar voices on this issue, e.g. "Building your own projects mainly consists of tinkering with materials that you get from China. Environmental sustainability is questionable here, that's obvious" (B005, man, GER, 33).

4.3.3 Gender and Environmental Views

One of the aims of this study is to explore if there is a relationship between different genders and environmental concerns within the Maker community. This topic was, therefore, discussed with all in-depth interview participants. The main question that was posed to them was whether they think that there are gender differences in how Makers view and regard the environment during their practice. Their answers do not provide a clear tendency towards

one side or the other. Seven participants agreed that women are more environmentally concerned in their Making practice, ten stated that they did not think any gender differences were prevalent and five were unsure. A couple of participants supported different views throughout the interview, hence a total of 22 views. It is notable that no participant thought that men were more environmentally concerned than women.

Three women and four men said they think gender plays a role in a Maker's environmental concern and practice. All of them stated that they thought women were showing more environmentally friendly behaviour than men. When asked how these differences show and why participants think these differences exist, various perspectives were shared. Common themes that came up were a difference in how women engage with old and new objects, a difference in language and approach, and a difference in care and empathy. Heidi and Jack mention how men and women engage differently with different novelty levels of objects. Heidi, whose husband is also a Maker and one of the interviewees, says:

> With my husband, if something goes wrong, he just starts from scratch with new materials. He throws the old thing out and starts afresh. I don't work like that because I always think 'we only have this one environment, what do we leave behind?' With him and the other boys, I realise that's not the case.

Jack, who is part of the organisational team in a UK-based Makerspace, has observed something similar. To him, "men are a bit more into building a new thing and bringing new things into being. Women are a bit more interested in the stuff that already exists."

Rose and Karl have emphasised how there appears to be a difference in language and approach of Maker projects. Rose, who helps set up Makerspaces and leads various Maker workshops, has reflected on this aspect a lot and states:

> I always find that advertising something with tech, the uptake with guys is just straight away. […] The language that we use is very, very important. […] Get the language right and we get the diversity that we're looking for, it's changed it around. […] There's a gender thing there. […] We know that with the environment, which is looking at solving real-world problems, will be helpful to get women involved first of all. […] Again, we're using language but doing something for creatively solving real-world problems, because we know that that will help to address gender imbalance.

Rose supports the view that including more environmentally friendly approaches into Making attracts more women to join in. Karl, father of a boy and a girl, does support this view. He observes both his wife and daughter to be more empathetic and caring. He thinks that communicating Making through a more environmental lens would get them and other

women more involved. These categorisations assists us later when analysing inclusiveness issues further in Chapter 6.

In terms of where these apparent differences come from two main reasons are brought up: evolution on the one side, and education and upbringing on the other. When it comes to the theme of women being more caring and empathetic Karl and Ryan seem to attribute these characteristics to evolutionary and/or hormonal differences between genders. Ryan believes that throughout human evolution women had to be on guard and learn to read men's emotions in order to keep themselves safe and protected from testosterone-related aggression. Karl relates the differences back to genes and the experience of caring and birthing children which make women, generally speaking, more caring and empathetic. The second reason that emerges is that of education and upbringing. Heidi reflects that she is not sure where women's increased care for the environment comes from, but that it could relate to education and upbringing: "The way we are raised might have to do with how we care for the environment." Another, less mentioned explanation is raised by Lisa. She ponders on whether women might, generally, be confronted more with decisions about the environment in relation to making product choices when shopping:

> On average, women work less and, thus, have more time to consider this [the environment]. Generally speaking, women are still the ones who do food shopping and who make decisions about what products to get. Here, they have the choice to decide this way or that way. […] It's more of an external reason.

A few participants who agree that women are more environmentally concerned, are much less sure of their answer and if this is, in fact, true. Jack and Anton both have a feeling that women are more environmentally friendly but cannot really put their finger on why they think so. Both of them start off with affirming a difference but, while thinking it through, arrive at the conclusion that, in fact, there is no difference. Even though they both have a change of mind, it seems noteworthy to mention this initial feeling of women being more environmentally concerned.

As mentioned initially, no participant stated that they thought men were more environmentally concerned in their Making practice. Various reasons for this can be considered. Besides this potentially being the truth, it could also be a reflection on the methodology and set-up of the study. Considering that the researcher of this study is a woman and obviously cares for environmental aspects, male participants might not want to

contradict or challenge her. Another reason might be that a lot of Makers do not know a lot of Makers of the opposite gender and, thus, find it hard to draw conclusions either way. This aspect, in fact, comes up further down when talking about interviewees who were unsure about their answer.

The survey results provide some evidence to support the notion that women are more environmentally concerned, generally and in their Maker practice. When asking whether a person considers themselves to be an environmental person, all female participants provided an affirming answer, leaving us with a 100% yes-rate. The answers of male participants add up to an affirming majority of 90%. Running the Fisher's exact test which tests statistical significance between categorical data of small samples, returns a p-value of 0.11 which rejects the null-hypothesis that there is a relationship between gender and environmental concern. However, the question if someone considers the environment in their Making practice seems to be stronger related to gender. Compared to women's affirming 88%, only 59% of male Makers said the environment plays a role in their Making activities. Almost 30% difference in answers is significant, as the Fisher's exact test confirms with a p-value of 0.003. This is below 0.05 which means a statistically significant relationship exists. Consequently, the gender of a person seems to correlate with their willingness to include environmental concerns in their Making practice. However, as mentioned above, for both of these variables we must keep in mind that participation from women is rather low and that these numbers, thus, might not be generalisable.

Five women, four men and our one non-binary interview participant did not agree that there are gender-related differences in environmental behaviour and values in the Maker movement. Four of them did not explain their answers. The other five provided brief ideas about where they think differences in people's environmental approaches come from or what other aspects might be more connected to someone's gender, i.e. confidence, which might, in turn, influence environmental impacts. Klara and Jane both think that environmental behaviour, actually, stems more from someone's education and cultural upbringing. Jane, who is 62, gives herself as an example and explains how she and her group of friends and, in fact, her generation "are all kind of a hippy mentality. Left of centre, we're all kind of geared to that kind of alternative growing up in the sort of 60s/70s/80s…all a bit left-wing and so on".

Karl and Robin, in turn, reflect on an aspect that to them is gendered within the Maker community and could be related back to environmental issues, namely the confidence to

engage with technology. Robin notes a complex issue around gender and repair which they relate to confidence aspects.

> Actually having the confidence to repair something can be a factor. […] because of education, women will have been taught more sewing skills and things like that, so they will actually be far more confident when it comes to anything to do with repair and reuse of clothes and all those kinds of things. Whereas men will have been pushed more towards other types of mechanical repairs, but I think this is all shifting. […] Yes, I think it's a much more complex issue around gender and repair than it would be around other kinds of areas.

Karl picks up a similar aspect but, as noted previously, connects to genes and more evolutionary aspects. He says both his wife and his daughter are lacking the confidence to "Just do something." Himself and his son are much more daring in taking things apart and trying to fix them.

> I think the 'just do it and fix things when they're broken' attitude is missing in the women in my life. At least my wife and my daughter, they don't have that. They always have someone, a guy, who says 'I'll do it, give that thing to me.' […] Girls are much more careful. If that stems from influencing each other that way or not, I think it plays a big role in making. Doing stuff without worrying about it. Maybe it comes from that empathy that girls are more worried about breaking something.

A final view is given by James who connects the care for environmental issues more to specific communities people are in. He says that the women in IT (as part of the Maker community) are not in it for environmental reasons but for the passion for IT. He does not see gender-related differences in this regard.

One quarter of participants expressed uncertainty when asked whether there are gender differences in environmental concerns. Lisa, Lewis and Moritz all explained that they do not know enough female Makers in order to make an informed decision about this aspect. Lisa, specifically, mentioned that she seems to be the most environmentally concerned in her Makerspace but that, equally, she is only one of two women in the space and, thus, cannot draw any conclusions. Equally, Anna states she cannot draw conclusions either because she is part of a feminist Makerspace and does not know enough male Makers to give a definitive answer. Last but not least, Rose, who delivers Maker workshops, is unsure about these differences but, as mentioned above, thinks it is more about language and approach than an actual difference in attitude and values.

The data regarding the connection between pro-environmental concern/behaviour and gender is inconclusive and even those Makers who do affirm or negate a connection are not always certain in their answer or explanation. To reach more insight, section 7.2 takes participants' environmental considerations one step further and develops environmental profiles for each in-depth interviewee. These profiles have helped to show that female Makers in this study, indeed, appear more environmentally friendly (see section 7.2).

4.4   Inclusiveness

The data on gender and environmental differences lead us well into data regarding inclusiveness of the MM and its spaces. Even though there appear to be various aspects through which inclusion could be discussed, the main focus shall be on gender. Section 4.4.1 briefly looks at general beliefs about inclusiveness and section 4.4.2 then presents more detail on issues around gender specifically. Lastly, section 4.4.3 presents solutions and approaches interviewees suggest taking or having taken in order to make Makerspaces more inclusive, again with a focus on gender.

4.4.1   General beliefs

The survey provided two statements relating to the overall inclusiveness of the movement. Levels of agreement might appear contradictory, at first, but can be further explored with in-depth interview data. The first statement *The Maker movement is truly inclusive and open to everybody, despite aspects such as gender, educational background, race or age* received high levels of agreement: more than 250 participants (67%) agree or strongly agree (Figure 4-8). Equally, the seemingly opposite statement *Despite being inclusive in theory, I think the Maker movement still has some work to do in order to call itself truly inclusive* (Figure 4-9) reaches similar levels of agreement: more than 190 participants (50%) agree on some level. Albeit not being the same level of agreement, it is still closer than one would assume.

Survey: Maker movement & Inclusiveness Statement #1

The Maker movement is truly inclusive and open to everybody,
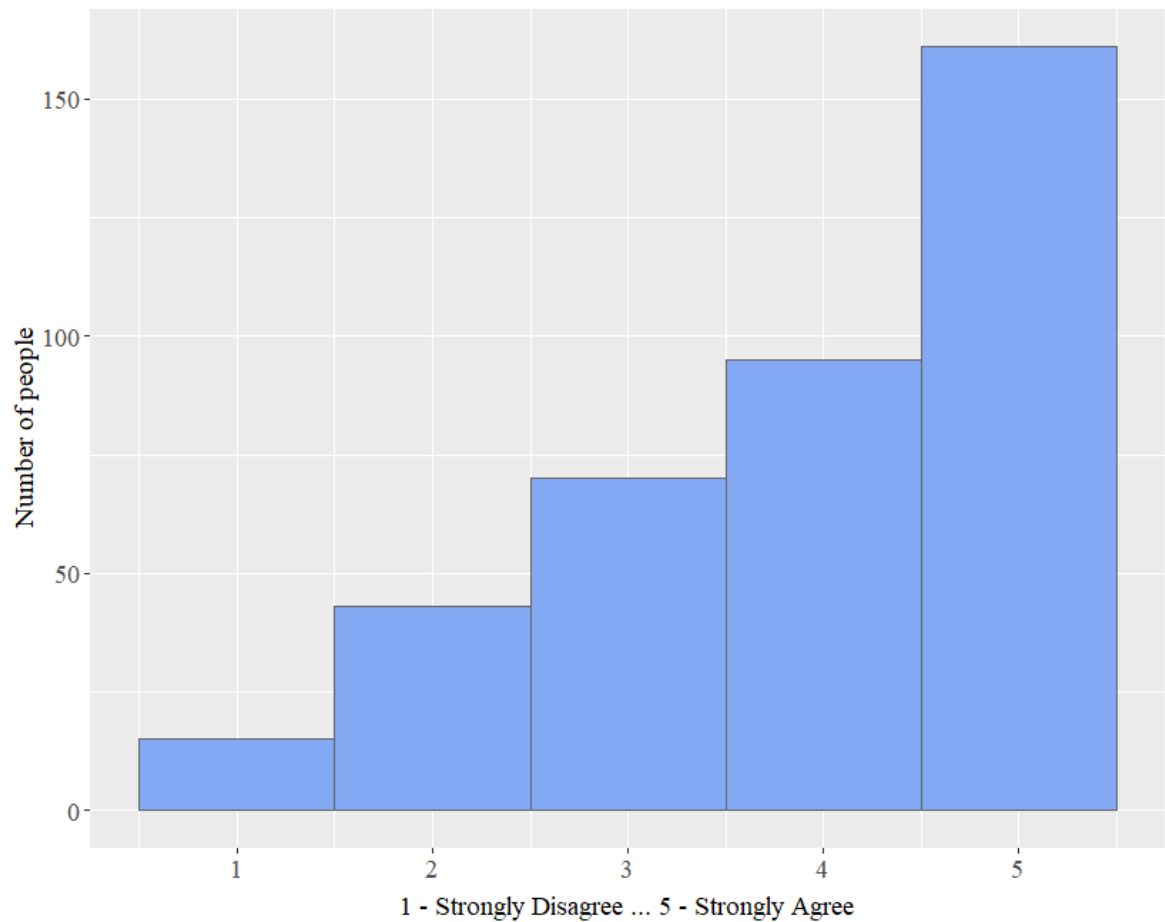*despite aspects such as gender, educational background, race or age.*

Figure 4-8 Survey: Maker movement and Inclusiveness Statement #1.

Data gathered through in-depth interviews provides us with an idea of how the seeming contradiction can be explained. Many interviewees have answered similarly to the overall averages and explained their answers. Generally, the first statement was understood theoretically. The movement *in theory* is open to everyone no matter who they are. The second statement reflects more on the real-life implementation of that aspiration. Here, many Makers still seem to see a need for action. Frank puts it as follows: "In theory, it is inclusive. But in real life it's probably still got quite some way to go. That's why I see a discrepancy…What do we want to be? And who are we really?" Many others, e.g. Klara, Jane and Jack, mirror this sentiment. None of the in-depth interviewees claim that the movement is truly inclusive both in theory and practice. Heidi comes closest, though. She acknowledges problems here and there but thinks that

There is no other movement I know of that works so hard on taking everybody along. There are negative examples in the spaces and there are obstacles you

have to overcome, but in the end the Maker and hacker movement – those are the people who are most likely to cater to people's needs.

Survey: Maker movement & Inclusiveness Statement #2

*Despite being inclusive in theory, I think the Maker movement
still has some work to do in order to call itself truly inclusive.*
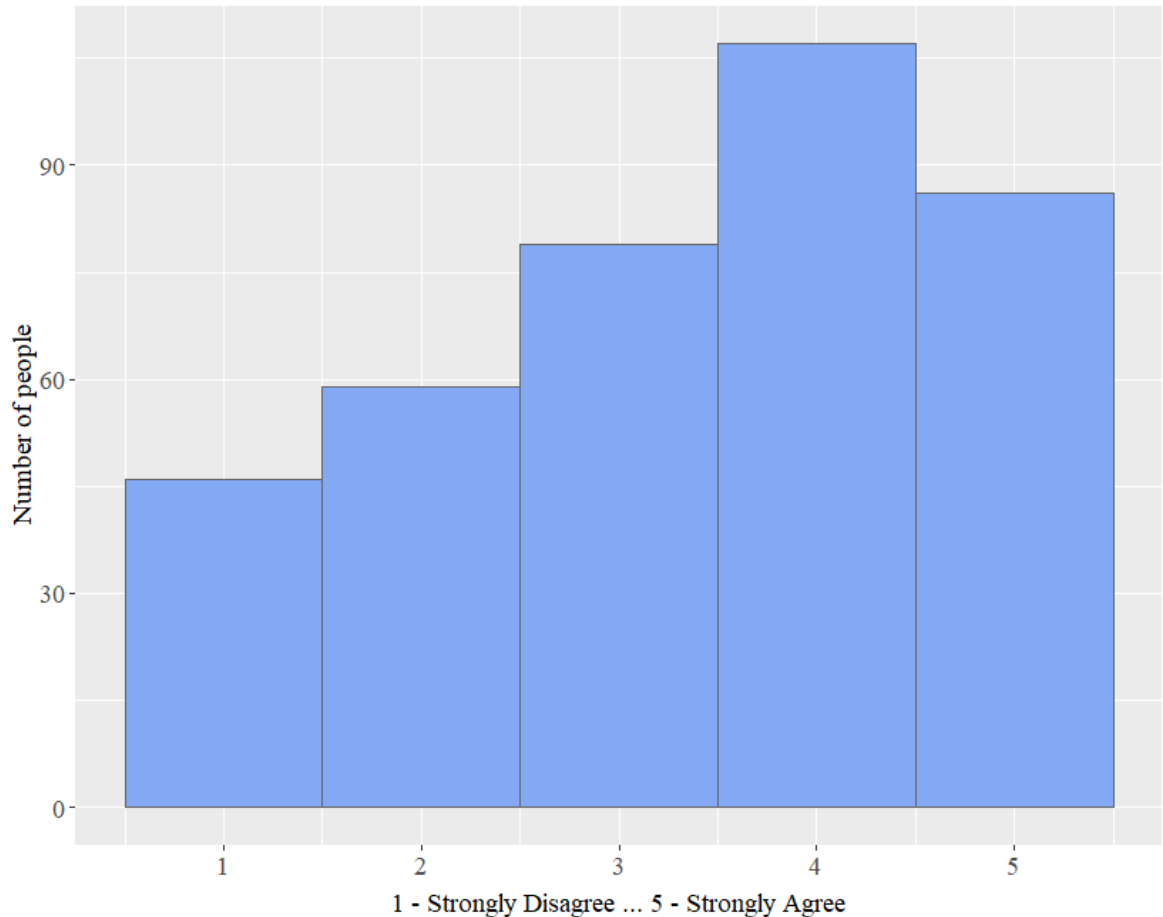

Figure 4-9 Survey: Maker movement and Inclusiveness Statement #2.

The survey makes it obvious that inclusiveness and diversity is valued highly by the majority of participants. Almost 91% of women and 82% of men agree that inclusiveness in their Makerspace is important. Anton emphasises that his Makerspace works so well because of its diversity and because its community includes everyone: "Diversity is the key to success." Not every Maker sees it that way though. As mentioned earlier already, some survey participants were not pleased with gender being a focus of this study. Participant B227 (man, UK, 35) explains:

> The focus on diversity – sometimes at the expense of creativity – means that people are always trying to be 'politically' correct. This in itself puts many makers off and they retreat to their own safe spaces. Having an environment where you can be yourself, not be preached at and definitely not expected to fall into some left wing [*sic*] ideology.

The notion of safe spaces is brought up in various ways as we have already seen in section 4.2.3 when talking about community. Quite a few Makers in Makerspaces seem to see their space as a safe space and a refuge from reality. Anton points out that being included and having support to be whoever you want to be is, in fact, a privilege. This notion is an interesting one, especially when considering participant B227 who does not feel the need to provide a safe space for others and rather retreats into his own safe space. The analysis Chapter 6 explores this further.

It is easy to see that there are different levels of inclusion and different ideas about how to implement existing ideals of inclusion in Makerspaces. Before focusing on gender inclusion, other characteristic groups interviewees named as important to include are highlighted. One of these groups can be summarised as people from disadvantaged social-economic backgrounds. A few Makers name this as an obstacle to join and do point out that Making itself is somewhat a privilege:

> It's a time-intense hobby, which has to do a lot with class and background. Who has the time to tinker around in the evening? There are many reasons for that and the maker scene is actually a quite homogenous bunch (Anna).

> And still there are access limitations. The commonality is the passion for computers or politics and so on. But that requires that you don't fight for your survival on a daily basis. In the sense of if you're down on your uppers, you won't have time to deal with things like that (Anton).

Quite a few Makers acknowledge financial burdens as well. Klara comments on Makerspaces struggling for financial stability themselves and thus relying heavily on membership fees which not everyone can afford. Similarly, though, Frank acknowledges that without Makerspaces many Makers would not be able to access the expensive tools that these provide them with.

A further group that is mentioned as needing active support is that of introverts and people with low confidence. Some interviewees remark on the importance of making sure that people with low confidence are included and not left out. Rose, who already mentioned that she hasn't found a space yet where she has been comfortable, says:

> [it's] predominantly [a] white males late 30s social interaction. It wasn't the relaxed and supportive makerspace environment that I'm looking for. If I said that to them they'd be really surprised. I'm confident enough in my own inability in a couple of times to confidently ask for help. If I wasn't as

> confident, then there wouldn't be eye contact and it would be very difficult to go in as an individual person.

This aspect resurfaces when talking about gender-specific issues as the connection between gender and confidence levels has been raised by a few interviewees. Other aspects that face exclusion issues are political affiliation, language barriers, mental health issues and disabilities. All these aspects are highly intriguing and demand further in-depth exploration – strong potential cases for further research.

A last paragraph before moving on shall briefly highlight issues that are not so much raised as inclusiveness but accessibility and practical issues. For example, some interviewees remark on the distance to their Makerspace and that they might have gone to the space more often before they moved away and are now not close enough anymore to drop in during the week. Equally, we have already seen that time and money can be a reason that people cannot access Makerspaces. Other commitments, such as a full-time job, studies or the family, can prevent someone from being able to access a space regularly. Even though these are mostly named as more practical issues, the discussion chapters shall examine them under inclusiveness issues because stereotypical gender-roles might have a big impact on these aspects.

4.4.2   Gender Inclusiveness

When consulting all collected data, there can be no doubt that women are less included and a minority in Making communities. Looking at the survey data, for example, reveals a higher level of agreement for the question whether men are well included (median: 5 out of 5) than if women are well included (median: 4 out of 5) (see Figure 4-10 and Figure 4-11). The medians for non-binary and transgender people are even lower with a 3 out of 5 for both.

Survey: Women & Inclusiveness Statement

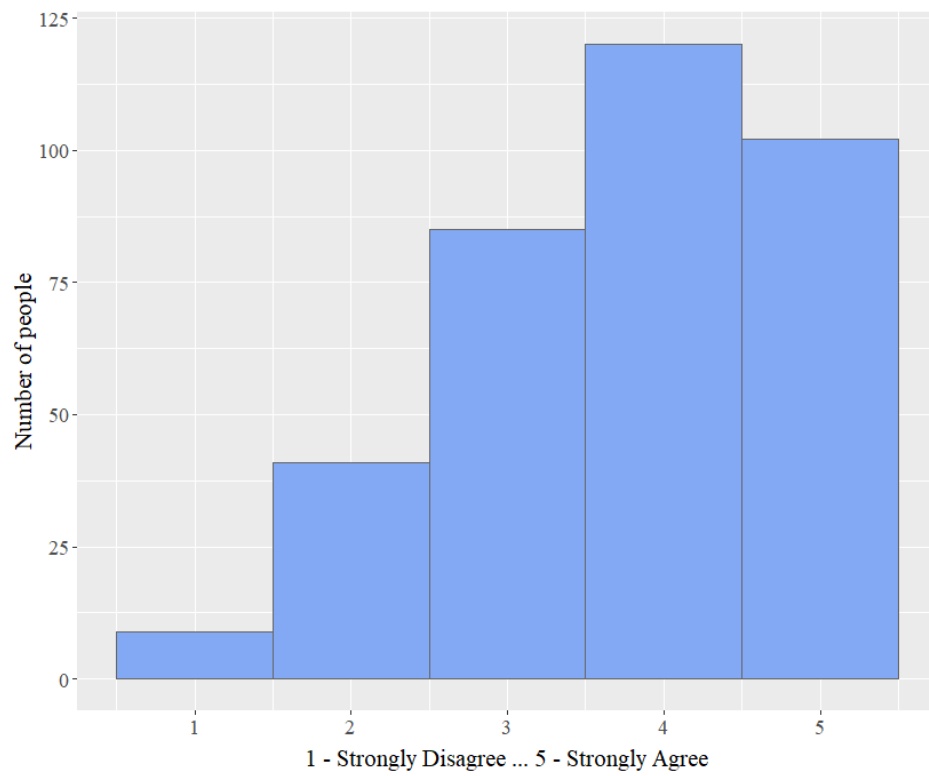*Women are well included in my hacker-/Makerspace.*

Figure 4-10 Women and Inclusiveness.

Survey: Men & Inclusiveness Statement

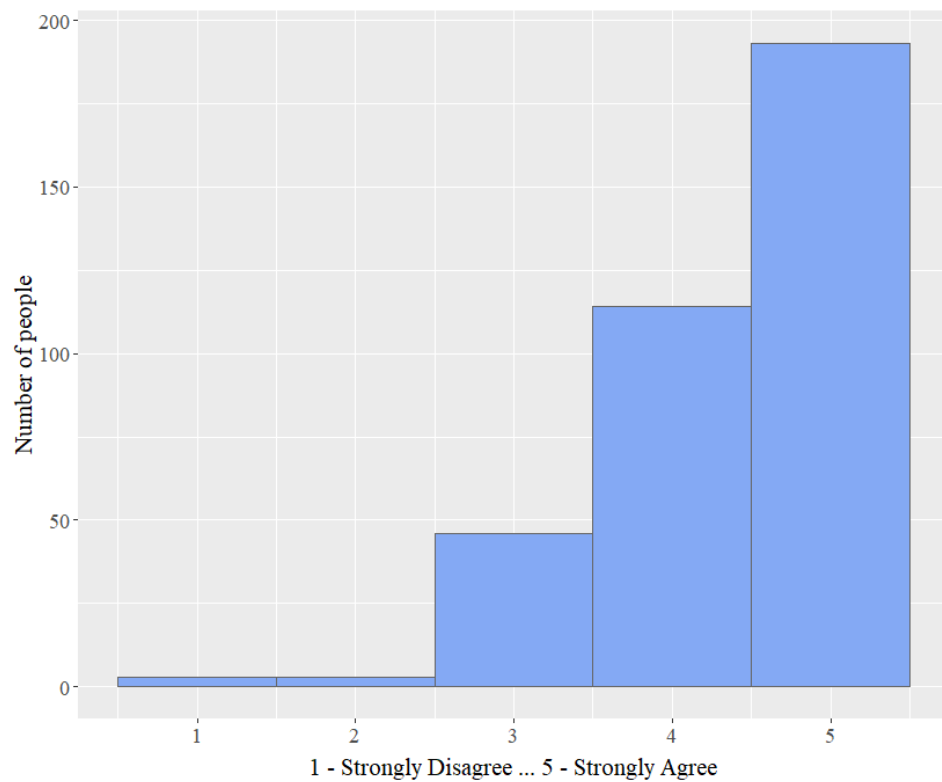*Men are well included in my hacker-/Makerspace.*

Figure 4-11 Men and Inclusiveness.

Equally, almost all in-depth interview participants note that women are in a minority in their Makerspaces. Some remarks that stand out are, for example, from Moritz and Lewis who both say they do not know enough or any female Makers at all. Also, Jane explains "we have got a majority of male members because we have attracted fewer females [but] we were about 50:50 when we first started".

A noteworthy observation relates to how female in-depth interview participants engage in the movement. Five of them, plus our one non-binary participant, are involved in Making-related community engagement activities such as workshops, in running a Makerspace or helping other Makerspaces set-up. Four of them even do this for a living. None of the male participants engage in paid work that helps other Makerspaces and only two are involved on an organisational and workshop-providing level. The tendency for female Makers to be more involved on the organisational side of things has already been pointed out by Millard et al. (2018) and is further explored in the analysis chapters.

The following paragraphs explore some of the issues that interviewees suspect as leading to the aforementioned gender imbalances. Two main problem areas are raised: the physicality of a space, and its community.

4.4.2.1 Physicality of space

The way some spaces are set up has been an issue for some female Makers. Rose says she does not "particularly want to go into a dark dank really awful space. […] Some people do, they are fine with it, they think it's really edgy." She goes on to describe a local Makerspace that is industrial, freezing and "really not too pleasant." She is not alone. Lewis focuses on closed doors when talking about the unintended exclusion of some people:

> […] from a physical point of view, an awful lot of maker spaces, by their nature, are locked-door closed premises. Now, that is very necessary in terms of theft, health and safety, all these things, but I think also a lot of maker spaces don't go out of their way to publicize themselves. I think that particularly applies to the ones that run on the more closed-door they are in terms of their entry requirements, the more closed they are in their, if you like, their community relations.

These conditions are often not comfortable for women and they might feel unsafe which will be discussed further in later chapters. Another aspect relating to the set-up and physicality of a space are the tools and workstations that can be found in them. More than half of the

interviewees agree that there is a difference in what Making activities different gender groups engage with to some extent. Klara remarks that

> it depends on the tools. So we have been to some makerspaces where the gender is more towards the men, […] because the tools they have in that makerspace are more stereotyped as male-oriented. So they have these laser-cutters and CNC machines and 3D printers. And maybe other makerspaces don't have these things but have more sewing machines, more embroidery things, more craft-orientated making equipment. I think then you have more females there.

Reasons for a gender-divide in tool usage are mostly seen as located in upbringing and socialisation. Anna thinks that "there's little difference in haptic aspects. […] I think it's a lot about what we show children and that remains with them into adulthood." Lewis, however, disagrees to some extent and locates these imbalances in physical differences:

> I think it's more about physiology than necessarily about gender […]. The endurance required for doing some of the woodworking and metalworking, you have to be quite physically tough to actually do it. Whereas, for example, something like jewellery making to me seems to be almost entirely female dominated. That is partly because women do tend to wear more jewellery, but I think it's also partly to do with the fact that an awful lot of men don't have the manual dexterity to necessarily do the precision work that's required.

He hints towards imbalances in both ways which other Makers remark on too. In fact, when talking about closing the divide between genders and tool-usage, some interviewees see a higher rate of emancipation among women than the other way around. Lisa, for example:

> Women nowadays are less affected than men, because when it comes to women, I think they have emancipated themselves more. Now no women will be looked at weirdly because she's dealing with 3D-printers; men who knit probably will.

Another Maker who confirms this view is Frank. He similarly sees less men involved in stereotypical female activities than the other way around. These aspects shall be discussed in more detail in Chapter 6.

4.4.2.2 Community of space

When it comes to the community in a space, the main issue that is brought up is that it can be an unfriendly and even sexist space in which women do not feel comfortable or free to engage in their Maker practice. Quite a few female interviewees describe their experiences

of Makerspace communities as something uncomfortable. Nancy recalls her experience in a university-based Makerspace:

> I wasn't made to feel very welcome there when I started going and it took me quite a long time to feel confident in that space […] There weren't many women who felt very comfortable […]. All the technicians were also men as well and seeing all the older male students there, you just felt like this wasn't your space. […] I actually needed to ask for help quite often and felt bad about asking for help so much. Especially the instructors were men who were used to explaining it to men who didn't need that much explaining to. […] when a girl would come up to them and ask some questions, I think that they would look a little bit 'oh here we go…this is going to take quite a lot of work'. And that was a problem that was creating itself by the women not being there very often and therefore not being as good and therefore needing more help and then they'd go and the guys would make them feel bad.

Lisa is another Maker who felt weird when she first entered a Makerspace:

> As a woman I was made feel welcome, they were all very happy when I showed up. But I did sometimes have the feeling that I was treated differently than everyone else. Not even in a negative way, but just because I was a woman and they partly didn't know how to treat me. That was a bit weird sometimes.

Megan mentions that some of this behaviour might be done unconsciously. She works with a few men in her Makerspace team and, when alerting them to the fact that they mostly pick men over women to help out during a training, they say things like "Oh, shit. Sorry. I didn't even think about that" and then change their behaviour.

One further aspect adding to an un-welcoming atmosphere was mentioned by two interviewees. They recall instances of porn being displayed in their spaces. Frank recounts:

> For some time […] we had this weird porn movie running on an old television device. Someone had set it up in a way that the moment it had electricity it would automatically boot and play that movie. That's just an example but it could be deterring.

He says by now it has been stopped mainly because some Makers have started bringing their children along to the space. A second interviewee who mentions porn, Heidi, is annoyed that she has to put up with sexist behaviour in her space: "Why do I have to listen to all these sexist jokes? Why do I have to watch these porn snippets that are projected at a wall?"

Lisa, who has already mentioned that she was treated a bit differently in her space, explains that something that made her really uncomfortable was that she got hit on in her first couple

of months: "I was wooed a bit which I didn't really notice at the beginning but it got more over time. That felt really, really strange and I found that attention quite repulsive. I did not feel comfortable." Felix, from the side of the men, explains that women are welcome by men, potentially because the latter are looking for a girlfriend:

> Especially with Hackers and nerds, women are very welcome. Everyone is happy if some are there because so few are interested in the topic. And of course, it's also this 'maybe one of them will be right for me because I would like to have a nerdess' thing.

He adds later on: "Generally women are very welcome. Unless they start handing out creeper cards [flyers criticising that the movement is male-biased], like at the congress[7] a few years ago, then it's problematic. […] These women are just different." There is an obvious double-standard here of what kind of women are 'allowed' and what kind are not. This is discussed further later on.

Not just women, but also men might find the environment in a Makerspace difficult to handle. Karl explains why he is not keen on joining a group of Makers:

> Especially if you have a lot of men, you have the feeling it quickly evolves into dick-comparison. I can't be arsed with that at all. Especially because I often think as arrogantly 'I can simply do it better'. I'll be quite arrogant then. […] And I don't want to get involved in the whole goading each other thing. […] It's silly, I can't stand that at all.

He points towards a potentially quite masculine atmosphere in a Makerspace and that one might have to adopt stereotypically masculine characteristics in order to fit in and feel comfortable. Quite a few of the interviewed women have described themselves as exhibiting masculine characteristics which might be why they, in particular, fit in:

> Heidi
> In this one space I am always called a dude because I just somehow integrated. […] They say 'you're just a guy with tits'. […] I am one of the guys. […] It didn't bother me in the beginning, it was just normal. But now, the more I think about it, the more it's a problem because I am a woman. Why do I have to become a man to fit in?

> Rose
> I think I'm a square peg. [talking about her love of digital Making and crafting]

> Megan
> I've always had the tomboy bit of me anyway, but to go into tomboy mode …

---

[7] Chaos Communication Congress, an annual conference organised by the Chaos Computer Club Germany.

to go just 'I am not a sexual object. I'm as good as any of you guys.' …
everyone deals with it in different ways, but it's really tough.

Jane
The female profile is a bit like a kind of tomboy type thing. Sort of on the edge
but not really like the sort of … like I was a tomboy, I was described as a
tomboy when I was a kid. […] I was never very girly and I liked the kind of
things that were the sort of boy's activities. And generally speaking, I think it
[making] probably attracts that kind of border line…I think girly people would
find it all a bit male.

Jane hints towards the observation that it is not just herself exhibiting masculine
characteristics but other women as well. Megan, in fact, goes one step further and calls it "a
tribe of Maker women." She describes them as exhibiting a kind of tough femininity and
often having dyed hair and being tattooed. According to her, there's also a high percentage
of gay women involved in Makerspaces because they might have these characteristics more
naturally. Megan remarks that by far not every woman is or has to be part of this 'tribe' but
she guesses that about 50% would fit that description.

Equally, women who do not exhibit typically masculine characteristics can feel left out. We
remember Nancy who did not feel made welcome in her space and who also says:

I see this in myself and some of the women around me, that we want to kind of
[…] want to know exact not only what we're doing but also the how we're
going to do it, […] whereas men are a lot more 'let's just go for it, try it, if we
fail we just try again, it'll be fine' and I think that kind of tentative element
when it comes to machinery can feel quite…can basically put you off very
easily.

This links well into the notion of confidence which was already hinted at previously when
raising the inclusion of introverts and people with low confidence. In fact, some interviewees
have explained that confidence is a deciding factor and that, equally, women usually have
less of it than men in Makerspaces. Anna is part of a feminist hackerspace and reflects:

We do FLTI [female, lesbian, trans, inter] crypto parties and we have people
joining who never dared to before. It changes the climate and people dare to
attend. We often have people who would otherwise never join. […] There are a
few women in other spaces who dare to go there. But there are also people who
say: 'I think that's cool but I never dared to go.' And then they realise it's
totally their thing and they stick with it.

Heidi is a good example of that confidence which might explain why she has emphasised at
the beginning that the MM is the most inclusive movement despite still having to deal with

a few issues. She says "I can totally understand that a woman feels uncomfortable when first entering a makerspace. There are only men […]. You are looked at and then ignored. You have to have the guts to say 'I'm going in and I will participate anyway.'"

In fact, a couple of interviewees have linked the level of confidence in a Maker not just with gender but with the specific kinds of tools and activities. As seen previously, Robin has remarked on the difference in gender and confidence. Anna, who we have heard from in regards to gendered upbringing in relationship to tools and Making activities, also highlights this point, namely that it often depends on your level of confidence in terms of which things you try and engage with: "If you have no idea about technology, your inhibition threshold will be higher."

4.4.3   Tackling Gender Issues

When talking about if and how some of these gender imbalances could be mitigated, three main tendencies emerge: those who do not see the need for or do not actively engage in change, those who attribute this change to the individuals who are not part of spaces, and those who suggest changes Makerspaces could make. These three categories do overlap. The first group is a rather small one. Study participants here do not see Makerspaces as responsible to tackle gender imbalances. One survey participant states:

> The hackspaces that I am involved with (3 main ones) are all predominantly male. They are all tolerant environments and do their best to welcome all. However, the questions that you asked did not address the larger societal issues of whose responsibility it is to attract women and specific minority groups. In looking at questions of inclusion, I do not see how this has to be the responsibility of the making organisation (B289, man, UK, 61).

Along similar lines is Frank's space. When asked if they discuss how to attract more women into the space, he answers that this is not discussed, and they do not actively look for women. Earlier on in the interview, he also emphasised that he does not see the solving of social problems as part of the task of a Makerspace as this is not the right place to change society.

A couple of interviewees, maybe along similar lines, hint towards the responsibility of the individuals themselves. Hans says: "If they [women] aren't there, we can't please them." Even though Heidi never says it directly, she seems to locate a lot of the responsibility also with the individual when, as we saw above, she says a woman needs "to have the guts" to participate in a space. Some of the women of the study remark on the emotional strength it takes for a woman to include herself. They do not demand women are responsible for their

own integration but merely point out that it can be emotionally draining. Megan finds it "a very tough thing to do" when reflecting on how to succeed in a field that is completely dominated by men. Nancy felt a lot of disadvantage in her Makerspace at university and a lower confidence level than her male classmate. She reflects:

> it's difficult but I got over it. I mean I'm still not as confident by the end of 4 years as he was by the start but I would go down there and I would just make…do it my own way and I would accept that I was going to have to ask more questions.

Lewis points out that he sees responsibility with the individuals as well as with the spaces. He states:

> […] individual makers who find themselves excluded should make a point of approaching the organization which is excluding them and saying, 'I wish to be part of your organization or one like it,' so that the organizations are aware of the issues. Because I think it's all very easy to say, 'Well, they should just open their doors' but if they haven't had people knocking, then they won't know that they need to open the doors. I think it goes both ways. I think the individuals who are excluded need to make themselves known, but then the places that are doing the excluding need to open the doors.

Two Makerspaces who were interviewed at Maker Faires did also see some of the responsibility on themselves to attract a more diverse crowd of people, but both seemed to struggle to some extent as to how to achieve this. Whereas one of them actively advertises in a variety of online places and has a policy on misconduct in place (A037, man, UK, 28), the other have a code of conduct in place but still struggled to attract more female members (A051, man, UK, 21). The question as to who is responsible for the integration of minority groups was not directly raised with interviewees which is why these were only glimpses into the issue when it was raised by interviewees. What was talked about specifically were ideas of how to tackle gender imbalances in the Maker community. The gathered ideas are presented in the following paragraphs.

Many ideas were highlighted when it came to the active integration and recruitment of women/minorities. Some interviewees spoke about what can be summarised as a friendly, welcoming culture in the space. This starts with a contact person for new people who enter the space. Felix calls this person the contact Maker. Heidi talks about one of her two Makerspaces and explains how one of them takes care of new people:

> when someone new comes into the space, they'll get a tour. There'll be asked 'Is there a specific topic that interests you?' and these people are a little bit taken by the hand. That works better than in the other [space]. That's how it should be so that new people don't run into a wall.

Another aspect that is raised is that of creating the physical features of a space more balanced. For example, a balance of stereotypically male and female tools and workstations can be installed. When talking about this balance, Klara suggests that

> it's good to have a balance of both things and also it also doesn't stop the other gender from coming. […] you could have a CNC machine that attracts more males and a more crafty side in it, but once you're in there I found that most people are also interested in the other things too. So it might not attract them in the first place but once it's there, they are also interested.

Equally, generally a nicer and more appealing appearance of the space could attract more women. Jack reflects on a recent increase in female Makers in his space:

> It's getting better. We moved to this new space six months ago, which I think is a much nicer environment to hang out and we have more space and things as well. […] I'm not sure if that's the thing that's caused the increase in that or whether it's just a general increase in membership and we're getting word out a bit more and so more women are doing stuff.

Even though he is not sure if the move to a nicer space has increased female participation, it is worth mentioning this development, especially when some women find closed-off, dark spaces very unappealing. Something Jack also mentions as an idea for the future is to make their Makerspace a parent-toddler co-working space, meaning that parents could bring their toddlers who will be taken care off while the parent engages in Making. He does not mention this specifically to increase female membership, but it can be assumed that this would benefit women as well. Again, this aspect is reflected on further in later chapters.

A few Makers have mentioned the positive effects a female role model can have or is having on a Maker community and its female Makers. Jane and Megan are good examples as they themselves function as leading Makers in their spaces. Megan explains:

> If I'm the first person you see when you walk in it's really different. If in the tour you're talking about women making stuff, you're talking about how important women are in the space […] just as part of the narrative.

Others mention the importance of having women and generally a diverse group of people involved at the planning stage. "I think the more diverse the planning committee, the more probably welcoming the space is – that's what I've seen" says Rose.

An idea that is a bit more contested is that of women only spaces and/or workshops. Anna as part of a feminist hackerspace and Nancy having delivered women-only workshops are absolutely in favour of this kind of positive discrimination. Nancy thinks back on a women-only workshop where one participant struggled to handle a drill because she had never used one before:

> I have run women's woodworking classes, […] I kind of create a save space [and] make that seem totally fine. [It] really helps creating that friendly environment. […] These woodworking classes were led by women for women and I think that that helps too, cause just being sensitive to those issues is very important.

Anna notes that her feminist hackerspace often "gets shit" for excluding people openly. She defends that choice: "They [regular spaces] don't make it explicit but if you look around those spaces – there are mainly white middle-class men … totally by accident [ironically]." She continues to explain the privilege of class and socio-economic background that we already read about previously and closes with: "it's just a very homogenous bunch."

Jane and James are sceptical of such measures. Jane would never join a women's only group because she does not want this kind of segregation. "It's like I'm almost against them because I understand why they exist, but I almost feel that's counter-productive to what we're trying to do." James does not voice his disagreement this decisively but is still sceptical. When asked what could be done to include more women he answers:

> I'm not really sure what you can do apart from things that might then in their turn seem to be discriminatory, like having women-only workshops or something which I think is laudable, but you can get wrong… You can get some people's backs up as well, I think because it looks a bit discriminatory.

Another area that is raised regularly is communication. Two aspects emerge: challenging sexism in spaces directly, and how Making and a space's activities are communicated in general. Some of the examples of directly challenging some of the behaviour that makes women uncomfortable has already been mentioned, i.e. asking men to stop hitting on female Makers or challenging unconscious bias in how workshops are led. Heidi, being the confident character we have already got to know, explains how she tackles sexist comments

towards her: "I will tell them. I won't mince matters." When asked how men react to this, she explains: "mostly with an embarrassed smirk. I sometimes manage to make them feel ashamed about what just happened. And they will get a full load back, it's not like we women can't be sexist."

Megan, Rose and Robin are especially focused on the way Making activities are communicated – and through that gender. All three are actively involved in setting up spaces and delivering Maker workshops – and thus how to approach marketing in these cases. We have already heard from Rose in the environmental section and how communicating through the lens of real-world problems instead of technology can alter participation:

> […] we never put technology first, and that's coming from our practice and recognizing that to look at diversity and to encourage more women to come into makerspaces and the tech. Whereas, I always find that advertising something with tech, the guys, the uptake is just straight away.

Robin, very similarly, works on their communication in order to ensure diversity. They reflect on their time of working in a local Makerspace:

> I am a geek myself. […] It's about who knows the most, who's got the most experience about the most cutting-edge technology. It becomes very jargon-led. If you don't know the right words, then you don't fit into the crowd kind of thing. I think that kind of setup can be very men-driven. [...] The fact that we were more design-led, it was very much about what you were trying to make. It could be any type of motivation and meant that it was more open to everyone.

Megan approaches communication a little bit differently but also with women in mind. In her Makerspace they put women on the front of all their publications. "Even on the website now, the first thing you see is a drawing of a woman using some tool and that picture of a woman is bigger than the picture of a man. All these […] things, they are invitations."

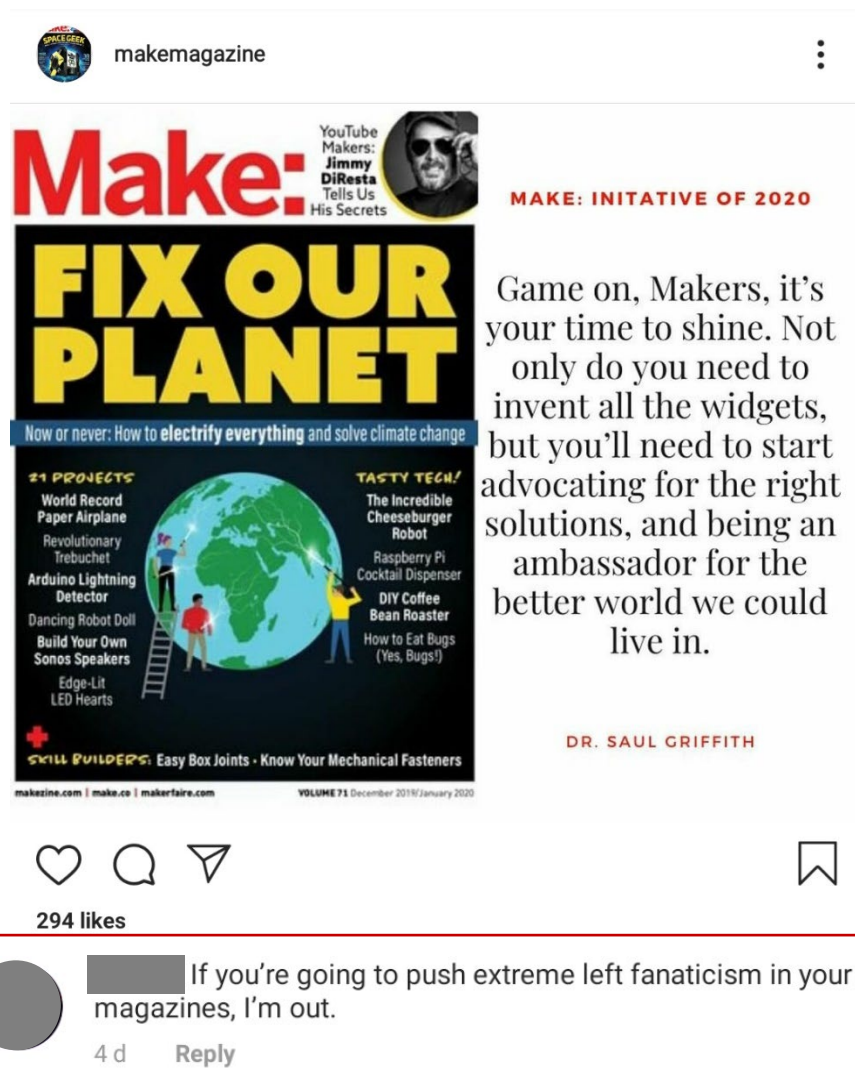# Chapter 5   Morphology of the Maker Movement

Figure 5-1 An Instagram-post and comment on *Make*: magazine's call to Makers to tackle the climate crisis.

The literature review has shown the difficulty of devising a singular definition of the MM. This chapter, therefore, sets out to develop a morphology which allows for tensions and a multitude of Making constellations while ensuring a unifying and stable conceptualisation. This is achieved through applying Freeden's morphology of ideologies. His ideas and concepts of how to define complex and dynamic ideological structures offer ideal tools to unpack the various concepts characterising a movement. This study appears to be the first applying Freeden's political theory model not to an ideology but to a cultural movement. The reasons for why Freeden's model is used in this context can be traced back to the model's flexible yet sturdy approach to understanding a larger complex system of beliefs and motivations that shape a social group. Just as within ideologies, important aspects of

being a Maker are contested and contradict each other. Freeden's model allows for the existence of these tensions and does not require a decision between different aspects as to what can be included in defining a social system and what cannot. Additionally, as noted in the literature review, this study views everything as political, whether it is a conversation between two amateur Makers or recycling old devices. As such, there is no contradiction in applying Freeden's political conception to the MM.

While applying his theory as laid out in section 3.2.2 of the research design chapter, the following sections follows a straightforward approach. Section 5.1 examines core concepts, 5.2 adjacent concepts and 5.3 peripheral concepts. These concepts are often very complex in and of themselves and deserve much more attention than can be attributed here. However, this morphology employs sufficient detail to distinguish Makers from other activities. Every section in this chapter explains the respective concept and why it is relevant, addresses why it is located within core, adjacent or peripheral concepts, and shows connections to other concepts and how they shape each other. Not all connections between all concepts can be pointed out and explained, however. A more comprehensive study is necessary if each connection were to be explored.

Before moving on, a short note needs to be given on the visual representation of the morphology as provided by this study. Freeden, to the knowledge of the author, has not developed a visual representation for his theory in any of his writings. The visuals in this study are, thus, developed from scratch without previous models. The visual representation of the morphology as a whole as developed in this chapter is largely shown without connecting links between the concepts as these are likely to differ between various manifestations. One of those manifestations, namely that for Makerspaces in the UK, Germany and Austria, is explored towards the end in section 5.4 and shows links. The only connections already portrayed in the general morphology visual are those between the core concepts as they are essential in showing the core of Making activities. To ensure an understanding of where this chapter is going, Figure 5-2 already presents the model in full.

Figure 5-2 Morphology of the Maker movement.

5.1　Core Concepts

The first three concepts that are discussed are core concepts. They are at the core of what it means to be a Maker and are indispensable when talking about Making activities: *Re-/Creating*, *Technology*, and *Personal Agency* (see Figure 5-3). These core concepts have been chosen due to their centrality within all Making activities as found in the literature as well as in the data collected by the present study. Not only is shown what each concept entails, but also how they shape each other.
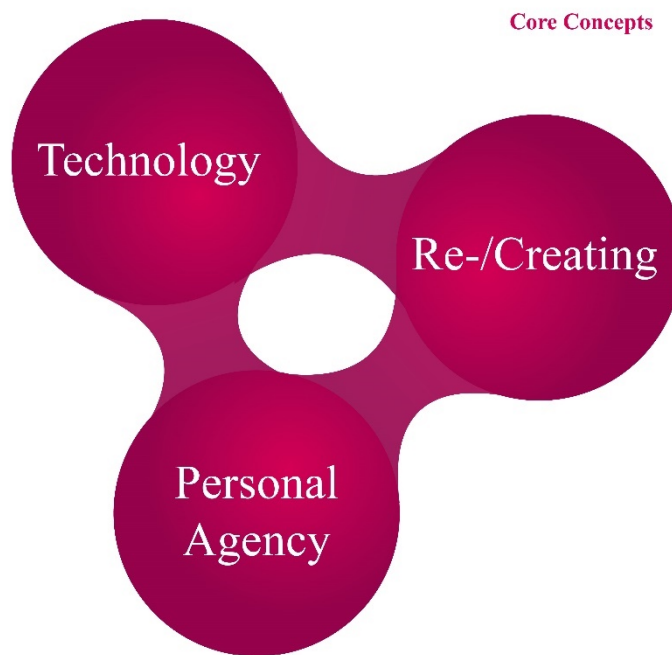
Figure 5-3 Core concepts of the Maker movement.

5.1.1　Re-/Creating

It is challenging to define the verb *Making* with one that captures a similarly wide variety of activities without using the word itself. Thus, *creating* is not an ideal choice due to its connotation of the created object not having existed before, but is applied in a suitable way. Lexico (2020b), a collaboration between Dictionary.com and Oxford University Press, defines the verb as follows: "Bring (something) into existence." This implies that, for example, repairing something that already exists cannot be considered as creating. However, here it not only refers to things newly brought into existence, but also to those being, for example, repaired, fixed, or upcycled. As such, they are transformed into a new form of

existence – from broken to fixed, from waste to functional object. They are re-created. This includes not only the final object of re-/creating, but also the process of transformation itself. Therefore, the process of transforming something without reaching an endpoint is, equally, part of Making. The verb 'create', then, captures all kinds of active transformations of the material and the non-material including processes and not just completely new forms of existence.

Due to the rather obvious nature of *re-/creating* as at the core of Making activities, it is not specifically discussed a lot in literature, albeit mentioned often. The literature review cited statements such as "the concept of a maker as one who makes things" (Kwon & Lee, 2017, p.319) or Davies' account (2017, p.65) of Maker being motivated by "the sense that most people had lost touch with the realities of creation and production." Other academics, often in their abstracts and introductory paragraphs, briefly voice similar sentiments: "making refers to the creation of tangible artifacts" (Grimme et al., 2014, p.431) or "maker cultures are pointing towards the ideas of (almost) everyone designing, creating, producing and distributing renewed, new and improved products, machines, things or artefacts" (Nascimento & Pólvora, 2018, p.927).

Not only the literature but also the data of this study supports this notion. 111 survey participants stated that Making is about creating something from scratch, for example "Making has the purpose to create things" (B249, man, GER, 27) and "Making for me is defined by projects being created from scratch" (B047, man, GER, 32). This study does not only define Making as *making from scratch*, but proposes that it also includes, as core features, re-creating, modifying, optimising, assembling, in fact any kind of transformation of the project, which is due to the evidence supporting a much broader understanding of Making. Ames et al. (2018), for example, showcase a variety of Making communities who re-appropriate old material to use it for a different purpose. Similarly, interview participants of this PhD study regularly talk about repair and recycling. Heidi sums it up nicely: Makers "are people who are mesmerized with a specific topic and who are keen to make things themselves…to optimise things and to really work hard on it." We can remember survey participants' reasons of why they engage in Making (Figure 4-2). More than 300 participants (78%) said they enjoy Making things from scratch and 348 participants (87%) enjoying tinkering, thus confirming that Making does not only have to be about Making from scratch but also about fiddling and playing around with technology. Nevertheless, these different understandings hint towards first tensions within this concept and point towards different morphologies that contest this aspect in different ways.

Evidence for the importance of the process of transformation is equally ample. Gauntlett (2011, p.24f) states "the inherent satisfaction of making; the sense of being alive within the process; and the engagement with ideas, learning, and knowledge […] come not before or after but *within* the practice of making." Many Makers who were interviewed for this study have reported that it is not the final product that motivates them to Make, but the process itself:

> I find it quite relaxing and even a bit meditative sometimes […] I just enjoy the process of […] not quite knowing what the end result is going to be (A025, woman, UK, 25).

> I enjoy making because it's quite therapeutic. The process takes you away from all your worries and anything else because you're just focusing on the one thing in your hand (A039, woman, UK, 26).

> I enjoy making because it's a slow activity, so it gives me mindfulness about the stuff that I do. In a way it gives me the feeling that I can change something in the world. I come from an activist notion of Making. It's about taking back control and subverting capitalism and all these things. It's also about the process and valuing the process. Slowing down the process in a society that is so focused on consuming and getting the ready-made stuff (A053, woman, UK, 35).

> This is time out from everything that is going on in my life, I can actually concentrate on this piece of work and everything else is pushed on the burner. This is me-time, and afterwards I can go back to the real world (A064, woman, UK, 58).

These statements do not only talk about the process of Making, but relate it to other concepts as well, such as activism (section 5.2.6) and well-being (section 5.3.3). This is a prime example for Freeden's morphology and how concepts influence and shape each other. The process of re-/creating for these participants is about countering a modern lifestyle that is fast and focused on consumption. It is about improving your health and mental state of mind. We can clearly see that some Makers engage in Making for the challenge and the process of it, not (only) because of a certain outcome they wish to achieve. Making is valued as an end in itself. Frauenfelder (2010, p.220) sums up the importance of the process as follows:

> The planning, selection of tools and materials, creation of the workspace, method of construction, documentation, and final product of a DIY project are things to be savoured, not to be thought of as hassles or expenses. The end result […] is important, but it's also a reminder of an experience that serves as its own reward.

Further on, other concepts that are connected with this are explored, such as learning (5.2.3), activism (5.2.6) and the creativity that lies within the process (5.2.2). Important to note, however, is that the enjoyment of the process might not be felt by all Makers. Ames et al. (2018), for example, tell us about a collective of Makers in Bangladesh who (illegally) build their own water pipelines and electric circuits to sustain their living. This community might enjoy the process of doing so, but it does not appear to be at the core of their activities. Much more important seems the raising of their living standards and using direct action to do so. Again, a variety of contested beliefs come to light within this concept.

5.1.2   Technology

The concept of technology and exactly what kind of technology is created is less clear than that of re-/creating. Firstly, it is important to mention that the technology referred to in this section is about the things Makers create. In the literature review we have looked at technology in the movement in different categories, i.e. tools, skills and knowledge. This core concept refers only to the actual object of transformation. While acknowledging that the other categories of technology are heavily shaping the things that are re-/created, these other aspects are part of concepts that are explored further on. Specifically, digital technology considers modern technology that is used as a tool (with the necessary skills and knowledge) to create artefacts, not necessarily the artefacts themselves.

The literature review showed that many researchers and Makers connect Making almost exclusively to digital technology and objects that are, thus, equally often digital or shaped by those digital tools. However, Gendron's definition of technology (1977, p.23) which is employed in this study is wider than what is nowadays considered technology. As seen previously, it includes "any systematized practical knowledge, based on experimentation and/or scientific theory, which enhances the capacity of society to produce goods and services, and which is embodied in productive skills, organization, or machinery." The data chapter already provided a more varied picture of what it actually is that Makers make within their top 20 Maker activities, including textiles and woodwork. Equally, non-tangible things are being created: software and applications, illustrations or websites. Quite in extreme opposition to that are Maker communities that build infrastructure (Ames et al., 2018), houses (Ames et al., 2018) or agricultural devices (Open Source Ecology, 2018). Even though the MM as conceived in Western cultures is still very focused on digital technologies,

this is clearly opening up and more varied. Criticisms of this narrow focus came from some participants in the present study and interviewing Makers at Maker Faires has proven that people engage in much more different kinds of technology, e.g. building boats (A115, woman, GER, 36) or baking moveable cakes (A070, woman, UK, 40). Thus, the morphology created here and its core concept of technology includes everything that can be defined as technology according to Gendron's definition. The special role of digital technologies is further examined in the adjacent concepts section (5.2.4) whereas the less important role of traditional technologies is examined in section 5.3.4.

Besides easy to grasp and more or less tangible creations, more abstract creations are possible as well. For example, if spaces are transformed into meeting places for Makers to form communities in, then that can also be defined as a product of creation according to Gendron's definition. In this case, a space would be created through knowledge and organisation of how to create such a space for a community to form and work together effectively. This is a good example to iterate another important point: objects of creation are not always finished. In the case of a community space this is easy to understand as such a space is never fully finished but will develop over time and be shaped continuously. But also more material creations like the ones mentioned above do not necessarily reach a finished state. Sometimes a Maker is motivated simply by the challenge a project poses and, thus, by the opportunity it offers to be creative and learn. The final project might not be the actual goal and it might, therefore, never reach a final state because its Maker continuously works on it, changes it or abandons it for a new challenge. Consequently, we not only encounter a broad variety of projects but also a fluid idea of where these projects start and finish. This reminds of re-/creation as a process where the process of Making might be more important than the actual artefact. Not only is this concept heavily linked to re-/creating but to all other concepts as well. Being the centre of a Maker's attention, the object they work on and the reasons for doing so directly influence all aspects of their practice, e.g. activism (challenging production processes) or entrepreneurship (wanting to sell the object).

5.1.3   Personal Agency

This is key and one of – if not *the* – main defining attributes of being a Maker: the self has to be involved in the process of Making. It creates, hacks, fixes, tinkers. Making is about being active in your desire to make something happen. This agency is crucial. A quick definition of what agency is shall assist fleshing out the meaning of this core concept:

> In very general terms, an agent is a being with the capacity to act, and 'agency'
> denotes the exercise or manifestation of this capacity. […]
> The exercise of agency consists in the performance of intentional actions and,
> in many cases, in the performance of unintentional actions (Schlosser, 2015).

This capacity to act and create something is easily spotted within Making. The notion of self has been mentioned many times and by multiple authors, especially non-academic writers such as Dougherty and Hatch, who have remarked that Making things yourself is inherent to human beings and that, in fact:

> We all are makers: as cooks preparing food for our families, as gardeners, as
> knitters (Dougherty, 2012, p.11).

> Making is fundamental to what it means to be human (Hatch, 2014, p. 1).

But also in academic writing this notion of being an active agent within Making can be found (Miller, 2011; Margetts, 2011; Millard et al., 2017). In fact, Davies (2017, p.64) describes it as an essential aspect:

> *Action* is what counts, however small-scale and messy and imperfect. Just get
> something going, and see what happens. […] try something out rather than
> waiting for authorization or accreditation, […] The spirit of doing things was
> seen as a spirit of experimentation and of freedom. As we were told: don't ask,
> just do. Done is better than good.

It is not about wanting something done and asking/paying someone else to do it. It is about being pro-active and Making with your own skills, knowledge and creativity. A connection with re-/creating and technology becomes clear. Re-/creating technology has to be done by the self in order to be considered a Maker activity. The transformation of our material world is an active one undertaken primarily by the self. Repairing ones' own mobile phone is, for example, fully covered by these three core concepts, getting it repaired in a local shop is not as the personal agency component is missing. Within this morphology, therefore, all other concepts are contested and shaped by this active individual agent.

Gauntlett (2011, p.245) takes it one step further and declares that "Making things is about transforming materials into something new, but it is also about transforming one's own sense of self." Frauenfelder (2010, p.223) equally talks about Makers who "understand that when you do something yourself, the thing that changes most profoundly is you." Makers do not only transform externalities, but also themselves. The concept of empowerment, which is discussed within section 5.2.6, comes into play here. Makers might transform themselves

into entrepreneurs, disruptive hackers or environmental conscious citizens – a lot depends on which environment, with what goal and with whom they make. Again, certain morphologies will contest these aspects differently and are more likely to shape certain Makers and certain Making practices. Well-being is another prime example. Recalling participants' A025, A039, A053 and A064 quotations from section 5.1.1 shows that because of their personal engagement in Making, they feel an increase in their well-being. Buying an item is likely not to have the same effect.

This does not necessarily mean that no one else can ever be involved in your Making practice. Part of the MM is about sharing and community. For some Makers these concepts heavily shape each other which is further discussed in section 5.2.1 on Community. Many people can be involved in someone else's project through lending their expertise and skills, as seen in Chapter 4 and the way some Makers interact within their communities, or a group as a whole decides to work on a project together and within that group of people agency of the individual members will be just as important in getting a Making project off the ground and finished. An example is Klara: she suggested a project (a coded app) to her Maker group and together they embarked on realising this idea.

Personal agency is, as the previous core concepts, connected and shaped by notions of empowerment and activism whereby activism is defined rather broadly (see 5.2.6). Having another look at Schlosser's account of agency (2015) and its characteristics provides us with the following: "It seems that when we act, we have a sense of doing something: a sense of control and of being the agent or owner of the action." A sense of control is something many Makers speak of:

> It's the element of control. I like making things do what I want them to do. I'm not just taking a thing. It is mine. There is an immense satisfaction in saying 'I made that, that's mine, I did that'. […] It's really satisfying. The thing you're working on is there, it's real, and I just enjoy that feeling (A051, man, UK, 21).

Sometimes that sense of control is connected with an emphasis on political circumstances, as we have already seen with Megan who cherishes the idea that people can be active agents and challenge the top-down political system together. This example shows one way that personal agency is viewed is as a means to empower oneself (see section 5.2.6) and connect to others (see section 5.2.1). Again, we encounter a good example for Freeden's morphological theory in which different concepts shape and influence each other. This becomes clearer and clearer as we move through the different concepts.

5.1.4   Interim Summary

These three concepts together are at the core of this thesis' morphology (Figure 5-4). This is Making broken down into its core aspects. For now, these concepts might seem quite broad and include a too wide variety of human activities. If only employing the three core concepts, a Maker is everyone who actively creates or modifies an item of technology. Making a cup of tea would, thus, count as an act of Making culture. However, this study assumes a difference between everyday

Figure 5-4 Core concepts of the Maker movement, repeated.

making and Making. Where these three core aspects might define any aspect of everyday making, the following adjacent concepts provide further guidance and nuances to create a more specific understanding of Making cultures.
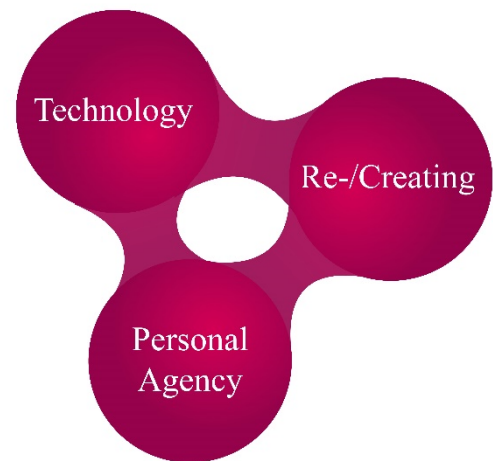
5.2   Adjacent Concepts

The following concepts are classed as adjacent concepts within this morphology. As mentioned previously, adjacent concepts are influenced by core concepts and, simultaneously, influence and further shape those core concepts (Freeden, 2013, p. 125). Contrary to core concepts, adjacent concepts do not necessarily appear in all different versions of the ideology. However, they are crucial in anchoring the core and defining it further (2013, p. 125). The following concepts are deemed to occupy that role within a Maker context: community, creativity, learning, digital technologies, amateurism, and activism.
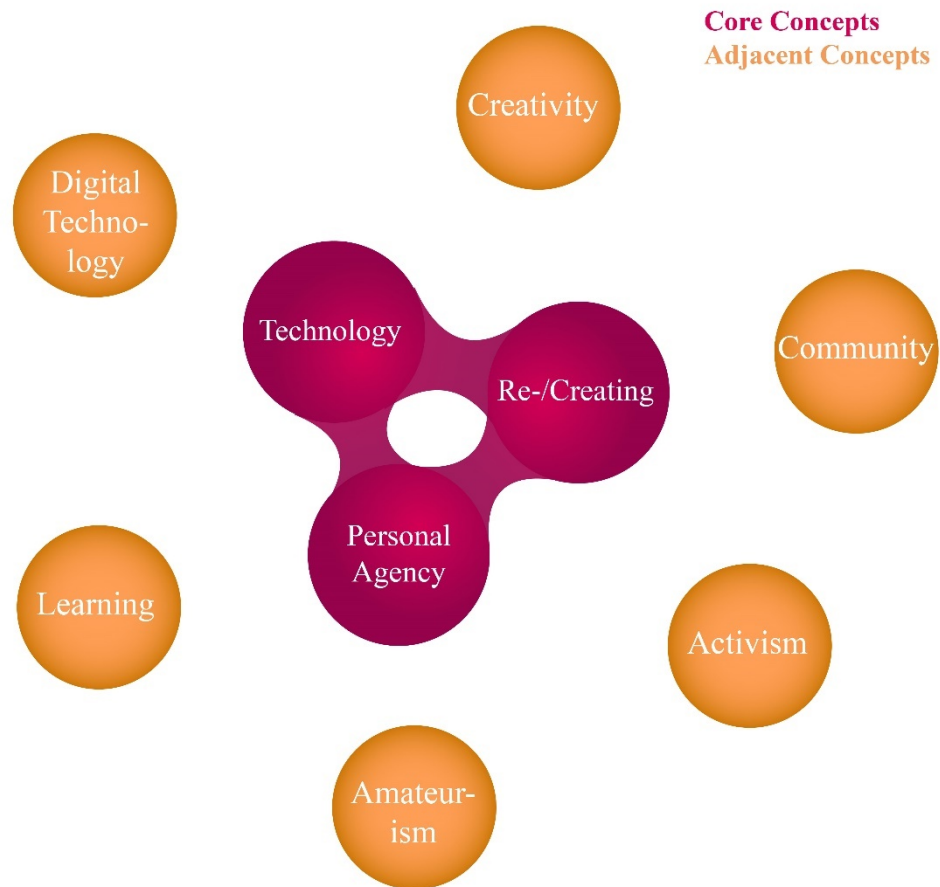
Figure 5-5 Core and Adjacent Concepts of the Maker movement.

5.2.1 Community

Community is a major consideration for many Makers, especially when they are part of a Maker- or hackerspace. Returning to the survey question of why Makers regularly attend their Makerspace, 213 out of 244 who do so have chosen the answer *I enjoy the community in the space/during the meet-up*. This answer beats all other answer options which include that the space is convenient for Making things (see Figure 5-6). As seen in the literature review, Davies (2017, p.157) defines community as one of the two main aspects of what Maker culture is all about and, thus, suggests this is a core concept:

> Community, community, community. It's hard to emphasize enough how central the idea of community was to the conversations that we had with hackers and makers. […] It is community that animates a hacker or makerspace, to such a degree that we were told that franchised or impersonal makerspaces were not 'real' hackerspaces because they lacked community.

Survey: Reasons to attend a Makerspace

Why do you go to a Maker-/hackerspace?
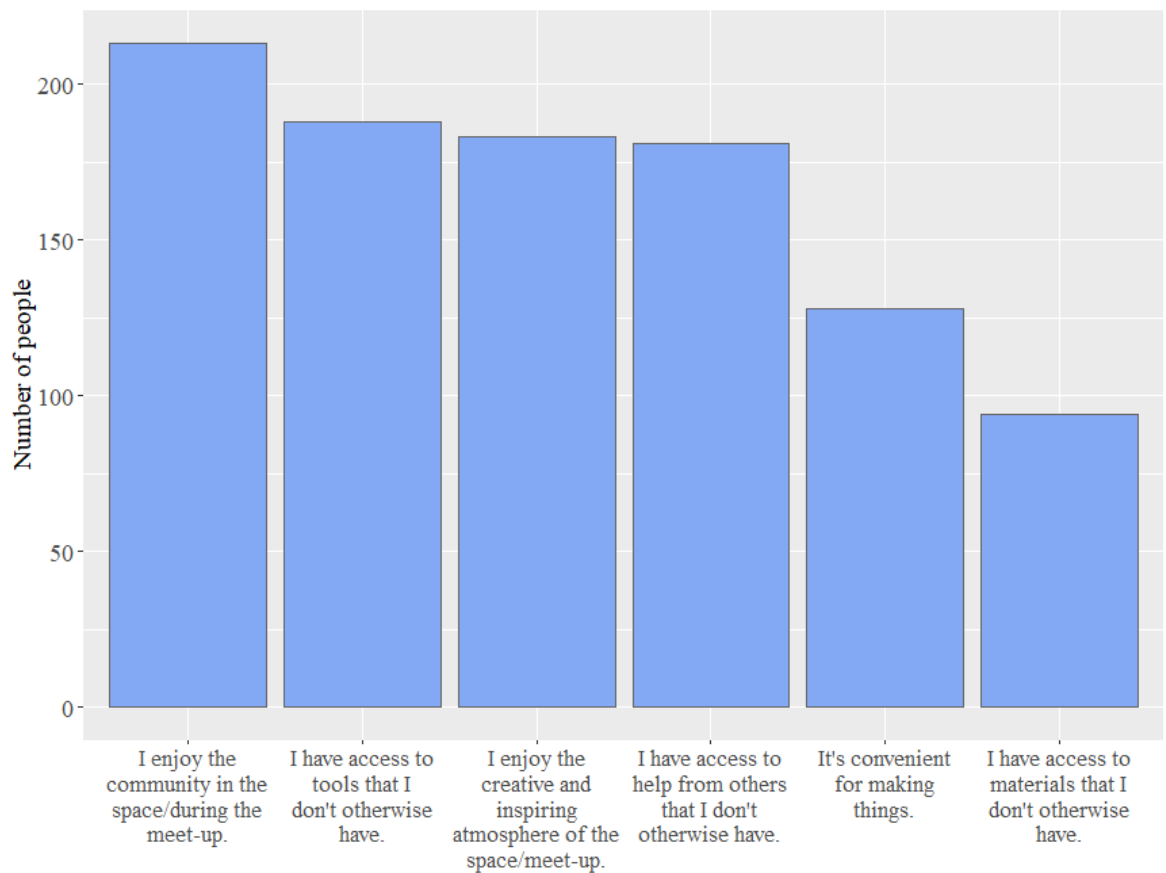
[Multiple answers possible.]

Figure 5-6 Survey: Reasons to attend a Makerspace.

The present research, by contrast, does not say that being part of a Maker community is essential in order to be a Maker, hence listing the community aspect only as an adjacent concept. Arguably, Davies only reached this conclusion because she exclusively spoke to Makers who are part of Making communities and not to those Making in solitude at home. Nevertheless, community seems to be important and decisive on different levels for many. These levels shall be explored in the following paragraphs.

Makers are organised on different levels, from local Makerspaces, which often form around digital tools, to globally accessible online platforms and mailing lists. The two are very much interlinked, with Makers in spaces drawing on online resources and online resources being influenced by Makers in their local Making environments. As already observed in the data chapter, something that seems to happen almost automatically when Makers are active within some kind of community is the sharing of ideas, knowledge and blueprints. About

half of in-depth interviewees acknowledged and celebrated the sharing of ideas and knowledge in their local Makerspace and short interview participants raised the benefits of meeting other Makers at Maker Faires and inspiring each other's creations and sharing ideas. Klara from a community-run Makerspace in Germany even acknowledged sharing of not only Making-related knowledge and skills, but generally social skills of problem solving and overcoming challenges in a community. Equally, more tangible things are shared, such as tools and material. This is clearly related to the concepts of learning whereby community and learning contest each other directly and profoundly.

Often, this takes place free-of-charge. Sharing is not an act based on exchange of money for goods, but of voluntary and free-of-charge giving. Ideas, blueprints, knowledge – all of it is created to share, not to own (Carpenter, 2011, p. 50). This encourages positive relationships build on trust, especially in Makerspaces where interactions are face-to-face. These dynamics seem to challenge the basic workings of neoliberalism and the way society works on a structural level – a stark contrast to the concept of entrepreneurship (see 5.3.5); yet another tension and sign for a variety of manifestations within Maker morphologies (also see section 5.2.6 on Activism).

Gauntlett is an advocate of the community-building power of Making and, as observed in the literature review, specifies three principal ways in which Making is connecting: connecting things together (materials and/or ideas), connecting with other people, and connecting with our social and physical environments (2011, p.2). The first point refers to our core concepts of modifying technology. In fact, not only materials and ideas are connected, but also the socio-technical systems behind those materials and ideas. Gauntlett's two latter points, in contrast, talk about how Making directly connects people, either during the creative process or through sharing creations with others. Even though he is not talking about the MM as such, his points are general enough to include Makers and their creative doings. Makerspaces are the epitome of these dynamics, showing us that Making brings people together and that sometimes the formed community can be more important than the act of Making itself. But not only local communities form around Making, also global connections are made which, on a non-hierarchical network basis, make a movement possible.

Socialising is the second level which emerges not only from the literature but especially from the data collected within this study. James, Anna and Heidi, for example, talked of "good friends" (James) and being part of "a gang" (Anna) within their local Makerspace.

Heidi spoke of her Maker community as a family that she shares her private life with. The survey data backs up the importance of socialising and a well-working community. Looking back at Figure 4-3, which shows survey participants main activity when in a Makerspace, makes clear that socialising is almost as important as working on a project (participants were only allowed one answer option).

However, the strong bonds can also be the source of tensions and problems. To put it simply, being 'in a community' also means there is an 'out of the community' – those who are not included. Being aware of these dynamics and actively pursuing inclusiveness goals can have a major impact on how a respective community is shaped. This idea is explored more in section 5.3.1 and in Chapter 6. Another tension that arises through the literature, as already explored in Chapter 2, is the contrast between free sharing, community and the neoliberal zeitgeist that can be found within some Making configurations. Some Makers' focus on entrepreneurship and the emphasis of predominantly Western Making narratives of individualistic self-realisation and empowerment do not seem to align well with communities based on collaboration, free sharing of knowledge and ideas, and strong social bonds. This contradiction has been noted by some authors (Davies, 2017, p.162; Toombs et al., 2015, p.636). This evidences once more the adjacent nature of community and its shifting meaning depending on how it is connected to other concepts. As much as it might be important to some Makers, others might prioritise entrepreneurship and self-realisation. Both of these latter concepts and their various characteristics are discussed as peripheral concepts (see 5.3.2 and 5.3.5). Nevertheless, this is not to say that for some Makers community cannot be a core concept. Also, this is a good example for how logically and culturally adjacent concepts within Freeden's morphology interact with each other. In this case, logically speaking the two concepts community and entrepreneurship might not go well together, but due to cultural shaping and decisions they continue to both form an understanding of Making within certain societies. The notion of neoliberalism is picked up in section 5.2.6 Activism.

5.2.2   Creativity

Creativity is at the forefront of Making, as we have already seen when looking at some of the data of this study. 75% of survey participants noted that working creatively was a motivation for them to engage in Making activities (Figure 4-2). This was mirrored by participants of all methods. Some survey participants, for example, when asked whether they deem Making important for our society and, if so, why, emphasise the notion of creativity that Making brings to people:

> I feel it's important for people to have an interest in creating things for yourself, because it gives you an appreciation for creativity (B088, woman, UK, 34).

> It stimulates minds, encourages creativity and innovation and aims to solve problems rather than make profit (B101, man, UK, 60).

> It's a great outlet for creativity and helps people understand how the world around them works (B104, non-binary, UK, 25).

Makers value creativity which is why some of them even name it as one of their top three priorities when choosing a project (B173, B174, B183). It is necessary to differentiate between the adjacent concept creativity and the core concept re-/creating, though. Whereas the latter is a core action that is necessary to define any Making activity, the former is a quality with which this action might potentially be carried out but does not have to be. Additionally, there is no room here to engage with definitions of creativity. For the purpose of this morphology, creativity is seen as what Makers themselves view as creative.

As with the previously looked at concepts, creativity interlinks with other aspects of Making. Participants B244 and B251 add political notions:

> If we lose our creativity, we are completely at the mercy of big corporations (B244, man, GER, 34).

> Society develops more and more to a consumer society. People dully consume what is presented to them. Creativity is necessary to ensure that humanity doesn't go daft (B251, Gender unknown, GER, 42).

These two German participants value creativity within Making as important to counteract passive consumer behaviour and encourage critical thinking and, thus, connect creativity to political criticisms/goals. Similarly, participant B101 who was cited previously mentions innovation in conjunction with creativity, the former of which, in turn, relates strongly to digital technologies (see 5.2.4) and entrepreneurship (see 5.3.5). Freeden's morphology and its application to a social and cultural movement, again, lends itself well to conceptualising those influences and contestations.

Thus, despite the wide acceptance of creativity as an important part of Making, the concept itself is not free of tensions. Connecting it to inclusiveness, for example, has some Makers disagree about its role and impact:

> […] the maker spaces I have felt welcome in have been ones with inclusive values and where policies are in place to defend those who face discrimination and abuse. I think it's wonderful, and have seen it spread and reach new people, new generations, who embrace those values along with the joy of creativity shared. I really hope that continues (B107, woman, UK, 34).

> The focus on diversity – sometimes at the expense of creativity – means that people are always trying to be 'politically' correct. […] Unfortunately as many spaces are activist lead – they have the time and energy to lead – this is exactly what happens. […] many spaces remain exclusive because of their focus on only welcoming people who think like the leadership. Rather ironic for a movement that want [*sic*] inclusivity (B227, man, UK, 35).

The notion of creativity is contested between the two respondents, one seeing it as being mutually reinforced by inclusivity and diversity and the other seeing it as disconnected and perhaps threatened by threats to purity. It would need more inquiry with both participants to flesh out what their detailed views are, but it is intriguing to see that a concept as seemingly straight forward as creativity can be contested in such a way by the concept of inclusiveness (see 5.3.1). A further tension that has been identified and is explored later on is that between creativity and environmental sustainability. Two participants (B199, Lisa) have stated that being creative often requires being wasteful and harming the environment.

Because of these identified tensions and the collected data, creativity, despite its dominance for many Makers, has not been defined as a core concept. Not all Makers in the present study have emphasised or even mentioned creativity as a core aspect for them. Whereas some list it as a priority, others engage in Making for other reasons, e.g. the 25% of survey participants who did not state that they Make due to enjoying creatively working on items. Not only does this apply to setting up illegal settlements in Bangladesh (Ames et al., 2018, p.5), for example, but potentially also to entrepreneurial Making that grows into a more and more commercial enterprise. Besides occupying different levels of importance for Makers around the world, creativity can have a variety of functions as we have seen already. It not only can be connected to inclusiveness (see 5.3.1) and environmental sustainability (see 5.3.6) but also to learning (see 5.2.3) and entrepreneurship (5.3.5). It is a highly diverse concept that plays a big role within Making, albeit not a core one.

5.2.3 Learning

Learning and acquiring new knowledge is another important adjacent concept in defining many Making activities. The literature review has already shown that understanding how things work and learning by doing are extremely important to many Makers (Davies, 2017).

The data gathered within this study supports these claims. When asked why Making is important to us as a society, 160 survey participants gave answers surrounding learning and understanding technology. It is, in fact, named as the main reason to engage in Making: *I'm learning new skills* is the main motivation chosen by survey participants (see Figure 4-2). In-depth interviewees talk about learning as well. Heidi, for example, says:

> Every project I start helps me to that effect that I learn something from it. […] Every bigger project that I've started or never done before, advances my learning process. I have to dare to start and I have to dare to ask for help if I'm stuck. And if it doesn't work, then I know I have a bug build in somewhere, something isn't right. And if it works, I'm totally delighted, and I've learned something again.

Analysis of the data of Charter and Keiller (2014) supports this interpretation. They have surveyed hackerspaces around the world and asked for people's motivations to engage in Making and hacking. *To be intellectually stimulated* and *To learn new skills* are the two motivations that occupy the two top answers when combining all agree and strongly agree answers. In fact, as mentioned previously, Making's various opportunities to learn are employed for using it in educational activities with Makerspaces in universities and schools and, in general, for its opportunities in STEM education (Thompson, 2014; Halverson & Sheridan, 2014; Martinez & Stager, 2014).

Given the new nature of digital technology, the described learning effect of Making is almost automatic when one engages with these tools/artefacts. However, Makers do not only learn new skills and knowledge. Equally important is learning about and reviving more traditional skills (see 5.3.4) which reaches into political realms again. Some Makers here lament a crisis of de-skilling brought about by current modes of production and monetary structures. As previously seen, Carpenter declares that Makers are organising around a multiple crisis of de-skilling, proprietary licensing and outsourced production which are fuelled by a geo-political exploitation of technologies for profit (2011, p. 49). Makers, however, are re-skilling themselves and others. Re-skilling does not necessarily refer to an individual Maker who is re-learning a skill they once had, but to society as a whole. Even though they do not have to, Makers voluntarily learn skills such as woodworking, sewing, or how to programme your own phone. To some extent, this can be understood as a response to the crisis of de-skilling Carpenter mentioned. On the other hand, it also happens because learning a new skill can enrich someone's life (Dougherty, 2012, p.11) and increases someone's sense of empowerment (section 5.2.6 Activism).

Learning old and new skills, for here explained reasons, is very important to many Makers. However, as we have already encountered with other adjacent concepts, not all Making needs to or emphasises this component. Looking at Makers in Taiwan again who out of necessity build their own houses and infrastructure: they might value the potential side effect of learning something new while building these objects, but it is likely not their main motivation. Equally, entrepreneurial minded Makers might not seek new knowledge continuously, but rather aim to master a specific skill in order to bring an object to market and make profit with it. Learning, nevertheless, affects and shapes other concepts, as we have partly already seen. Community (see 5.2.1) is shaped by sharing knowledge and learning from each other, while amateurism (see 5.2.5) is to some extent build on the premise that a person starts out with no or little skills at all and acquires them through engaging in Making activities. Other related concepts that are yet to be examined in detail are activism (see 5.2.6), digital technology (see 5.2.4), traditional technology (see 5.3.4) and environmental sustainability (see 5.3.6).

5.2.4   Digital Technologies

There is little doubt that digital technologies, such as digital prototyping machines, are of importance for many Makers. Recalling the definition for technology as offered by Gendron, we have identified four categories of technologies within Making: tools and materials, skills and knowledge, final artefact, and forms of organization. All four can be and often are heavily interwoven with forms of digital technologies. Of special importance are technologies such as coding and software, microcontrollers, 3D printers and CNC machines (computer numerical control machines). Some might argue that due to the prominence of digital technology it should be named as a core concept for Making. While some local and regional communities might do just that, in general, digital technologies cannot be defined as essential for Making and its cultures. Thinking back to the survey figures on Making activities and motivations provides evidence: even though more than 250 participants stated they enjoyed using digital technology, more than 100 did not. Non-digital activities named in the survey as well as observed at Maker Faires included things such as jewellery Making, glass blowing, and hand-drawn comics. Thus, even though digital technology plays a big part in defining some Making cultures, it does not do so on a fundamental level that affects all Making.

Whereas the core concept *technology* referred mostly to the artefacts which can be created, the adjacent concept *digital technologies* is closer connected to the tools and materials

Makers use in order to create these artefacts. Due to the importance of these tools and materials, digital technologies are viewed as a separate concept. The literature review as well as the data of this study confirm that the wide availability of prototyping technology, such as 3D-printers and laser-cutters, is a big part of and motivator for Makers, especially in the Western understanding. In the literature review, we encountered prominent Makers (Anderson, 2012; Osborn, 2013) as well as academics (Kwon & Lee, 2017; Mota, 2011; Seo-Zindy & Heeks, 2017; Roedl et al., 2015) celebrating wide access to these digital tools around which Makerspaces and their communities often form. Participants of this present study have mirrored this picture with statements such as "The word Makers is new for something that people have always done. I think it developed because new technologies appeared which didn't exist before and which everyone can use" (A091, woman, AUS, 26). Figure 4-1 which was devised from survey participants' open answers to the question what their Making activities look like, lists some form of digital Making in four out of the five top activities with number one, 'digital making', leading by far (250+). Often, Makers celebrate that this kind of technology is now available to everyday people:

> In addition to offering control of technology, making allows democratised and diversified technical exploitation which is free of many economic constraints (B115, man, UK, 65).

> Making is a source for innovation, that advances society and contributes to the democratisation of technology (B165, man, GER, 44).

> Through making yourself you expand your skills. Expensive technologies (3D print) become affordable for everyone, the lifespan of devices is prolonged (B322, man, GER, 37).

This so-called democratisation of technology – the wide availability of digital tools – is regularly seen as the driver of the MM, as seen in the just mentioned literature, and motivates many Makers to make. Figure 4-2 lists motivations to Make. The fifth highest answer was *I like using modern technologies (e.g. 3D-printers, laser-cutters, etc.)* with close to 300 Makers choosing this motivation. Clearly, the digital fabrication technologies now available to amateurs have a strong bearing. However, the focus on digital Making has been criticised and is discussed further on within this section.

The second category of digital technology is that of skills and knowledge. This might not be a point that a mainstream understanding of technology would include, but only through skills and knowledge can tools and materials be handled and assembled in whichever way is

desired. They form, therefore, part of the bigger socio-technical system. The reason the two terms 'skills and knowledge' are grouped together is that skills, within this study, are viewed as applied knowledge of how to do something. This aligns with Gendron's definition (1977, p.23) of technology as "systematized practical knowledge" and "productive skills". When looking at the status of skills and knowledge within Making, many facets emerge: loss and revival of more traditional skills and knowledge, acquiring and mastering new skills and knowledge, and a general strive for learning. The first aspect is further discussed in section 5.3.4 and the last has already been discussed in section 157. Here, the focus is on skills and knowledge tied to digital fabrication technology. Many Makers are keen on developing the necessary knowledge to operate and make use of digital technologies. In contrast to more traditional skills and knowledge these have never been widely practised, so need not be brought back into the collective consciousness; they are nonetheless important to Makers who are concerned with acquiring them and making them broadly available for the first time. As with the tools and machinery, they celebrate the democratisation of this technology and the skills and knowledge that come with it.

When it comes to the objects of creation, these have already been discussed more broadly in the core concept section 147. A focus on digital fabrication tools and the possibilities they offer in creating objects expands the scope of what can be produced compared to times when these technologies were not available. People can now easily 3D-print spare parts of an item that needs fixing (MyMiniFactory, 2019), easily create (and sell) on demand highly personalised artefacts, for example a door stopper that carries a theme from one's favourite TV show (Riveros, 2016), or (unfortunately) print items that are usually more difficult to get in certain areas of the world, e.g. guns (Hanrahan, 2019). An exploration of relevant websites, e.g. www.instructables.com or https://cults3d.com/ offers astonishing ideas and insights into what an amateur can fabricate. Innovation is tightly connected within this category. For some, Makers are innovators and at the forefront of technology production. Survey participant B165 who was just cited calls Making "a source for innovation, that advances society", thus connecting innovation with activism. But he is not alone. When justifying why Making is important for society, other participants give similar answers:

> Widens the number of people innovating and promotes knowledge exchange (B184, man, UK, 30).

> Innovation in today's highly engineered time is only possible if information is freely available and everyone can build on the knowledge and developments of yesterday (B189, man, AUS, 47).

> Making brings out creativity and the ability to bring unique inventions and ideas to the table (B390, woman, Country NA, 17).

> Many innovations come from Making (B029, man, GER, 41).

As expected, popular Makers promote similar ideas, for example Anderson (2012, p.14): "The idea of a 'factory' is, in a word, changing. Just as the Web democratized innovation in bits, a new class of 'rapid prototyping' technologies, from 3-D printers to laser cutters, is democratizing innovation in atoms." Sometimes, Makers are even seen as the new innovators of a Silicon Valley spirit: "Makers at their core are enthusiasts, such as those engaged in the early days of the computer industry in Silicon Valley. […] those makers in the early days of the computer industry were essentially playing with technology" (Dougherty, 2012, p.12). However, as much as some Makers adhere to this view, it has also been criticised. Lindtner (2015, p.858) with her knowledge about Making in China says:

> China's makers demonstrate that the future of making […] rests on taking seriously sites and social fabrics of professional making such as practices of repair, mass production, craftsmanship, and reuse that prevail outside of information technology hubs like Silicon Valley.

The present study has not examined notions of innovation closely. Nevertheless, acknowledging its importance for some Makers is crucial. Makers who are concerned with facets of entrepreneurship (see section 5.3.5) are especially likely to value innovation. Thus, digital technology and entrepreneurship are two concepts within some forms of Making that significantly contest and shape each other. The present study posits itself closer to Lindtner's argument in that it acknowledges different morphologies of Making and a variety of configurations in which people make.

Besides the democratisation of technology, networking mechanisms are often named as the second important aspect making the MM possible. Kuznetsov and Paulos (2010, p.295), for example, have named "the emergence of new sharing mechanisms" as the second main facilitator of it. However, this morphology shall not regard these new networking and sharing mechanisms as a separate factor from new technologies as they are very much part of those and, similarly, fall under the technology definition employed in this study. Therefore, they shall be considered under the same heading. The ethos of (freely) sharing ideas and knowledge through those mechanisms have already been discussed more in the sections 5.2.1 Community and 5.2.3 Learning. Here, we are primarily interested in the actual technologies that make this sharing possible.

These technologies almost exclusively take the form of online tools and websites. Numerous websites particularly aimed at Makers have developed over the last decade. These tend to be run in a non-hierarchical way: everyone can share their projects and files for a global audience to see and inquire about. Nothing is curated. Not only do these Maker-specific websites offer inspiration, but also an endless number of blogs, how-to videos and pages, and social media pages on Facebook and Instagram. In particular, www.etsy.com and www.pinterest.com should be mentioned. Etsy, founded in 2005, is an e-commerce focused website providing anyone with the possibility to sell their handmade items (another connection to entrepreneurship). The website is popular especially for fabric items and jewellery and is with more than 60 million listings (Wiggers, 2019) one of the biggest platform that offers the possibility to sell hand-made items. Whereas Etsy showcases the end products of the Making process, Pinterest, founded in 2010, focuses more on providing inspiration. The reason these two websites are mentioned specifically is that Etsy is the biggest online platform for selling homemade creations and Pinterest the biggest platform for sharing creative and inspiring ideas. Noteworthy is that both are more used by women than by men.[8] On a more digital side, www.tindie.com is the platform for digital Makers to sell items. The website currently lists 9100 products (Tindie, 2019).

A second aspect of network mechanisms does not only relate to sharing ideas and projects online, but also to how Maker groups communicate online. As much as all kinds of interest groups form community spaces on social media, so do Makers. Some examples are mailing lists, the team-collaboration tool Slack or Facebook groups. Again, many types of these tools exist and make communication and organising of groups much easier. Jack, for example, mentions how his Makerspace websites include possibilities to share ideas and find allies for communal projects within their local community:

> We have a GitHub[9] repository and issue list. […] That's the place where we keep track of what things people should do. […] Somebody should fix such and such things. It's like, 'Yes they should, put it on the list.' Then at some point somebody can go and do that.

This is a good example to show that not only global communication depends on online tools, but also local Making communities use these technologies in order to coordinate their

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[8] In 2016, 87% of Etsy sellers were female (Clement, 2017). In 2019, 71% of Pinterest's users were female. (Clement, 2019)

[9] GitHub is an online platform for hosting and developing software: https://github.com/.

activities. Without all these possibilities for connecting online and sharing information and inspiration the MM would most likely not be a movement: "[T]here is a new default of sharing online. […] Individual Makers, globally connected this way, become a movement" (Anderson, 2012, p. 13). Anderson describes well how online sharing is crucial for Makers, especially those who are keen on Making within a community, in order to communicate and be part of a more global community.

Earlier findings illustrated how usage of digital technology is connected to concepts such as community and amateurism. Some of the adjacent concepts create tensions and difficulties, though. Activism is an obvious example. Democratising digital technology and access to it is, in itself, a political act. It might not be a strive for radical change of the status quo, but it is an attempt to provide more people with the power and possibilities these tools provide. Unfortunately, empowering some people who can afford membership in a Makerspace that provides these tools does, at the same time, exclude others who cannot afford accessing these spaces, or those who do not feel comfortable in their local Maker community. Not just membership fees, but also material costs can easily be beyond someone's means. Despite improvements over the last decade in terms of availability and price, it is worth keeping in mind that the tools for Making (especially digital) are not as easily and cheaply accessible as is sometimes claimed and while making digital technology available in Makerspaces is a step on the ladder of democratising this kind of technology, it does not truly provide access to everyone. Financial and more general inclusiveness issues might be in the way. This is further explored in section 5.3.1.

Another tension surrounding this modern technology is equally connected with activism. As we have shown in section 4.2.4, many Makers in this study mention inbuilt obsolescence of market technologies from big companies and the way technology is produced nowadays as something that is problematic to them and that they wish to counter through their Making activities. Activities such as repair feed into this. According to survey data, just over 50% of participants want to counter inbuilt obsolescence and around 25% generally are opposed to the way things are produced in Western society. Using the fruits of that production system, namely modern digital fabrication technology, seems ironic. Mota (2011, p. 279) states:

> This democratization of manufacturing […] is based on the fact that, after one century of mass production and consumption, a growing number of individuals now has access to sophisticated production tools and the knowledge to manufacture objects for artistic, personal or commercial purposes.

The new tools for production and manufacturing have come about through older forms of production, i.e. mass production. Digital anthropologist Daniel Miller (2011, p.17) even remarks that without machines taking over more conservative forms of industry we would not have the time or money to afford Making ourselves. This point exemplifies the various tensions and conflicts surrounding the idea of democratising digital technology. Similar tensions come to light when considering environmental sustainability (see 5.3.6), e.g. 3D-printing plastic on demand does not align well with positive environmental behaviour.

5.2.5   Amateurism

The notion of Makers as amateurs has already surfaced when exploring democratisation of technology and does so again when considering notions of activism. The etymological origin of the word amateur stems from the Italian *amare,* meaning 'to love'. This applies to a rather large group of Makers, especially in the Western context. Looking at survey data provides evidence. When asked why Makers engage in what they are doing, only 19% of participants stated that they were aiming to make a living with their Making projects. Thus, more than 80% presumably engage in Making as a hobby and as something not done directly for professional or financial gains, but as something that is enjoyed and valued. That is not to say that Making for financial purposes cannot be enjoyed, but it might be questioned whether that enjoyment is still as important as the financial gain.

Common definitions of the amateur emphasise two main notions: (1) "a person who takes part in a sport or other activity for enjoyment, not as a job" or/and (2) "(usually disapproving) a person who is not skilled" (Oxford Learners Dictionary, 2019). The first one ties in well with the origin of the word and the overwhelming majority of Makers enjoying what they do. More academic accounts also offer this idea, albeit more nuanced. Science and technology historian Sean Johnston's account (2018) traces the way amateurs have been defined and represented in relevant scientific publications throughout the five middle decades of the twentieth century in America and identifies three distinct contexts: the amateur's passion "as an innate juvenile interest to be nurtured; as an enabling trigger to launch adolescents towards nationally valuable careers; or as an inspirational adult avocation that can be harnessed to promote wider public understandings of science" (p.98). Distinctions between the three and their individual characteristics were by no means universal, but rather "firmly shaped in changing cultural and political contexts" (p.118) which hints towards the label's own morphology with contested concepts. Whether "juvenile interest", "enabling trigger" or "inspirational adult avocation", all three conceptions include

a voluntary engagement and interest in scientific knowledge and practices, thus aligning with the origin of the word.

Even though the distinctions examined by Johnston were shaped by publishers from above, an application to Makers as amateurs is not far-fetched. Most pertinently, the third classification appears to apply. From the literature and data in the present study it has become clear that most Makers are indeed adults who engage in and often simultaneously promote a public understanding of technology, especially a digital one. Less prominent, but also present among some Makers is the view that Making can be used to interest more children and young people to engage in technology and science. A variety of initiatives that use Making to encourage scientific learning are proof of this (Stewart, 2014; Maker Ed, 2020). Making as a juvenile interest reminds of the second commonly given definition as per the Oxford Learners Dictionary, namely that amateurs are unskilled people. Although not meant in a disapproving way, Makers make a point of engaging in activities that they have no or little experience in and that they want to master. Some survey participants said they wanted their project to be a challenge. Many Makers make because they want to learn and experience something new and as yet unknown to them. The democratisation of technology that we have looked at already makes exactly this point: people who are not experts can now access digital tools without having to be professionally engaged in working with them or without having to know initially what they are doing. Kwon and Lee (2017, p.318) make this point:

> Recently, the nature of making – how to make things – has changed. Previously, the company, an entity, led in creating things. Now, one can create, innovate, make a fortune, and even drive positive societal change with nothing more than creativity and hard work when information and communications technology (ICT) is incorporated into the culture of making. […] Currently, anyone can make and change the world.

Millard et al. (2017, p.24) who have devised their own morphology (2.1.3) define this as a big aspect of do-it-yourself culture in general which they view as a "method of building, modifying, or something without the direct aid of experts or professionals."

An amateur, then, can be defined in a variety of context-dependent ways. Johnston (2018, p.99) puts it as follows: "the qualities and status of the amateur are variously configured, hinting at a practitioner who may be a free spirit driven by intellectual curiosity, or alternatively a dilettante pursuing a pastime on the periphery of science." Within the realms of Making, it is more likely that amateurism is seen as something positive and admirable. Makers revel in the opportunities they have to engage with and use the newest digital

technologies even though they might have no professional skills to do so. That, indeed, for many is the point: access without expertise. So even though Makers might be unskilled initially, many participate in Making to become more skilled and do something that they love. An obvious connection to personal agency can be seen: it is essential when wanting to develop from unskilled to skilled amateur.

Even though the status of being an amateur seems important in defining what Makers are on various instances, it cannot be defined as a core concept here. Not all Makers are amateurs in the sense that they do not make a living with their Making projects. As portrayed previously, 19% of Makers in this study do indeed engage in Making to make a living. Avocation becomes vocation. In-depth interviewee James, for example, at the time of the interview had just given up his full-time job in order to sell digital music technology that he produces himself. Entrepreneurship is discussed as a peripheral concept in section 5.3.5. Equally, not all Makers are amateurs in the sense that they do not engage in Making activities from an un-skilled starting point. Nancy, for example, remembers that she did not do much Making activities before she went to university and started studying Product Design. Her course and professional training turned her into a Maker. Nevertheless, the importance of the concept cannot be denied, hence its position as an adjacent concept. Within its position as an adjacent concept, it shapes and influences other concepts as well as creates tensions, both of which have just been shown. Entrepreneurship and activism are particularly connected to it, both of which are explored within this chapter.

5.2.6 Activism

The idea of activism as an adjacent concept might be unexpected. Many Makers state what they are doing is not political and all they are doing is pursue a hobby (Davies, 2017, p.132). Recalling the Instagram picture and comment with which this chapter was opened, underlines this point. *Make:* magazine published their newest cover calling for Makers to tackle the climate crisis. The first comment they receive is a Maker finding the "extreme left fanaticism" off-putting and announcing he will not buy the magazine anymore. Some appear to get offended when it is suggested that their activities might be political (as observed in confidential feedback to this study). But can 'not being political' be a political statement in itself? Heywood (2017, p.1), as observed previously, puts it perfectly when saying that we are all political thinkers, whether we know it or not. We use political ideas all the time when expressing ourselves. Thus, Making and its activities can be seen as political as well. Indeed, we have already encountered a variety of political ideas throughout this chapter. However,

the popular understanding of politics, which mostly refers to party and state politics, prevents many people from realising just how political their everyday lives are. With that in mind, this morphology tries to do justice to the Makers claiming their activities are not political while at the same time showing the potential political dimensions of what they do. The remainder of this section briefly defines activism as used here and then explores the main political and activist aspects of Making activities.

The term activism conjures up scenes of demonstrations and protestors potentially engaging in illegal action. At first glance, this does not seem to fit well onto Making activities. However, when activism is defined, a clearer picture emerges. Jordan (2002, p.11) defines it as "some transgression of an existing state of affairs". Collective activist action requires "a sense of shared identity, which can best be understood at this stage as people recognizing in one another the anger, fear, hope or other emotions they feel about a transgression" (p. 12). Firstly, transgression needs to be qualified further. Jordan (2002) differentiates between causes that only appear to be transgressive but, in reality, enhance the authority and existence of current social institutions (p.33) (=activism) and causes "may seek the entire reconstruction of social systems" (p.39) (=activism!). "Activism! must be transgressive, whereas activism can […] change society while also conserving it" (p.39). As we have shown, within the MM both forms can be found. A note of caution: the requirement of some kind of change, whether truly or pretend transgressive, excludes forms of activism that want to openly preserve the status quo. Despite being aware of this omission by Jordan, his definition is used here as the present study focuses on forms of activism within Making that demand some sort of change, not that which wants the status quo. Most Makers appear to want some form of change. However, in future work an exploration of non-transgressive activism in Making might be fruitful.

Secondly, within the MM, the notion of collective action cannot be understood in established forms of activism, i.e. street protest. Rather, the forms of political activity we find within Maker practices are not always overt but part of processes which are rarely publicly displayed. On the one hand, even though Makers do assemble in groups, their activities are mostly individual ones. Collective action as understood by Jordan is not necessarily at the core of what Makers do. However, collectivist approaches are not necessary in order for something to be activist. Heywood (2017, p.21) has remarked that "political activism has become, in effect, a lifestyle choice", an observation that would fit Maker activities much better than traditional forms of activism. Tanenbaum et al. (2013) label DIY and Making practices as nonthreatening ways which makes them "effective at spreading [their] values to

people who might otherwise avoid taking a political stance" (p. 2610). The choice to make and approach one's own life as a Maker with one's own ideas and decision-making powers, then, can be a form of activism that opposes an economic system in which passive consumption is often favoured above critical engagement.

Something that seems to resurface whenever Makers speak about why they engage in Making activities, is a sense of having lost some kind of control and wanting it back, i.e. empowering oneself through Making. This sense of control has already been briefly discussed when exploring Personal Agency (section 5.1.3). Empowerment is not only mentioned regularly by Makers of this study, but also within academic literature (Davies, 2017; Nascimento & Pólvora, 2018; Grimme et al. 2014) and within the Western-centric narrative about Making (Ames et al., 2018). 33% of survey participants within this study stated that they are motivated by wanting to empower themselves, 20% by empowering their community and almost 40% want to take back control from companies that produce everyday objects. Grimme et al. (2014) devise three categories of empowerment within Making: the empowerment of oneself, the empowerment of others, and the empowerment of Making communities. Where is this need for empowerment coming from? Many of the things Makers criticise are linked to different forms of alienation and/or marginalisation and/or loss of control. For example, Makers move from passively accepting so-called black-box technology that can neither be understood nor fixed by an individual non-expert user to actively engaging as amateurs with technology and re-/creating it to their liking. Three aspects are of special importance: production processes, anti-consumerism, and not-for-profit practices.

By becoming producers, many Makers challenge global production processes (Stangler & Maxwell, 2012, p.9) which have been criticised over malpractices, i.e. exploitation of labour forces/people or reckless usage of resources. Upon closer examination, we encounter two different levels here. The first one has already been mentioned in the literature review when talking about Makers who foresee a new industrial revolution which does not fit onto old models of mass-production (Anderson, 2012; Gershenfeld, 2011; Hatch, 2014). Even though certain aspects of production are challenged, the new proposed industrial revolution does not seem to actually challenge or aim to overthrow current processes, thus this is activism, not activism!. Anderson talks about businesses that – in Silicon-Valley style – start small and grow big. This does not break with the social norms of capitalist production and is, thus, not transgressive activism.

But we also come across Makers whose activities criticise production processes on a deeper level. This includes the wastefulness of inbuilt obsolescence and the way many products are designed and made: "Makers have the ability to modify technology beyond the limits of its design, and thus they are more likely to engage in maintaining and repairing products beyond their typical life, or repurposing and reusing what others might consider trash" (Roedl et al., 2015, p.10). Many Makers who have been interviewed for this study have remarked on the wastefulness of society and how objects are often designed to break rather quickly in order for consumers to buy a new item. 40% of survey participants want to take back control from companies that produce everyday things, 51% want to counter inbuilt obsolescence and 21% do not agree with the way everyday objects are produced in our Western society. These criticisms of current widespread production processes go beyond small, re-affirming changes and challenge structures and manufacturing workings on a more general level. These Makers are likely to fall into the categories of activism! as they imagine a future where different norms and values determine production processes.

The second aspect to consider when reflecting on alienation from objects is anti-consumerism. Turning from passive consumer to active producer has played an important role in the Maker scene from the start. Dougherty (2013, p. 8) has remarked that "makers are seeking an alternative to being regarded as consumers, rejecting the idea that you are defined by what you buy. Instead, Makers have a sense of what they can do and what they can learn to do." In order to have something that you like, you do not have to wait for a big company to produce it, but you have the means to make it yourself, be it clothing or a notebook. This aspect puts emphasis on amateurs becoming active producers themselves instead of only passive consumers.

However, even though Makers might challenge capitalist dynamics, capitalism is also attempting to subvert Making through commodification. Some companies constantly produce new tools and materials for Makers to use and work with, e.g. Arduino microcontrollers. The company has developed a new model each year since 2003 (Arduino, 2019). This comes as no surprise considering that some of the main drivers of the movement promote and encourage this commodification, for example *Make:* magazine. The magazine's focus on entrepreneurship (Sivek, 2011) stands in stark contrast to an ethic of anti-consumerism which aims to discourage consumption. Whereas some Makers are more focused on repair and reusing old material, others are more focused on working with the newest devices and, thus, feeding into a cycle that aims to make a profit off of these seemingly subversive activities. This latter aspect is likely a deciding one when

differentiating between activism and activism! whereby those who counter passive consumption with active production of objects that involves a lot of new materials and tools might be defined as an activist and someone avoiding new Maker-related purchases as much as possible while still Making their own creations might be defined as an activist! as they aim for a transgression of the way the current consumer society works.

Last but not least, not-for-profit Maker practices are considered. Contrary to capitalist workings, sharing among Makers is often not an act based on exchange of money for goods, but of voluntary and free-of-charge giving in order to enrich production processes. Ideas, blueprints, knowledge – all of it is created to share, not to own (Carpenter, 2011, p. 50). This is a transgressive form of activism! which imagines a future that breaks with capitalist understandings of how the world works. The digital files Makers share present a new level of challenge to how our market economy works. Not only can they be replicated indefinitely, it is also difficult to protect them from being shared and/or changed. This is an important aspect when talking about activism within the MM as it is one of the most obvious, least contradictory elements to look at. Sterling (2011, p.70) in his piece on *The Future of Making* sums this up nicely: "Making is a folk aspect of a great, unfolding struggle over humanity's means for information, production and distribution", thus connecting some of the aspects we have already looked at while embedding Makers within a bigger picture. The sharing of ideas and information is not so much countering an alienation from objects as it is from knowledge and skills. Equally, Makers are master of their creation from start to finish. This is a stark contrast to mass-production processes during which parts of one single consumer item are fabricated in places all over the world and assembled in yet another. The alienation of labour division and production process is actively challenged, and other theories of technology production might suit better, e.g. Schumacher's appropriate technology (Schumacher, 1973).

This involves low hierarchies. Making an item from start to finish automatically removes some of the hierarchies that can be encountered in mass-production sites. When Making an object, a Maker is their own master, making all decisions from material, design and production to the final purpose of the project themselves. Even though for some Making might be much more about well-being and joy instead of an active need to take control, some Makers revel in this taking of control, such as Megan who has already mentioned previously that she enjoys the fact that Making is "counter-culture. It's people taking matters into their own hands and creating their own networks." She points towards another aspect here: connection with and networks of people, which illustrates the direct link of activism with the concept of community. This link is a complex one and deserves more deliberation than

can be provided here. But it is safe to assume that both decisively shape each other when political goals are pursued.

Embedding these various strands and beliefs in a specific ideology is difficult. On the one hand, we encounter low hierarchies, free sharing of information, an emphasis on community and transgressive activist claims that challenge the status quo. These elements could point towards Makers holding quite anarchist beliefs. However, we can also see an emphasis on entrepreneurship (see 5.3.5) and profit-making, consumption of new material and devices, a focus on innovation and a focus on individuals and their self-realisation (see 5.3.2). These are rather capitalist and neoliberal notions. Makers can be seen as celebrating atomistic acting individuals who enjoy the freedom from regulations they experience. Recalling Miller (2011, p.18f) who states "'I made it' is a claim to achievement. […] The emphasis is less on the 'it' that was made and rather more on the 'I'" mirrors this sentiment. Indeed, different groups can likely be placed into different categories and more analysis is necessary in order to bring these distinctions out into the open. Whereas many different ideological understandings of Making might be able to be found within its activities, it is likely that, depending on culture, space and society, there are main themes that can be found in each. Freeden's morphological approach is helpful in fleshing out these distinctions and commonalities in interpretation. Depending on which concepts are given priority by Makers and how these influence each other, different activist and political notions are identifiable.

In fact, it could be argued that many of the issues Makers oppose, as identified here, are focused on a Western form of Making. Whether these are also dominant in non-Western cultures, needs further exploration. What has already been stated is that some Making cultures go beyond this and raise aspects relating to marginalization. Even though the aspects mentioned here could be seen as things Makers feel marginalized from and, hence, crave more control in, it would be presumptuous to label a predominantly white, male, fairly well-off group of people in the West as marginalized. Ahmed, Jahan and Jackson in Ames et al. (2018) write about a group of Makers in Bangladesh who live in "conditions of marginality and disempowerment" (p.6) and try to help themselves by illegally building infrastructure to fight their status of marginality. In a story about Vietnam, we can read about an open-source collective that is mainly concerned with translating free/open source software from English into Vietnamese and, thus, establishing national community around this kind of software while (in vain) aiming to gain recognition from the global English-speaking open source software community (Ames eta l., 2018, p.9f). Thinking back on the African Maker Manifesto (2012) inspires similar impressions of marginalization and the fight against it: "2.

We will make the things Africa needs. […] 5. We will show the world how sexy African manufacturing can be. […] 10. We will remake Africa with our own hands."

We encounter ideas here that Western-focused accounts of the MM do not necessarily mention: extreme marginalization and, thus, vulnerability of Makers, connections with nationalism and recognition on a global stage, and even the aspiration to transform and remake a whole continent. Whereas alienation from objects, skills and social connections might be dominant in Western Making, other cultures and societies might center around other forms of alienation and marginalization. Freeden (1998) comes back to mind when he states that ideologies and their morphologies are not universal but socially constructed (p.69f) and, therefore, change over time and space. Ames et al. (2018, p.16) perfectly mirror this point when considering their different accounts of Making and conclude their paper thus:

> our point is that we need to see this itself [contemporary hype surrounding making and the connected countercultural technological vanguardism] as a local and contingent account of making. Our examination of other makings highlights the historical, political, and economic specificities of those Western accounts.

Consequently, forms of empowerment that are felt by Maker communities will differ largely depending on the forms of marginalisation and alienation that are encountered by the different groups. Some might already act from a place of empowerment whereas others come from a place of serious disempowerment (Ames et al., 2018, p.17).

5.2.7   Interim Summary

Looking back on the adjacent concepts of this section, we now have a morphology with a total of three core and six adjacent concepts that all influence and shape each other, as shown by this chapter. The adjacent concepts help us in understanding Making activities better and differentiating them from other activities that involve creating something. Figure 5-7 is now more detailed and helpful in understanding a variety of Making practices. Brewing a cup of tea in your everyday life, thus, cannot be defined by this morphology anymore as it likely lacks any influence from the adjacent concepts.
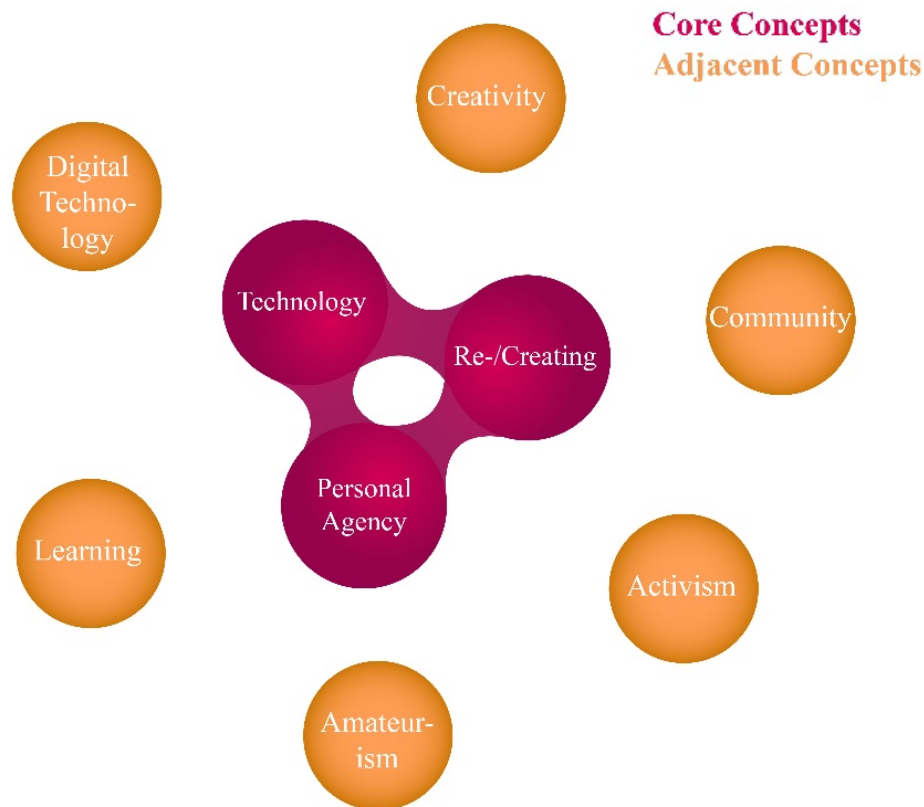
Figure 5-7 Core and Adjacent Concepts of the Maker movement, repeated.

5.3 Peripheral Concepts

This section explores peripheral aspects of the MM. As explained previously, peripheral concepts occupy the outer edges of a morphology. They usually change "at a faster pace diachronically and culturally" (Freeden, 2013, p.125) than adjacent or core concepts and have more marginal status within the whole ideology. Due to the evidence from the present study, it is argued that the following concepts are peripheral in the movement: inclusiveness/accessibility, self-realisation, well-being, traditional technologies, entrepreneurship and environmental sustainability.
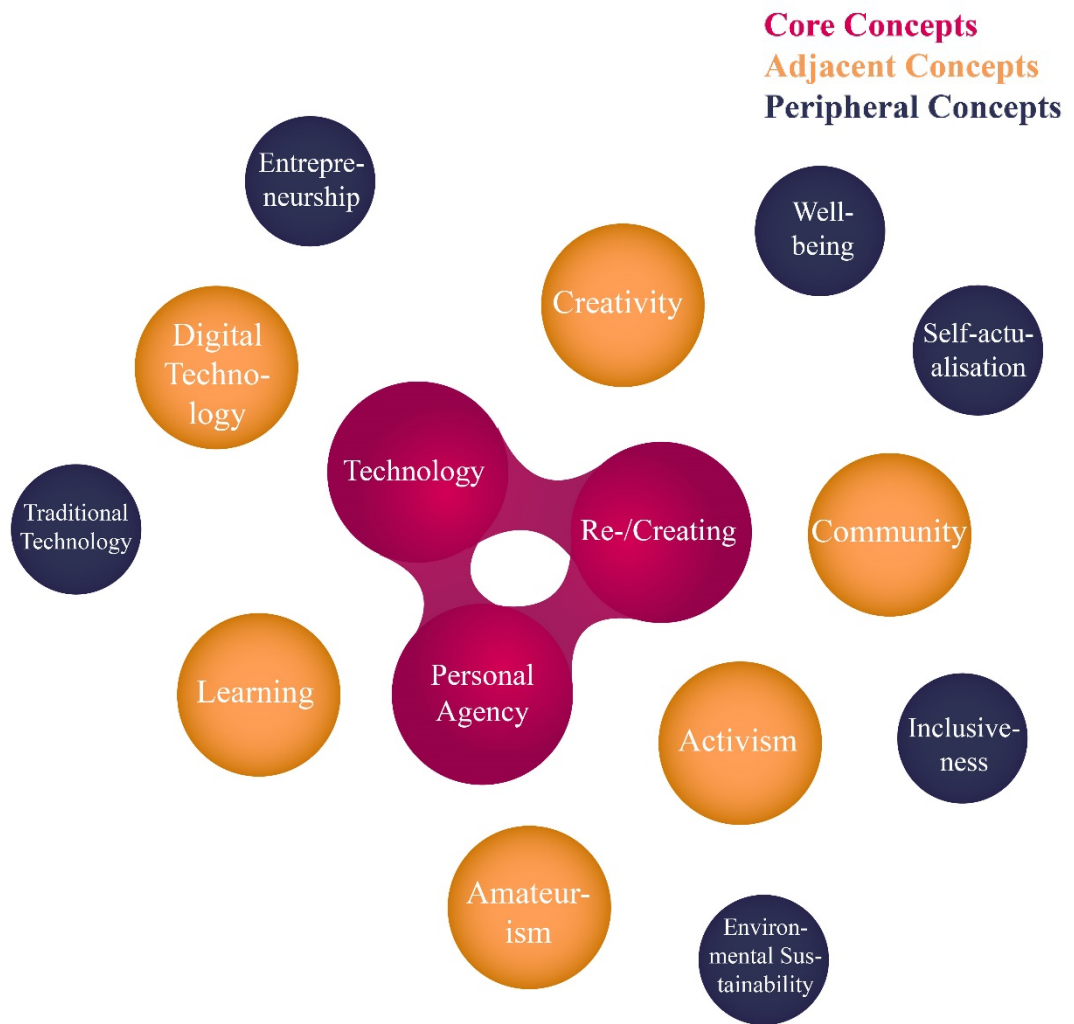
Figure 5-8 Morphology of the Maker movement, repeated.

5.3.1   Inclusiveness/Accessibility

According to certain rhetoric devices of Making promoters, one of the main tenets of the movement appears to be being inclusive, democratising and accessible to all (Dougherty, 2012; Anderson, 2012; Hatch, 2014). The democratisation of digital technology within the movement is emphasised. Makers celebrate that it opens up personal fabrication for everyday people. Many agree that it has inspired more people to re-/create things, given more people access to tools and resources that would otherwise not be available to them, and helped spread global knowledge on how to turn creative ideas into reality. In section 4.4.1 in-depth interview participant Heidi already stated that "There is no other movement I know of that works so hard on taking everybody along."

However, over the past few years problems and issues surrounding the true inclusiveness and accessibility of Making and its spaces have been raised on a variety of levels. Firstly, tools, material and knowledge are not always as accessible as claimed. A certain amount of financial freedom needs to be had, whether it is directly for obtaining access to tools and materials or indirectly for using recycled items. It is likely that a more affluent population can access the activity of Making. Low income or financial responsibilities hinder access. Furthermore, the resource of time plays a role. Making something from scratch usually takes much more time than buying a similar item and it requires the luxury of having time available to do so. This does not only apply to the actual time it takes to make an item from start to finish, but also the research of how to do it, and the trial and error process to get to a point of success. Anna confirms: "It's a time-intense hobby, which has to do a lot with class and background. Who has the time to tinker? […] There are many reasons for that and the maker scene is actually a quite homogenous bunch." Equally, social aspects of Maker communities can be tricky and potentially lead to people feeling excluded. In the data chapter we have already encountered in-depth interview participants who identify areas of exclusion: political affiliation, language, mental health issues, disabilities, low skill sets, and introverts and people with low confidence. One of the issues that has been raised regularly is that of gender inclusiveness (Toombs et al.; Davies, 2017; Nascimento & Pólvora, 2018; Bean & Rosner, 2014). The data chapter already gave a first impression of what challenges and obstacles non-male Makers face. This is explored in much more detail in Chapter 6.

All these aspects taken together show that even though the movement aspires to be democratic and inclusive, it is not just yet. Gershenfeld (2011, p. 62), founder of the global FabLab franchise, sums this up in the following way:

> [W]e're finding the most amazing people […] who didn't have access to tools and didn't have a vehicle to discover them. One of the questions this poses is: is it for everyone, or is it elite? I guess you could call it democratically elite.

Gershenfeld here closes the circle to what has been said at the beginning of this section: the movement has broadened access to digital technologies and certainly facilitated Making for many people. However, it has done so almost exclusively within a distinct group of people, namely predominantly white, male, middle-aged, and well-off people.

Some exceptions, however, confirm the rule. Feminist Makerspaces, for example, are focused on making Making accessible to and inclusive for all genders. Examples in the researched countries include *Mz*Baltazar's Laboratory* in Vienna or *Heart of Code* in Berlin.

The Vietnamese Open Source collective mentioned in Ames et al. (2018) aims at being recognised and included more in the global English-speaking open source community and, thus, wants to overcome hurdles of exclusion because of language. It seems as though these examples of positive inclusiveness practice within Making are, in fact, brought about by the excluded as active criticisms of the excluding status quo.

That is why this study only defines inclusiveness/accessibility as a peripheral concept. Making activities themselves do not seem considerably linked with inclusiveness issues. Some communities are keen on creating an inclusive space. We have come across Makers (more than 50% of survey participants) who agree that, on a practical level, the movement is not fully inclusive yet as sometimes suggested, even though most Makers (91% women, 82% men) agree that they value inclusiveness in their Maker communities. Thus, not only do some Makers talk about initiatives and ways to be more inclusiveness, we also encounter Makers who open up Makerspaces specifically for groups that are not properly included in regular spaces, such as women. Makers interviewed for this study acknowledge that these issues are important and relevant, but their actual Making projects appear to focus more on creativity, learning and digital technologies. Additionally, academic literature around inclusiveness and the movement has only emerged from 2014 (Weibert et al., 2014) onwards[10]. By and large then, inclusiveness and accessibility do not appear decisive in determining what Makers do or engage in. While adjacent concepts such as creativity or learning are directly linked to the Making process, inclusiveness and accessibility are usually not. The latter can be identified but are limited to certain spaces and communities and not generally practiced as some promoters of Makers would have us believe. That is why this concept is only included as a peripheral one. It already came up within community and defined that concept further. Equally, other concepts have already raised connections with inclusiveness, such as creativity where participants gave conflicting viewpoints on whether diversity sparks or hinders creativity. Making inclusiveness an active part of one's practice profoundly impacts that practice which is further explored by this study later on.

5.3.2　Self-Actualisation

Motivation is an important aspect when discussing voluntary activities such as Making. Some of the already explored aspects include belonging to a community, feeling empowered or using digital technologies. The notion to be unpacked in this section is that of self-

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[10] There are plenty of studies published on inclusiveness and DIY, hacking, computing, etc. but to the knowledge of the researcher the first one addressing Making is the one by Weibert et al., 2014.

actualisation. It is, indeed, closely interlinked with empowerment and taking control: realising your own ideals and following your own drives almost automatically leads to feeling empowered and in control. A close connection to activism surfaces in which personal goals might be heavily interlinked with wider societal ambitions. Albeit important, self-actualisation is not defined as core or adjacent concept because it only applies to some Makers. When it does apply, it is usually linked with the core concept of personal agency (see 5.1.3) and the adjacent concept of creativity (see 5.2.2). The next few paragraphs further explore its importance and how it relates to other concepts.

The notion of self-actualization has first emerged in the early half of the 20th century and was introduced by physician Kurt Goldstein (Sullivan, 2016). It is often associated with Abraham Maslow's hierarchy of needs in which self-actualization is the last need people try to meet after they have met physiological, safety, love and esteem needs. Maslow sees "self-actualization as the fulfillment of one's greatest potential" (Sullivan, 2016). This potential can show itself in different ways. According to Maslow, it is often a creative urge, but "it might also take the form of maximizing the quality of one's relationships or perfecting the physical form through athletics and good health" (Sullivan, 2016). Consequently, what self-actualization means will largely depend on an individual themselves. It can be the creative urge to make highly personalised technology, but it can also be to strengthen and foster close relationships and community around oneself. For example, when Davies (2017, p.162) defines the second driver of the MM as a neoliberal zeitgeist which emphasises the power of the individual and self-actualization, she describes an understanding rather focused on the self and individualistic tendencies. In contrast, a Maker who attends spaces to enhance community bonds might be less individualist inclined.

We have already mentioned that making a profit is not necessarily a main aspect of being a Maker. Anderson (2012) states that Makers are leaving one-size-fits-all products behind and instead focus on one-size-fits-one projects. He calls this *meaning*-maximisation instead of profit-maximisation (2012, p.69f). However, in a meaning-driven world this "view suggests that big business cannot sell us the route to happiness and self-fulfilment" (Gauntlett, 2011, p.227). Rather, self-actualisation and realising your own ideals and ideas can. Closely connected to self-actualisation is personalisation – the aim to create something exactly according to one's standards and personal wishes. This aspect presents itself rather dominantly within Making. When survey participants were asked for their motivations of why they Make, more than 68% chose the option *I want technology that does/is exactly what I want*. When they were asked why they deem Making as important for society, 20 voiced

ideas around realising own ideas. The reasons for this could be various: dissatisfaction with commercially available products, showing off or easing life circumstance. One short interview participant, for example, lives with a disability and takes pride in and joy from Making devices that are specifically adjusted to his needs and make life easier for him. Plus, he gets to choose the colour instead of having to rely on the usual commercially available black or white (A052, man, UK, 36). Next to aspects of personalisation and self-actualization, we can again observe an element of empowerment and control. Another participant says: "I love the idea that I can design something myself as much as I can and don't need to sacrifice anything. It's a control thing…I can make exactly what I want" (A116, woman, GER, 32).

Digital technology can be important in Making something exactly the way a Maker wants it, thus linking self-actualisation to the adjacent concept in section 5.2.4. Even though personalisation has always been possible when it comes to more traditional technologies, i.e. sewing or woodwork, now amateurs can also personalise electric and digital items. Through 3D-printers especially, customisation and fulfilling own desires has become easier. Sometimes, Makers relate this to pride and showing off. Short interview participant A133 (man, GER, 39) was asked why it is fun for him to make. He answered: "To have exactly what I want. And it's also the showing-off effect. You've made it yourself, you can be proud of it. And you can make something useful which has advantages." This shows a rather individualised and atomised account of Making activities and could, as already discussed in section 5.2.6 on activism, be linked to a neoliberal zeitgeist in which the self is responsible for their own happiness and does so in competition with other individuals. Davies (2017, p.162) makes this connection as well: "In fact, the idea that it is individuals who are primarily responsible for their own lives and situations is a key theme of our neoliberal times".

As with previous peripheral concepts, however, quite a few examples that do not predominantly have to do with self-actualisation spring to mind. For the Making communities in Shenzhen, for example, as described by Lindtner (Ames et al., 2018), self-actualisation might not be a dominant theme when creating a new profitable consumer electronics device. Or Makers of the Global Village Construction set might be more concerned about countering proprietary black-box technology instead of satisfying their needs for self-actualisation. Thus, the concept is only placed as a peripheral concept. It informs many adjacent concepts (i.e. creativity, digital technologies, activism), but cannot be defined as such an adjacent concept as it is neither mentioned as a main motivation by Makers nor appears to be dominant in the wider literature.

5.3.3   Well-being

Well-being, although not discussed a lot, continuously surfaced for participants during data collection. In the survey, 37% of participants stated that they are motivated by Making activities improving their well-being. Thirteen in-depth participants mentioned aspects relating to well-being and mental health. This section explores these notions and how they relate to other concepts. It shows that there are contested understandings of what well-being entails. Likely, this is due to people having different ideas of what is good for them and what role Making takes in their lives. The reason it is stated as peripheral concept lies in the minor role it appears to play. Compared to, for example, digital technology or creativity, it does not get mentioned a lot but it deserves more consideration as it might be an underlying cause for why people enjoy community or creativity as much as they do. A separate study is needed. In what follows, well-being's connection to the following concepts is briefly explored: process and learning, activism, and digital technology.

Section 5.1.1 has already provided some data that relates to experiencing well-being during the process of Making. A025 (woman, UK, 25) described it as "quite relaxing and even a bit meditative sometimes." A039 (woman, UK, 26) explains similarly "it's quite therapeutic. The process takes you away from all your worries and anything else because you're just focusing on the one thing in your hand." Megan talks of trying to incorporate one day a week for Making activities to ground herself and have some 'me-time'. All these data snippets show a clear connection to the core concept of re-/creating and how the process of it can increase Makers' sense of ease with themselves and the world around them. Equally, learning is an underlying connection, for example when Rose talks about tackling the challenges of a difficult project and the sense of achievement that comes from doing so. Another theme that seems to emerge is that of fleeing from the world and removing oneself from everyday life. This is explored further on.

Three study participants talk more specifically about mental health problems in relation to Making, e.g. Lewis (first cited on p.324) who explains that he suffers from poor mental health and focusing on something tangible that he can be proud of breaks his negative thought patterns. He shows a clear link between his debilitating mental health issues and an improved sense of self and accomplishment. This, again, strongly connects to the process of re-/creation and the activity itself having a soothing impact on the mind. Heidi makes a more general claim and says that, in fact, when hackers and Makers meet there will not be another event where more hours of therapy come together: "Often we do not cope well with the

world out there." Besides the reference to therapy hours and, thus, mental health issues, she also picks up on the further up mentioned notion of escaping reality and the 'outside world'.

The idea of removing oneself from the outside world is intriguing and mirrored by others. Short interview participant A035 (woman, UK, 24) says "It's kind of an escape for me as well. I just shut myself in my shed and just carry on and not really be bothered with anything that's going on." This resonates with what Heidi and other previous quotations revealed: an alienation from one's surroundings in order to improve personal well-being and a sense of self. Others state opposite ideas. Survey participant B129 (gender unknown, UK, 53) explains why Making is important to society: "I think of hackspaces as gyms for the mind and soul. Making keeps us sane, and keeps us connected to the real world." Whereas they agree that Making is good for one's well-being, they then continue to go into the opposite direction of the previously mentioned Makers and emphasises the connection to everyday life. A clear tension emerges which is likely connected to ideas about activism and how a Maker views aspects of alienation within their practice.

The alienation from self and others is pointed out by others. Ryan mentions a re-connection with his senses and, simultaneously, other humans:

> Especially for IT people, the other reason to get into making is because of course you spend your day not using your senses, everything's virtual. I get a figure wrong and it goes in a loop and […] nothing happens in the real world. […] So it's quite often software people who […] have a fundamental human craving to interact with other people. Even more fundamental than that is just to interact at all, like sense of touch, hearing, smell.

He continues to explain that men in their 40s, like him, often suffer from a much-reduced social circle and are, thus, more likely to become isolated. Making within a community of like-minded people, therefore, alleviates this suffering and improves well-being. On a structural level, he remarks that this increased isolation of men might partly be interpreted as a consequence of socialisation processes which instil in them to not rely on others and not connect as much with a community as women might be told to do. This is another good example of how everything is political and can be traced back to larger dynamics of power. These aspects, then, are connected to and mutually shape the adjacent concept of activism.

A last aspect that arises in connection with well-being is that of balancing out the use of digital-only technologies. Ryan has already stated in previous paragraphs that Making activities allow him to reconnect with his senses as a balance to his everyday job which is in

IT and, thus, mainly software-related. Lisa describes something very similar. She as well is required to do a lot of digital tasks in her job and is, thus, craving Making projects with rather traditional technologies:

> When I carve something from wood, then that's something very creative. […] The same is true for crocheting or knitting or sewing or whatever. To me, it's just a balance to what I do at work. I also enjoy drawing and painting a lot and that's simply a balance for me.

Megan takes it a step further and claims that the whole MM partly exists because of these dynamics between intangible and tangible objects:

> It's addressing something very deep in us that's got lost in this century. It was in the very late '90s that the web culture started kicking in. Early 2000's that smartphones and web too and all that stuff kicking in. […] It's an antidote for that. As well as opportunity, of course. It's both.

These ideas build a connection between traditional and digital technology. Even though digital technologies appear as very important to many Makers, activities that are only digital might not be appealing to all. Working with tangible artefacts appears to create a sense of well-being for some. Of course, working with sensors and coding microcontrollers includes tangible artefacts while still being an activity heavily influenced by digital technology. Nevertheless, as Lisa has shown, some prefer a much starker contrast to the digital world and purposefully make things that are classed as much more traditional. In terms of the morphology, then, traditional technology, digital technology and well-being might be closely connected for some Makers. It is likely that other concepts, such as self-actualisation and creativity, are also shaped by connections to well-being, and vice versa. A more detailed and focused study is needed to explore these dimensions further.

5.3.4   Traditional Technologies

The importance of technology is unquestionable within the MM. Not only is the object of creation significant, but also the technology used to make it. Special focus is on digital technologies. Not a lot of literature exists on Making and the use of traditional technology. Nevertheless, more traditional technologies play their part, too. Hence, as explained above, there is a need to differentiate between traditional and digital technologies within the morphology. It is challenging to define what exactly can be classified as traditional technologies, especially because development of technologies over the centuries is a rather

fluid thing. Considering the context of this study, it is viewed here as somewhat opposite to digital technologies. In a wider context this might not suffice, but for the purpose of the present research project, it is deemed acceptable.

Just as with digital technologies, traditional technologies do not only include the final object, but also employed tools, materials, skills and knowledge. In the online survey, participants were asked to list the kind of projects and activities they engage in within their practice. Even though a majority listed digital Making, many also listed things considered more traditional: 142 participants engage in some form of woodworking, 74 concern themselves with metalwork, 33 occupy themselves with some form of textile Making, and 10 list paper and cardboard Making. Many other areas are mentioned, e.g. music and pottery. Robin explains how their favourite Making activity is digital, but "that's not a definition of making. Making doesn't have to be digital and doesn't require digital tools in any way." Anna recalls how she has always made her own clothing but that has not been considered Making because "it's not techy enough". However, she herself does consider it Making.

For some, Making traditional technology is not only about having the final object, but also about keeping the knowledge and skills alive that allow them to make these items. Short interview participants A002 and A003 (women, UK, both over 50 years of age) came to their Maker Faire with a large loom to show visitors how fabrics are made:

> A003: It's an ancient technique and an ancient craft that's used throughout the world, it's also influenced the way the modern world is, because of computing.

> A002: And in the end all this technology still has to use this process when you make cloth of every sort, it is woven. […] Ok, they may use industrial machines to do it but the principle is exactly the same, it has not changed.

> A003: So we're trying to enthuse people in seeing 'where do our clothes come from?' […] The technology is pretty basic and this [points towards their loom] is probably the most basic way of doing it.

Both women emphasise that the underlying technology of how clothes are made is very old and easy to understand. Skills and knowledge for them seem to be more important to get across at their stall than Making an actual finalised object. Other Makers aim to combine digital and traditional technologies. Short interview participant A053 (women, UK, 35) says that she is "into connecting smart computer stuff with less high-fidelity stuff…knitting, crocheting, embroidery." Only a couple of authors remark on the inherent link between the two, e.g. applied arts scholar Martina Margetts (2011, p. 42) when she states that

"contemporary making relies on an accommodation between the handmade and the digital", thus emphasising that not everything can rely on digital technologies.

Even though traditional technology is not dominant, it is connected to and shapes some other aspects. Firstly, as just seen, there is a connection between old and new technology, be it through skills, knowledge or the object of Making. Digital technologies would not exist if it were not for the traditional technologies that came before. Some Makers promote this either through raising awareness for older technologies or through combining old and new within one project. E-Textiles, for example, connect textile Making with attaching sensors or other electronic devices, such as lights, to clothing. Makers combining old and new technologies will likely engage in a creative process (see 5.1.1) in order to make this combination work. Additionally, the reviving and (re-)learning (see 5.2.3) of old skills and knowledge connects to forms of activism (see 5.2.6). It comes back to criticising a passive consumer society in which knowledge about technology, especially traditional ones, is forgotten. Therefore, some Makers, such as the two women spreading awareness and knowledge about weaving and cloth fabrication, make a point of (re-)learning this knowledge and ensuring that this technology is neither forgotten nor lost. Both the concepts of learning and activism are shaped by traditional technologies.

Making, crafting and artisan activities have experienced a revival in the last decade and traditional skills and knowledge with them. In certain parts of society, it has become more common to create your own technology. Popular online platforms, such as Pinterest where people share instructions on knitting, furniture Making and the like, provide plenty of evidence. Nevertheless, within the MM, these traditional technologies do not (yet) play as big a part as digital technologies. However, as we have seen, they are important to some and seem to be growing in importance. In the morphology of present-day Making, they can be deemed peripheral.

5.3.5   Entrepreneurship

Some proponents of the MM attach its importance to entrepreneurship and fabrication of products. Some Makers do indeed use Making activities in order to make a living. Almost 40% of UK-based survey participants agree that they want to or are already making a living with their projects. This stands in sharp contrast with German and Austrian Makers where only 9% and 16% respectively state this as a motivation. This is a good example to show us how some concepts gain importance in one society and less in another. Peripheral concepts,

we can recall, are much more likely to change culturally and diachronically (Freeden, 2013, p.125) and, thus, have much different importance in different configurations of Making. Here, British-based Making appears to be more focused on entrepreneurship. Entrepreneurial Making is not a focus of this study, but these numbers invite further exploration and research on reasons and backgrounds. Prominent Makers who encourage people to Make often mention entrepreneurship. Anderson (2012), for example, sees the movement as "a Commercial Web model, defined by low barriers to entry, rapid innovation, and intense entrepreneurship" (p.225) and he wants to see the "creativity of entrepreneurs and individual innovators reinvent manufacturing, and create jobs along the way" (p.16). For him, the movement is not so much challenging and radically changing how society works but modifying the economic system. Stangler and Maxwell (2012, p.3) echo Anderson's predictions from an academic side: "[A] new type of producer society […] driven by grassroots movements in tinkering, entrepreneurship, and small-scale manufacturing, has the potential to transform how we think and talk about […] manufacturing". Some of those entrepreneurs can be met at Maker Faires where they promote and sell their products, e.g. iAMOK[11]. The Berlin-based business started out at the local Makerspace HappyLab and is now a thriving enterprise.

However, entrepreneurial Makers do not appear to be in the majority when considering Making worldwide. Indeed, some communities seem to uphold entrepreneurial Making rather high and might define it much closer at the core of what they understand as Making, e.g. Makers in Silicon Valley. Others, however, like Tanenbaum et al. (2013, p. 2609) might argue that Making items is important when countering dominant economic dynamics instead of fuelling them: "We contend that DIY practice is a form of nonviolent resistance: a collection of personal revolts against the hegemonic structures of mass production in the industrialized world." Nevertheless, just as with other forms of activism, i.e. environmental protection, capitalism is very effective and efficient in incorporating these within its machinery and in using them to make a profit. It does not come as a surprise that the same thing has happened and is happening to Makers and to potentially disruptive political craft activities, as cultural workers Anthea Black and Nicole Burisch (2009, p.610) note:

> Politically engaged crafting practices and many contemporary curatorial approaches share a common ability and imperative to challenge the dominant economies in which they are situated. While these approaches generally do not

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[11] iAMOK is a Berlin-based fashion-label: https://www.iamok.berlin/

> seek legitimacy within mainstream economies or spaces of display, this radical activity continues to be commodified into corporate and institutional cultures.

In case of the MM, this starts with tools and materials that are constantly improved and sold by Maker-related companies, such as the previously mentioned Arduino. Also observed before are *Make:* magazine and Maker Faire, which were both part of Maker Media, Inc. and were commercially run enterprises whose primary goal was to make money. Crucial, then, is the recent development in which the company has stopped all operations due to financial difficulties and has moved to establishing itself as Make Community, LLC. In a public statement, founder and president Dougherty has said that "I started this 15 years ago and it's always been a struggle as a business to make this work" (Constine, 2019). This development shows, in fact, that finance-focused Maker endeavours do not always work as well as hoped.

In fact, a case could be made for the whole movement being artificially boosted and initiated by companies in order to make a profit: *Make:* magazine praises itself for having first propagated and coined the term *make* in our sense of the word (Make: Community, 2019). Naturally, this does not mean that Making activities did not exist before, but it raises the question of whether the size and scale of the movement is, in fact, a commercially powered enterprise. These dynamics and their implications are too extensive to fully examine here. But when talking about activism and political aspects of the movement aspects of entrepreneurship have to be part of the equation.

Despite its dominance for some Makers, overall it appears that the majority of Makers does not seek to make a living with their projects, hence the classification of entrepreneurship as a peripheral concept. The concept appears to stand in direct contrast to notions of activism which challenge the status quo of the economic system. How the commercialisation of one's own Making practices and products influences other Maker aspects is something not studied by previous researchers and in need of more research. On the one hand, it can be assumed that in those cases aspects such as community, free sharing or inclusiveness might experience dramatic changes and develop into concepts that stand in stark contrast and tension to the goals of those Making activities. Other components such as empowerment, self-realisation and, naturally, entrepreneurship, are likely to be amplified. However, on the other side, just because a Maker is turning their free-time activity into a business does not necessarily mean that they put profit above everything else. People have to survive and if they do it with something they actually enjoy and through potentially spreading the benefits of Making to others, then profit-maximisation might not overtake meaning-maximisation.

Rather, they might be of equal importance. Within this general morphology, entrepreneurship remains among peripheral concepts while it is acknowledged that for some Makers it will have a higher priority and, thus, move to an adjacent or even core position. Again, different distinctive morphologies become apparent.

5.3.6 Environmental Sustainability

Just as with inclusiveness/accessibility, extra caution must be exercised when determining the position of environmental sustainability. Due to the topic being one of the two focal points of this study, it has been discussed extensively and in great depth with participants of all methods. Thus, the author's views on the importance of it might be unbalanced and skewed. Nevertheless, a quick overview over the general importance of environmental issues within the movement shall be given. When asked for motivations to engage in Making, just under 28% of survey participants chose the option, among others, that they want to reduce human impact on the environment. Upon being asked to list their top three priorities while choosing a project in an open-ended question, 14 Makers mentioned priorities relating to environmental protection and animal welfare. When asked to explain if and why survey participants thought Making was important for us as a society, 16 of them raised environmental issues as reasons. From those numbers it might be concluded that a minority of Makers cares for environmental sustainability within Making. While that certainly seems to be the case, the numbers might be a bit lower than presented here. Survey participants were primed for the topic of environmental sustainability through the survey's title and knew that the study focuses on these issues, so they might have given environmentally biased answers to these questions.

However, as seen in the literature review, some studies consider environmental sustainability within Making practices, including discussions around its importance and its actual environmental impact. On the one hand, literature from more or less the same collection of European researchers who examined Makerspaces across the continent deemed the movement pro-environmental and attributed many positive effects, e.g. repairing, recycling and upcycling, environmentally friendly materials and products, environmentally friendly production processes and impact of local production (Unterfrauner et al., 2017b, p.123f). On the other hand, a handful of studies deliver evidence for at least one of the following two statements: (a) interest within the movement to be environmentally sustainable is rather low and (b) the impacts of Making on the environment are potentially worse than often portrayed. A lack of interest in environmental issues is noted by Millard et al. (2018, p.19f) who

compare environmental achievements within the movement to social and economic ones and deem them less impressive. Rosa et al. (2017), in a technical report on the Maker scene within the EU, state that only 18 out of 826 examined spaces seem to care about environmental issues. Nascimento and Pólvora (2018), Charter and Keiller (2014) and Kohtala and Sampsa (2015) in their various assessments report similar levels of environmental engagement. The second statement is supported by Kohtala (2015), Mota (2011) and Roedl et al. (2015). Negative environmental aspects these authors talk about are: personalised fabrication by amateurs might have higher environmental impacts per unit, recycling such an object might be more difficult, and the usage of tools, such as 3D-printers, might increase the amount of waste that is produced, not decrease it.

The status of environmental sustainability seems unclear but taking together academic literature and data from this study appears to affirm that environmental concerns do not feature highly in Making activities which is why they are acknowledged as a peripheral concept. But even as such, they connect and shape quite a few other concepts. Firstly, environmental concern is directly connected to notions of activism that challenge current modes of production, especially inbuilt obsolescence. Repair and recycling of broken devices and material directly alleviate the creation of more waste. Secondly, some Makers have noted a connection between environmental sustainability and traditional/digital technology. In-depth interviewee Anna loves digital technology "but it's just not the most environmentally friendly thing you can engage with." She continues later: "Making, simply, includes an insane amount of waste. […] It's a lot of trial and error and, thus, per definition a process that requires a lot of material. It's just not a streamlined approach." Whether there is a difference between Making with digital and traditional technologies, and what those differences would be, needs further examination. However a connection, generally, can be made. Last but not least, the concept of community also appears to shape environmental sustainability. Robin has raised this connection and said that the environmental concern which a Maker might devote to their project can depend very much on their Making community and how their space values this aspect. Environmental aspects are further examined in Chapter 7. For now, we can record their rather small influence. Just as with entrepreneurship, though, it can be assumed that the concept has importance for a minority of Makers. Klara, Maker within an eco-hackspace, springs to mind. Again, a variety of contested beliefs and constellations within this morphology become clear.

5.3.7   Interim Summary

We have now reached a full morphology of the MM according to Freeden's model for ideologies. Figure 5-2 on p.143 has already provided us with a visual overview. Having defined and contested a multitude of concepts, we are now able to more clearly distinguish Making activities from non-Making activities. At the same time, the morphology allows us to account for different Making constellations and formations that will depend on culture, community and development over time. A Vietnamese Maker aiming to be recognised on the global level can be defined as much as a Maker as an entrepreneur Maker in Silicon Valley or a hobby Maker in a small community-run space in Austria.

5.4   Example constellation: Makerspaces in the UK, Germany and Austria

Having defined the most important aspects of the MM, we now need to take a step back. As Freeden claims, these morphologies and their aspects can change over time and space (2013, p.126). For example, whereas entrepreneurship is a peripheral concept within current Making practices and not necessarily important to all Makers, in a decade or two it could be *the* defining aspect of what it means to be a Maker and people not Making for money might have a new label under which they unite. Truly transgressional activism would not play a role at all anymore because Making would not be about transgressing the current system but merely about transforming it. Self-actualisation and empowerment might be even more important, and the meaning of community might have declined to a peripheral possibility that is not necessary. By no means is this a prediction, merely an example of how morphologies and their interrelated components can develop. Chances are there will be different manifestations, just like there are today. Equally, the composition of Maker groups/trends might differ from continent to continent, country to country, even Makerspace to Makerspace, as the Austrian feminist Makerspace shows. In what follows, one specific configuration shall be introduced briefly to pave the way for subsequent analysis chapters.

The configuration that shall be looked at is that of the focus of this study, namely Making in Makerspaces in the UK, Germany and Austria. It is thus based on data collected throughout this study. The stereotypical Maker in this configuration is an amateur regularly going to a local Makerspace. He does not go only to use the available tools but also to socialise with other Makers. In fact, the community of his space is rather close; most of his closest friends

are Makers within this space. The space itself is community-run and works on membership-scheme. Aspiring members are required to attend open-door days and/or workshops first before they can officially join. This is in order to ensure that they fit in and know the basic rules and workings around the space. Once a member, Makers can access the space 24/7. The space itself, due to its grassroots nature, is not very wealthy and is, therefore, situated in the basement of an old office building. The typical Maker in this space uses digital technology, such as 3D-printers and microcontrollers to create a project. Most of the members engage in Making for fun in their free-time. About half of them might be engineers or working in IT. They have joined the Makerspace as a creative outlet and to socialise with like-minded people. Even though they are quite well-versed in using digital technology, they enjoy a creative challenge and mastering a new skill. This requires them to not only receive help once in a while from fellow Makerspace members, but also to regularly consult online sources to understand a tricky piece of code or get advice on how to best assemble a certain project. The general opinion in the space is that commercially produced technology is not great as it is made to break quickly, difficult to modify and even harder to repair. Through their Making activities they learn more and more about digital technologies and understand them better than the average person. Nevertheless, this is a hobby to most of them and the projects are mostly chosen out of a desire to be fun, affordable and useful.

Even though most of them see Making as a hobby, some do not rule out the possibility of selling what they are Making if there was enough demand. In fact, one or two of them might be registered on Tindie (https://www.tindie.com/) to sell their digital devices. Quite important to the Makerspace's Makers is self-actualisation. They want to make stuff that adheres exactly to their wishes and ideas. Equally, Making itself is an act of self-actualisation for many as the time spend Making is creative hobby time in which no one tells them what to do. Thus, well-being also plays a small role. It might not be realised as playing a role but underlies their need for being part of a close community and having a creative outlet in contrast to their employment. Traditional technologies do not play a big part in the Makerspace, although sometimes someone in the space engages in woodwork or metal work. Inclusiveness, accessibility and environmental sustainability do not play a role at all.

The developed visual representation of this morphological configuration (Figure 5-9) requires a few comments. Firstly, considering the many, many connections between concepts that have been established in this chapter and the inherent complexity of Freeden's model itself, it comes as no surprise that the visual representation of this configuration is rather complex and might be confusing at first glance. Many concepts are connected and

decontested by each other which this visual is aiming to show. Secondly, the size of the different concepts is used to indicate their relative importance. For example, even though entrepreneurship and traditional technologies are both defined as peripheral objects, they do have a different weighing here and, thus, different sizes. Two concepts play no role at all and are, therefore, not included. Thirdly, to facilitate understanding further, most of the connections have been greyed out as they are not crucial in the chapters to come. Some other connections have not been made due to the extreme complexity this would cause. For example, entrepreneurship and learning will likely shape each other through learning how to create the products that are sold or how to run a business. However, this connection is not Maker specific and, as mentioned, would complicate the model even more.

This example is brief and only some dynamics between concepts and within the morphology could be explained. However, it suggests how different concepts carry different importance and different meaning in different areas. This particular constellation, then, differs from the more general morphological model that has been mainly developed throughout this chapter in that is shows a distinct constellation of Making with specific dynamics and concept interactions. As has been explained and Figure 5-9 illustrates, the importance of some concepts over others can be observed. This morphology is culturally specific and marks one constellation among many. Important to note, then, is that not all Makerspaces in the UK, Germany and Austria will adhere to this model. Many variations and completely different constellations will exist. However, data collected in this study combined with literature suggests that this morphological constellation represents overall tendencies which are present in many of these spaces.
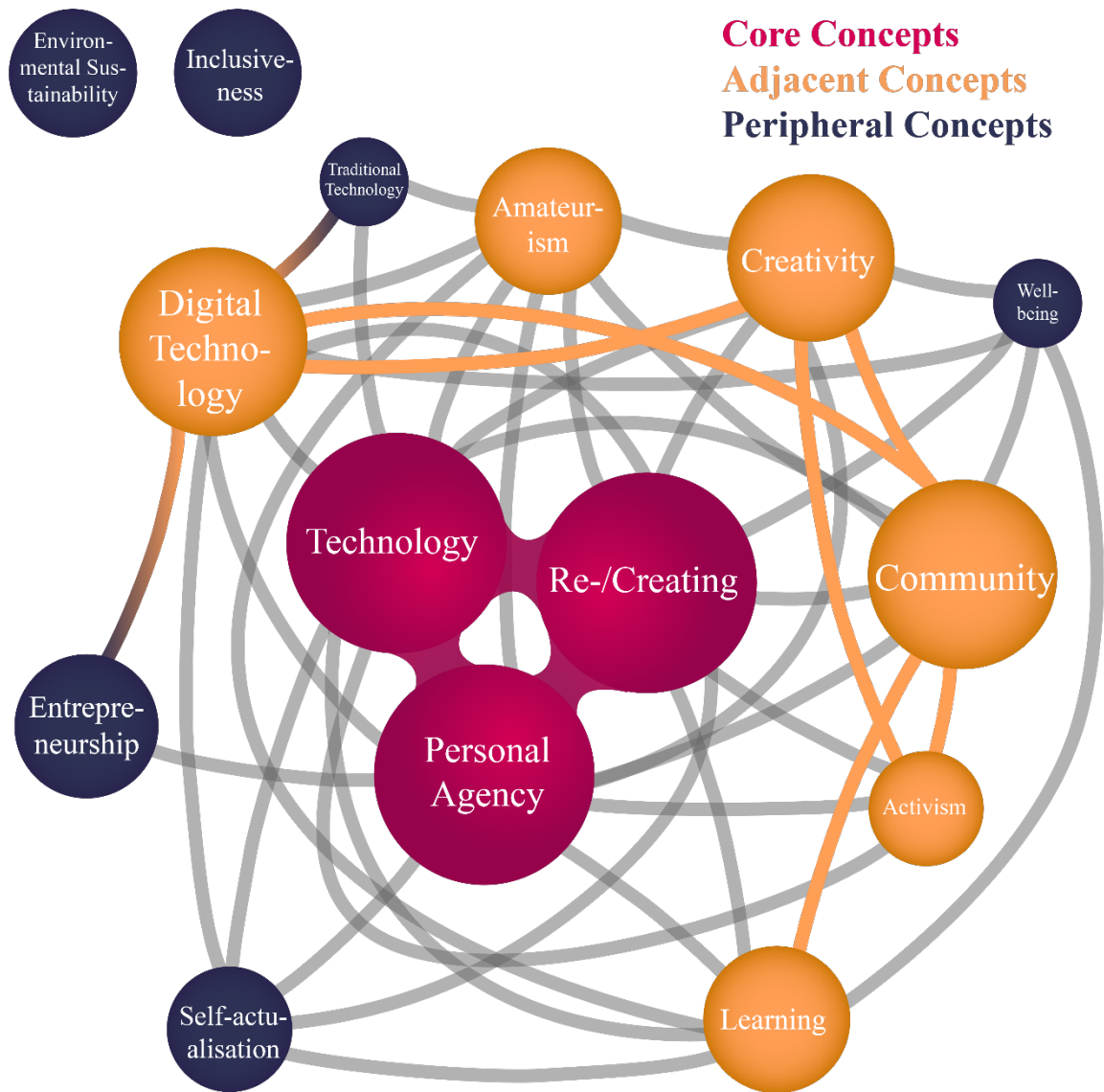
Figure 5-9 Morphology: Makerspaces in the UK, Germany and Austria.

5.5   Summary

This chapter has developed a morphology for the MM with the following concepts:

- Core concepts: Re-/Creating, Technology, Personal Agency

- Adjacent Concepts: Community, Creativity, Learning, Digital Technologies, Amateurism, Activism

- Peripheral concepts: Inclusiveness/Accessibility, Self-Actualisation, Well-being, Traditional Technologies, Entrepreneurship, Environmental Sustainability

Each section has shown (a) how a respective concept manifests itself, (b) why it is (more or less) relevant and (c) how it relates to and shapes other concepts. While developing these concepts, a visual representation of the developed morphology and a specific model for Makerspaces in the UK, Germany and Austria have been established. In the following two chapters, this specific morphological conceptualisation is considered in regard to the two concepts that have been left out: inclusiveness/accessibility (Chapter 6) and environmental sustainability (Chapter 7).

Chapter 6   Gender and Inclusiveness

"You as a woman have children and I as a man have making."

(A121, man, GER, 74)

Inclusiveness is, for many Makers, not an issue. For some, it is something they do not wish to engage with and, potentially, get offended by. Nevertheless, or maybe because of this, it is by now an important aspect, especially for those who do not feel included. Despite most survey participants agreeing that inclusiveness is important to them (91% of women, 82% of men), we have encountered many challenges already, most obviously that most Makers are male, middle-aged, white, and from a fairly affluent background. Now that a general morphology and one specific for Makerspaces in the UK, Germany and Austria have been established, this chapter specifically looks at women's exclusion/inclusion in these Makerspaces. Recalling the research question, this study aims to explore whether inclusiveness issues and environmental sustainability can be tackled together. This chapter aims to understand inclusiveness issues with focus on women and shows not only how they are excluded but, consequently, also what can be done to include them better. Figure 6-1 provides a visual representation of the morphological link that is explored. Inclusiveness as a concept is not included in the specific Makerspace constellation as developed in section 5.4. This chapter, thus, shows how neglecting inclusiveness shapes and constructs community and, in turn, what including it would mean for how the two concepts construct each other. Towards the end of the chapter, this visual is expanded to include the analysed aspects.

Figure 6-1 Community and inclusiveness link.

Two main aspects are considered: women's initial disadvantaged position in society that makes them less likely to participate in Making (6.1), and how the physical and social aspects of Makerspaces themselves can increase challenges for women to fit in (6.2). The chapter argues that, despite claims of inclusiveness, Makerspaces are in fact spaces that, by and large, exclude women. This analysis is specifically based on the Makerspace morphology developed in section 5.4. Data analysis shows that this configuration is inherently masculine and male-biased. It is, thus, a potent example for the social constructivism approach that underlies this thesis. Makers in this configuration construct a reality that does not acknowledge women as equal Makers. The end of the chapter establishes a more women-inclusive morphology based on how women in this study construct their Making reality and what they deem a more inclusive Making environment.

6.1   Outside Makerspaces

At the starting point are issues of access, or 'practicalities' as they might be termed. Some Makers have pointed out that Making is a time-consuming hobby and that it requires a certain amount of financial flexibility. This section sets out to show how women are, generally, disproportionately affected by issues such as less free time and financial means in society. These aspects were not particularly focused on while conducting this research but some of them were raised by participants. This data, some public data and available academic literature is employed to make the argument. Time, money and mobility are the three considered aspects.

Let's start with time. Literature on gender-based distribution of free time appears to agree unanimously that women have less spare time on their hands to spend freely. According to Sociologists Stella Chatzitheochari and Sara Arber (2012, p.451) "Free time, that is, the time that remains at one's own discretion after work and other necessary daily activities are

conducted, is an important non-monetary welfare resource, providing an opportunity for rest, social interaction, leisure participation, and self-realization." They continue to show how free time has been perceived as indicator for societal progress, freedom and individual well-being. When it comes to men and women, however, the availability of free time differs. It differs so much that the term *time poverty* is applied and used regularly (Chatzitheochari & Arber, 2012; Ringhofer, 2015; Turner & Grieco, 2000; Warren, 2003). The term is defined "as a *relative* deprivation of free time resources" (Chatzitheochari & Arber, 2012, p.452).

The most common themes of how this time poverty arises evolves around (unpaid) care work, travel patterns and modes of travel. When considering data from the UK, Chatzitheochari and Arber (2012, p.462) find that having children affects women's free time much more dramatically than men's. This is mirrored in the present study's participants: only one of the women has a child to care for (a teenager), but at least three men, if not more, have young children at home which indicates that women with children do not have time to engage in Making as they are primary care givers, and men with children might have more free time as they do not take on as much of the care work at home. Chatzitheochari and Arber (2012, p.465) find that even women who are not considered time-poor experience much less uncontaminated free time: "women's free time is significantly more *contaminated* than men's, as they spend almost half an hour more doing housework chores or minding children during their free time." These aspects are highly interwoven with class issues as well (Warren, 2003; Chatzitheochari & Arber, 2012).

Considering public data from our three focus countries underlines the issue. Starting with unpaid care work, data from the European Union shows that in all three countries, women are much more involved in daily caring for children (see Table 6-1). A similar picture arises when looking at domestic and housework. Without going into too much detail, it is painfully obvious that women in Europe and our three countries, in general, engage far more in unpaid care and domestic work than men. In terms of free time, this might be evened out if paid employment times were reversed and women would accumulate the opposite amount of paid work hours to men. However, in all three countries, the gender gaps are not as high as that (Destatis & Eurostat, 2017). Thus, women's availability of free time is less than that of men's.

	Care work unpaid, daily (Destatis & Eurostat, 2016)		Domestic and housework unpaid, daily (Destatis & Eurostat, 2016)	
	Women (25-49 years old)	Men (25-49 years old)	Women (18+ years old)	Men (18+ years old)
Germany	88%	64%	72%	29%
UK	86%	62%	85%	49%
Austria	90%	67%	83%	28%
EU average	92%	68%	79%	34%

Table 6-1 Care and domestic work in the EU, Germany, the United Kingdom and Austria.

Why is this important for Making? Because, as we have established earlier on, Making requires a lot of time as a hobby. Anna has said that Making is "a time-intense hobby" and Anton remarked: "Someone who is penniless, has no ideas and no free time won't come into the hackspace." Looking back to the developed morphology, it is highly likely that creativity, learning, amateurism and self-actualisation are heavily connected with time. Creativity and learning are both marked through a trial and error approach and learning a skill properly and working with it creatively are both things that require a certain amount of time. Both these aspects are often about solving problems, something that Makers seem to like to do. Amateurism, as defined previously, often refers to unpaid work which, besides financial aspects, also implies having the time to do something unpaid.

In-depth interview data provides some support for Making being time-intensive and not always in alignment with care duties. Karl, for example, has noted that he would like to set up a Makerspace "if I didn't have children. […] In the near future I don't have the time". Moritz who has been a Maker for decades cannot attend a Makerspace because he is caring for his invalid wife. Megan recalls a workshop she organised to which people could bring their kids: "Loads of people were single mothers or young mothers, because they could bring their kids, it gave access to them. If you took the disadvantaged, uneducated, young single mother, I'd say they're massively not included in most Makerspaces." Ryan provides a quite stereotypical example of the division of domestic work and the resulting availability of time for him in his home:

> Sometimes I have to be at home because […] my wife's going to make dinner, so I think today I've got 20 minutes that I can go and do something while she's occupied so I don't feel guilty that I'm kind of ignoring her. […] you get used

to grabbing those little chunks of time and count as blessings when they come around […].

However, Lewis also does "an awful lot of the childcare […] My wife works full-time, I stay at home and look after the children." He goes on to explain that he fits his Making projects around his childcare duties. Even though some of the examples given here include men who cannot engage in their Making activities as much as they would like due to care duties, in general, women are more likely to be in charge of care work, as just seen in the literature and the reason data here delivers male examples is that women with children simply struggle to engage in Making at all. Short interview participant A121 (man, GER, 74), who has opened this chapter and whom we will meet again later, drives this statement to an extreme when stating: "You as a woman have children and I as a man have making." Ryan and participant A121 are good examples here of how people socially construct gender and gender roles. In their views, women are responsible for care and housework; men can use their time for activities more connected to leisure. As we have seen in the data chapter and will continue to see in the following pages, this is not necessarily how female Makers construct themselves and their identity.

The examples here, then, show how restricting these care and housework duties can be on female Making. Available academic literature says almost nothing about the connection between structural issues like this and Making. The only one coming close is Lewis (2015) who examines barriers to women's involvement in Makerspaces. Albeit short, one paragraph mentions financial and time issues that disproportionately affect women. She has spoken to some female Makers who have said that child-care duties are likely to be a barrier to participation for women with young families. The only article that deals with this specifically is Rosner and Fox's (2016) account of a hackerspace that is specifically set up for mothers and allows them (and fathers) to work creatively while bringing their children along and without having to fit into the rules and ethos of a regular hackerspace. But within regular Makerspaces there does not appear to be a lot of concern for gender-related time constraints.

Closely interlinked with time poverty is the issue of gender-related financial resources. It is widely acknowledged that women, on average, still earn less than men. Economist Ricardo Aláez-Aller and his colleagues (2011), for example, consider gender wage gaps in the European Union and come to the conclusion that "the biggest differences in hourly wages between men and women are found in the countries of northern Europe" (p.82). Table 6-2 provides the latest numbers and confirms that all three countries considered here are above

EU average when it comes to unadjusted income. But even when adjusted for type of work, level of education and other factors, women are still at a disadvantage.

	Gender wage gap	
	Unadjusted (Eurostat, 2017a)	Adjusted (Eurostat, 2017b, p.9/11)
Germany	21%	6.7%
UK	20.8%	13.4%
Austria	19.9%	9.5%
EU average	16%	11.2%

Table 6-2 Gender wage gap in EU, Germany, the United Kingdom and Austria.

Many factors contribute to these differences. Often recognized is the increased rate of women working in part-time positions which provide less pay (Aláez-Aller et al., 2011, p.76). In 2018, women are 22.8% more likely to hold a part-time job in the EU. In the three countries considered here the ratio is even higher (see Table 6-3). Not only less pay, but also less employment in general impacts women's financial situation. The same figure portrays that a gender employment gap adds to women's disadvantaged position in society. Lastly, even if men and women earn similar amounts of money, they seem to spend it differently, especially when children are involved. According to economist Shelly Lundberg and her team (1997) and economists Shelly Phipps and Peter Burton (1998) women are more likely to spend their money on their children. When a woman's income increases, expenditure for her child does as well. This was not observed with men. Thinking back on Figure 2-4, which showed average monthly Makerspace fees and average hourly earnings for the respective EU membership countries, now leads to the conclusion that, on average, women might have to work more hours than their male counterparts in order to be able to afford membership fees because their average hourly income is below that of men.

All of these numbers merely scratch the surface of the relevant issues. For the purpose of the argument, the surface shall suffice in establishing that women, in general, have fewer financial resources available to them to engage in leisure time activities, such as Making.

Recalling the data chapter provides support for the claim that Making does require some financial resources. Anton remarked that engaging in Making "requires that you don't fight for your survival on a daily basis." Frank remembers that he was not able to make things when he was younger because it was too expensive. Affording the materials Making requires can easily go beyond someone's budget, especially when they are new and digital. Thus, the concept of technology in general, but specifically digital technology is likely to be affected by financial capabilities of a person. Klara points out that Makerspaces, especially grassroots ones, often struggle for financial stability and are reliant on collecting membership fees that not everyone can afford. This connects strongly to the concept of community in that persons with low income are less likely to be able to afford membership to a space. Lewis (2015,

	Gender part-time work gap (Eurostat, 2018)	Gender employment gap (Eurostat, 2019)
Germany	37.4%	8.1%
UK	29%	9.9%
Austria	37.7%	9%
EU average	22.8%	11.6%

Table 6-3 Gender part-time and employment gap in EU, Germany, Austria and the UK.

p.11) interviewed a female Maker who recalls: "I couldn't even afford to join for a while, and after I did there were some months where I went hungry to maintain my membership."

Lastly, issues of mobility are mediated by notions of gender, too. This aspect, contrary to time and money, is likely to affect the participation in Makerspaces specifically. Makerspaces tend to be located in urban settings which is likely due to a city's higher concentration of interested people and, therefore, a higher chance of being able to financially fund such a space. Transportation might also have to do with why women access them less. Firstly, some studies suggest that women have less access to a car and, thus, are more dependent on and use modes of public transport more than men (Ceccato, 2017), but with a higher fear for their safety. According to the Global Mobility Report by Sustainable Mobility for All (2017, p.50) "Security issues create a significant burden on women's mobility. The

lack of personal security, or the inability to use public transport without the fear of being victimized […] can substantially decrease the attractiveness of public transit." This fear for their own safety is especially prevalent at night (European Institute for Gender Equality, 2016, p.3).

Taking all of this together might explain further barriers for women to participate in Makerspaces. Women appear to be more dependent on public transport to access Makerspaces. It can be assumed that leisure activities such as Making will be pursued more in the afternoon and evening hours which, especially during winter months, might increase travel time during dark hours. Not only could that increase women's uneasiness about their safety while travelling, but they might decide to refrain from such a trip altogether. This also ties in with the already discussed time poverty as trips by public transport are likely to take longer than by private transport. Thus, women who are already considered time-poor might be required to spend more time in transit than men. How far public transport fares have a detrimental impact on financial resources compared to using private modes of transportation would have to be considered as well. The data collected through this study did not include any references to transportation issues. This is not considered as detrimental to the just discussed issues, but rather a strong implication that research on this topic is necessary.

In the literature review, we came across Toombs et al. (2015) who stated:

> [T]he ethos that 'anyone can be a maker' obscures the fact that *not* everyone can be a maker. A single mother with three part-time jobs and no car probably cannot be a maker—not, at least, in the sense that 'being a maker' is specifically understood in this and other hackerspaces. Such an individual becomes literally invisible in the maker ethos, thus redefining 'everybody' down to a certain social class; it is presumably not a coincidence that the majority of dues-paying members are men in their thirties with professional careers, many of which are in IT (p.636). [emphasis by authors]

Albeit brief, this section has established that, by and large, this statement holds true for women in the UK, Germany and Austria as they are likely to face more obstacles and challenges in engaging in Making activities, especially when it comes to regularly attending a Makerspace. It is important to establish these external conditions as they might not be recognised by Makers as issues affecting women as a group. More likely, they might be referred to as practicalities that have no gendered nature. James, when asked if he would consider societal issues when setting up his own Makerspace, replied:

> When setting up my own makerspace, I would think far more in terms of practicalities of, you know…It should be good for this, it should be good for that. If I was setting up a makerspace, I wouldn't set out to tackle societal issues kind of thing.

What is not realised is that so-called practicalities, e.g. membership fees, location and opening times, do have different effects on different groups of people and might easily be interlinked with societal issues.

Portraying the importance of these issues also shows why waiting for women to knock on a Makerspace's doors might not be where inclusiveness work should start. When asked about the poor representation of women in their space, two participants of the Toombs et al. (2015) study say: "our door is always open to anyone who wants to come." When the topic was discussed in their members' meeting, the consensus was that "all we can do is make sure everyone feels equally welcome here. If you hear of anyone feeling unwelcomed please bring it up so we can address it" (p.635). Hans, a participant of the study at hand, states: "If they [women] aren't there, we can't please them." This neglects people who might not be able to access the space in the first place. It seems as though some Makers wait until women step into their space in order to tackle inclusiveness issues while neglecting that the latter might be disadvantaged from the off – through time-poor schedules, fewer financial means and mobility issues. Whereas Makerspaces cannot be expected to solve such fundamental societal issues all by themselves, they could consider taking measures that would make it easier for women to get involved.

Even though these Makerspace-external issues are difficult to locate within the established morphology, they are not invisible. Previous paragraphs have already hinted at the time-demanding (i.e. learning and self-actualisation) and finance-demanding (digital technologies, access to community) activities some of the morphological concepts entail. Whereas, for example, the nature of thorough learning as a time-intense process cannot be changed, including inclusiveness into the morphology would potentially facilitate a more flexible approach. Megan has spoken about workshops that were child-care friendly and attracted many more single parents than an adult-only workshop would. Thus, even if in a female morphology the concepts themselves would not disappear or change in importance, the way they are contested and executed might change dramatically.

Even though we have not yet explored the social make-up of Makerspaces themselves, this section has already shown how women's identity and their general role in society are

constructed in a way detrimental to them. The social construction of women as caretakers and homemakers has grave ramifications: less free time, less income, less mobility. That this role is socially constructed and not inherent to women can easily be seen in the fact that not all women adhere to this gender role, for example the female Makers in this study who have obviously incorporated Making as a leisure activity in their lives despite their gender role potentially not aligning with it. The exceptions to the rule confirm that the rule itself is not universal but a social construct. For Maker communities to be more gender-inclusive they need to recognise this initial disadvantaged position, that it is socially constructed and as such it can be challenged and changed if serious inclusiveness work is to be done.

6.2   Inside Makerspaces

This section more closely considers physical and social aspects of Makerspaces and how these might have underlying gendered dynamics. Within physical spaces the location and general atmosphere of a space is looked at (6.2.1), as well as the technology that is used within them (6.2.2). The social space initially differentiates between bonding and bridging communities (6.2.3) and then continues to show how the culture in Makerspaces is often rather masculine (6.2.4) and, thus, difficult to access for women. Taken together, these sections argue that despite claims of being open and inclusive, Makerspaces and their culture are often inherently masculine and, therefore, likely to be difficult to enter for women. These inherent dynamics can be seen in the morphology which, consequently, show masculine and patriarchal notions. Section 6.2.5 briefly shows how women cope with these exclusions. In a last step, then, the chapter develops a Makerspace morphology that aligns more with female Making (6.3).

6.2.1   Physical Space – the Space

This study has given more weight towards social aspects of inclusiveness and less towards physical aspects of spaces. Nevertheless, during the interviews the physicality of a space and its impact were remarked upon by a few participants. Brief examination suggests that the physical set-up of a space can sometimes have gender dimensions.

To start with, the location and physical atmosphere of Makerspaces were criticised by some female Makers. Some of them mention Makerspaces being in basements and/or old industrial sites. Short interview participant A92 (woman, AUS, 55) explains where her Makerspace is located: "a couple of basement rooms…well, back rooms in a house, so not very light and ventilated that you could use it as living space. It used to be an old factory." Hans talks about

two Makerspaces; one is in the basement of an institute and the other is an old transformer factory, and Heidi calls the participants of a hacker congress "basement children". The researcher herself was invited to a social gathering of Makers in a local Makerspace at the end of a Maker Faire. In order to get to the space, I had to take the elevator of a fairly old looking office building into the basement, make my way into the parking garage and, from there, access the Makerspace which was located behind heavy fire doors and had no windows. All of this happened at night when the building was otherwise empty. While not every woman objects to such a space, some do, such as Rose. She has visited quite a few Makerspaces around the world and compares them to her local space in the UK:

> Here in [local makerspace] you have to pay about £25 a month to get access. It's just industrial and it's really not too pleasant. It's freezing […] I got the chance to go into FabLab in Tokyo but [it was] so very much café based, really welcoming. You could go and you could check your emails if you're working that way and spend time in the café. The café is run by makers. Everybody's a maker. Whoever is even serving you coffee, you can ask them questions. That's really, really inclusive, and then you can go into the other part of the makerspace and you can take time to use the kit one afternoon or you can sign up for the courses. […] I don't particularly want to go into a dark dank really awful space. […] Some people do, they are fine with it, they think it's really edgy. No, I'm not going to do it. If I could get involved with the community where I could sit have a coffee, that's really inclusive, that's brilliant and then I can have a look.

Rose describes two very different spaces, one is industrial, unpleasant and freezing, the other invites to socialise, talk to Makers and slowly get to know the place. These observations suggest a very different approach to Making and community, and therefore a different morphological set-up in which inclusiveness and physical comfort play a much bigger role. Again, we encounter a very good example for how Making is socially constructed in different cultures and communities, and how differing viewpoints and constructions of reality result in different approaches of Making. Lewis remarks that "an awful lot of makerspaces, by their nature, are locked-door closed premises." He attributes this to safety and health issues. His statement contrasts to Rose's, which shows that, in fact, Makerspaces do not have to be locked-door premises. But to him who has maybe not been able to experience different models and, thus, different morphological set-ups, it might appear as though they must. Jane agrees with his observations and adds insurance reasons as to why spaces need to be able to monitor who accesses them and, therefore, cannot have an open-door policy. As mentioned earlier, another reason for the location of spaces and their maybe not-so-inviting nature is financial. Grassroots spaces do not always have a lot of funding and can only afford spaces that do not have the best market-value and are not going to be in safe,

populated areas. Jack talks about recently increased female participation in his Makerspace after his space moved:

> It's getting better. We moved to this new space six months ago, which I think is a much nicer environment to hang out and we have more space and things as well. I'm not sure if that's the thing that's caused the increase in that or whether it's just a general increase in membership and we're getting word out a bit more and so more women are doing stuff.

Even though he is only assuming and cannot say for sure what the increase in female participation is about, he does make a link to the environment of the space itself and that that could have the potential to influence those numbers.

Unfortunately, being in an appealing location is not always all it takes. Even if women might not mind the location, the space itself might not always be pleasing. Henry (2014), who was involved in setting up a feminist Makerspace in San Francisco, talks about reasons why a regular space might not be particularly inviting:

> maybe it's […] kind of dirty and cluttered and there's no toilet paper, and there is some creepy guy who won't stop talking to you about how he wants to teach you things that you already know, while he backs you into a corner.

Davies' (2017) interview with two female Makers talks of similar circumstances:

> […] the makerspace had been located in a smaller, colder, smellier room: 'I could live with it', Willow said, but she didn't like it. It felt like 'a boy's space'. Keira agreed: even though she didn't smoke, she used to go outside with people taking a cigarette break just to get away from the smell and the mess (p.97).

Lewis (2015) also recalls interviews with female Makers of UK Makerspaces in which, for example, "the ladies' toilet light switch was located so high on the wall that it was out of reach for most women" (p.10). While following discussions on mailing lists of Makerspaces, as the researcher of the present study has done, conflicts and tensions about uncleaned and messy spaces appeared regularly, not only from women. In fact, Lewis (2015) emphasises that not only women commented on the state of a space and its messiness but also men. However, she notes that it seems to be more off-putting to women. Interview participant Lewis actually constructs men as messier when talking about gendered Making activities:

> Typically, most of the things which are very messy will tend to be male dominated. I think by and large, for example, woodwork, when you get a

> female woodworker, they tend to be much more sort of precise and clean and neat and tidy and pay more attention to detail.

Even though Lewis' claim needs more evidence before being accepted, together with the above-mentioned examples it seems as though there is something to be said about a connection between the set-up of a space, its cleanliness and a connection to women's involvement. These areas of inclusiveness have not been raised a lot by the female participants of this study which might have various reasons, e.g. they might not object to this state of a space which is why they are part of one. Nevertheless, thinking more about inclusiveness when choosing a space and setting it up might have dramatic influence on the community that forms within that space. As previously mentioned, the concept of community within the morphology would remain important, however much more shaped and formed by inclusiveness concerns. No doubt, due to financial challenges grassroots Makerspaces might not be at leisure to choose a perfect space that is appealing to all genders. However, considering inclusiveness concerns within the choice of which space to rent might be enough and a promising start to ensuring a community accessible for all.

6.2.2   Physical Space – the Tools

When considering the physical set up of a space, the provided technologies, i.e. tools and machines, are important as they, too, have gendered dimensions. The kind of tools that are predominantly used have already been discussed at length in the literature review (Chapter 2), data (Chapter 4) and morphology (Chapter 5) chapters. The study established that the tools that are identified with Western Making are 3D-printers, laser-cutters and other digital fabrication tools. That the technologies used by Makers have a gendered dimension is acknowledged by many study participants. Some of them connect men with technology by saying things like "it skews techie, it skews male" (Jack). Short interview participant A50 (woman, UK, 38) talks about her Maker company and its customers' gender balance: "it's not *even* at all, it's very techie […] I think around 90% of our clients are male" [emphasis by researcher]. A023 (woman, UK, 53) talks about the electronics and coding workshops she provides for school children and states "Boys usually get really excited, they think it's for them. Girls are less excited but really good at it!" A055 (woman, UK, 28) also teaches kids how to code and finds it important to get "more girls into coding and showing them different ways that coding can be used. Not just in terms of building electronics and robotics but there is a wearable component as well." Powell (2013), the infamous Maker who has commented on a global discussion list that women enjoy "e-textiles or whatever it is females like to talk about" (see p.44), clearly links women to textile Making and attributes all

responsibility for more inclusiveness to them. Participant A121 (man, GER, 74) comes to mind again. His statement "You as a woman have children and I as a man have making" epitomises all the previous statements and once more highlights how women are socially constructed as being less connected to technology and the Making of it than men are. The underlying assumption of his statement surfaces regularly.

Some Makers acknowledge this constructed bias. For example, A037 (man, UK, 28) states that

> Hacking […] has been co-opted by nerdy white guys […]. Women already make a lot more than guys ever did and it gets downplayed a lot. […] a lot of stuff that comes to Maker Faires [are] tools, electronics, hardware stuff… blokey things.

In-depth interview participant Megan has set up a Maker consultancy which helps Makerspaces get off the ground:

> When people want to start makerspaces, they come to us and they say, 'What tools should we buy?' We just won't ever give people a kit list without doing a whole load of work with them about what community they want to build. Because if they want a 50% female community, they're going to buy different tools.

Megan and her agency acknowledge clearly that different tools and technologies will attract different genders and, therefore, have a gendered dimension. She goes on to give the example of a specific kind of drill they recommend to spaces as it is lighter and easier to handle – advantages for many women.

This connection to digital technology is clear not only in Makerspaces but in the MM as a whole. Surveying two Making magazines, namely Make: and HackSpace, shows a clear tendency towards digital technologies. HackSpace's website lists projects and on a random day (11/10/2019) five out of the first six projects involved digital fabrication technology (see Figure 6-2). Prominent Makers also connect digital technology tightly to the movement as seen in Chapter 2. Two women among the study participants oppose the importance of this connection: Nancy has already remarked earlier that she's bored of the MM and is frustrated by how digital it is and short interview participant A066 (woman, UK, 24) stated: "I don't see a lot of community merging unless the community has already an interest in electronics and I find that quite limited." The dominance of this kind of technology has already been addressed in the morphology chapter (5.2.4) and it has been linked to Learning, Activism,

Entrepreneurship and Amateurism. The gendered nature of digital technology automatically leads to all of these aspects also being influenced and shaped by gender. Viewing all these different aspects with a gender lens cannot be accomplished here but it is reasonable to suggest that, for example, a form of activism that is 90% guided by men will look differently than one that is 90% guided by women. It can, thus, be said that the focus on digital technology is heavily masculine and the morphology, therefore, infused with a male bias.
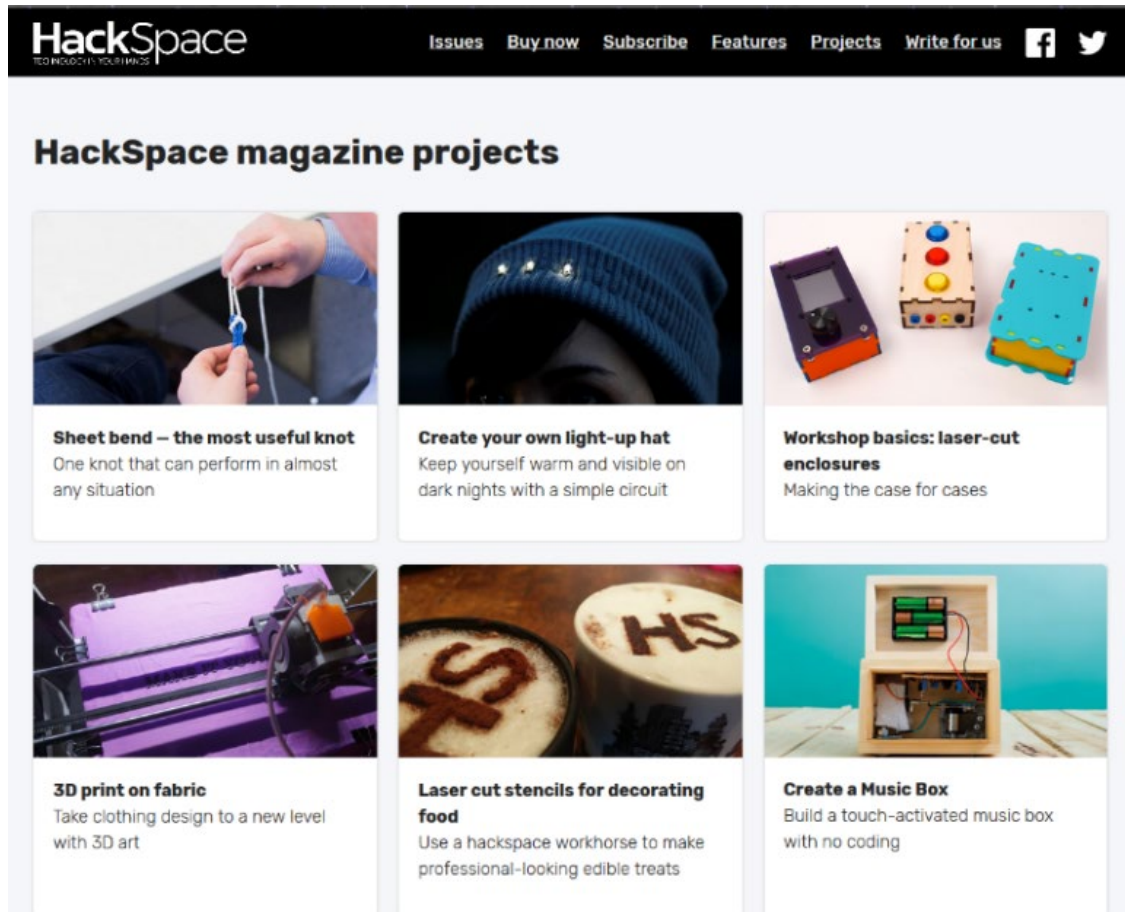
Figure 6-2 HackSpace magazine projects from 11 October 2019.

These findings fit well into existing literature around gender and technology. In 1997, Cockburn reflected on domestic technologies and their gendered aspects. She differentiated between technology/nontechnology, public/private and masculine/feminine (p.361f). Whereas men were seen as technologically minded public actors, women were non-technical and tied to the private domestic sphere. It might be questioned whether accepting this highly binary approach to Making is ideal. Whereas this is generally commendable and done in some works (Carden, 2018), in this particular case it appears prudent to keep to binaries to some extent. There appears to be a sharp gendered divide between the technologies here termed as digital and traditional/non-digital and an analysis of this divide will be more fruitful if constructed/perceived binaries are accounted for. Despite more than 20 years of 'progress', the MM appears to portray dynamics similar to those underlying Cockburn's

assertions. Men are often still thought of and raised to be technologically minded and as engaging with their technological prowess in a public setting. The technology they use is new and exciting. They appear to be at the forefront of experimentation and innovation. Female Makers, however, are often not associated with this kind of technology. Their technological engagement – if any – typically relates to more traditional and private categories, i.e. textiles (albeit sometimes electronic textiles). In short, women are socially constructed as 'different' when it comes to technology. Makerspaces, within this understanding, are set up and geared towards men: digital technology, public spaces. No doubt many spaces will have technologies that might be more linked to women and, thus, more appealing to them: (digital) sewing machines or ceramics workshops. But these are seen as additions. The essence of Makerspace tools, as we have seen in the literature and data section, is digital: 3D-printers, laser-cutters, coding.

More traditional technologies, such as textile making, are – in contrast to digital practices – often seen as "outdated and unskilled feminine activities" (Twigger Holyrod, 2017, p.37). We, thus, find the social co-construction of gender and Making activities whereby co-construction describes a mutual construction of each other. Fashion and sustainability researcher Amy Twigger Holyrod (2017) attributes an inherent sense of denigration to this connection which is partly reflective of a patriarchal culture (p.38). Despite the digital focus of the MM (and the male-bias examined here), it has nevertheless contributed to a slow shift in how textile Making and other traditional technologies are viewed (p.38). However, Twigger Holyrod remarks the following on the connection between textile making and gender:

> Although it may now seem somewhat less remarkable to meet someone who knits, sews or mends their own clothes, the minority status of male makers in this sphere is still seen by many as a cause for comment. […] there is an 'odd hint of latent gender prejudice' in any remark. (2017, p. 46)

This finding reflects those of the study at hand. In section 4.4.2.1 we recall Lisa comparing the progress women have made on using digital technologies compared to that men have made in terms of using traditional technologies: "when it comes to women, I think they have emancipated themselves more. Now no women will be looked at weirdly because she's dealing with 3D-printers; men who knit probably will." An explanation might be connected to the sense of denigration in the current patriarchal culture that Twigger Holyrod attributes to textile making.

Returning to the morphological concepts as developed in Chapter 5 and the assertion that these are likely heavily influenced by a focus on digital technology can now be shown more clearly with the example of learning and activism. One important aspect that connects these two concepts is the strive for deskilling and re-learning skills that have been forgotten in a society that can easily order and use a computer, jumper or chest of drawers without having to know how to make and repair any of those items. This strive for deskilling would, logically speaking, include the motivation to re-learn knitting, sewing and textile making in general. However, within the MM, these skills are in short supply. The focus is on digital technologies and, thus, on skills connected with those. Specifically, learning skills is often connected to those digital technologies that have been termed black box technologies: technology that can neither be understood nor fixed by an individual non-expert user, nor is it supposed to be. Twigger Holyrod talks about openness and points out:

> Many within the maker movement are also concerned with openness: frustrated by sealed electronic units and proprietary tools, they protest, 'If you can't open it, you don't own it.' In that context, openness is primarily limited by physical restrictions. In contrast, the knitted structure is inherently open and tinkerable, […] (123)

This openness and the specific connection with physical restrictions in digital technologies might be of much help in differentiating between the skills Makers want to re-learn and those they might deem less important. Thus, not only the skills and focus of what is learnt might be different, but also the specific political implications of those activities: MM Makers more directly challenge physical limitations and the loss of digital skills, whereas more traditional technology Makers might, more generally, challenge consumerism and throw-away culture. A more detailed exploration of the differences in traditional and digital technologies is necessary to flesh out detail and the complexity behind these dynamics, but these brief considerations are already sufficient in showing how a focus on specific technologies creates a very different space and Making environment.

This problem is not only an issue in Making. As widely known, women are generally under-represented in fields of science, technology, engineering and mathematics (STEM). EU statistics deliver unambiguous figures. For example, in 2014 the share of women among science and engineering professionals was 23% in Germany, 26% in Austria and 22% in the UK (European Institute for Gender Equality, 2018). These numbers clearly refer to a mainstream understanding of technology as cited previously, not the more general one employed by this study. Equally, the strong connection to hacking cultures which are predominantly male (Adam, 2003; Davies, 2017; SSL Nagbot, 2016) substantiates the claim

that new technology, especially coding and digital modification, are connected to masculinity and masculine cultures. This prevalence of digital technologies and natural sciences being associated with men is largely determined by socialisation and environmental influences. Karl, for example, talks about his children and relates how his daughter is very good at maths but does not enjoy it because her friends do not like it which shows how external influences are shaping girls' and women's understanding of their compatibilities in these fields. Lewis (2015, p.4) also examines reasons why women might not be as interested in digital technology and Making as men and states: "We note that society is likely to play a large role in shaping peoples preferences; as such, any apparent differences in patterns of mens and womens [*sic*] preferences and skills may be due to historical and ongoing social influences." Here, Lewis, whether consciously or unconsciously, provides a clear example for how social constructivism underlines, strengthens and explains the dynamics examined in this project. She describes well how society plays a large part in how people shape their own realities and how these, in turn, shape society.

It can now be suggested that the morphology underlying Making in Makerspaces in the UK, Germany and Austria is not only inherently masculine but patriarchal. The focus on digital technology which is often linked to men creates dynamics that exclude women by suggesting to them the technology connected with Makerspaces is not technology they can (or even should) be using as, for example, A121 has done when connecting men to Making and women to child care. The social construction of technology is evident here. Cockburn's assertion (1983, p.203) whereby men have been constructed "as strong, manually able and technologically endowed, and women as physically and technically incompetent" comes to mind and underlines the point that women are not only not seen as technologically able, but as incompetent to handle technology. This social co-construction of gender and technology is furthered in the MM by a heavy focus on digital technologies.

Intriguing to reflect upon are a couple of Makers' remarks regarding women's emancipation in these fields. They see a higher rate of women emancipating themselves and using these masculine-associated technologies than men using feminine-associated ones. Lisa states: "Women nowadays are less affected than men, because when it comes to women, I think they have emancipated themselves more. Now no woman will be looked at weirdly because she's dealing with 3D-printers; men who knit probably will." A Maker confirming this view is Frank who similarly sees fewer men involved in stereotypical female activities than the other way around. Reasons for this can only be speculated upon here. One hypothesis might be that men's activities are looked upon favourably and worthy of pursuing. Women want

to break down the barriers of stereotypes through challenging the ways that they are socially constructed in society and, therefore, use these technologies more and more. However, female associated technologies and their Making might be seen as inferior and less desirable which might be why men engaging in sewing or crocheting are still a rare sight. Haraway's (1997) and Plant's (1998) predictions come to mind which both attributed liberating powers to modern technologies for women. Having analysed the connection between gender and technology within Making, however, has shown that this technology does not actually liberate women. It is connected to a masculine culture which still stands in the way of true female liberation. Deeper exploration and evidence for these ideas are required to reach more clarity. For now, this section has analysed more closely how a focus on digital tools is likely a strong indicator for women's exclusion. The underlying morphology, then, is highly masculine and includes patriarchal notions.

6.2.3   Social Space – Community bonds

It is undeniable that community is important for many Makers. The morphology has located community as an adjacent concept that heavily influences Making activities on various levels: online and offline sharing of information, tight-knit connections between Makers, especially in local communities, and inclusiveness of various groups of people. Nevertheless, creating inclusive communities appears to be a problem, especially when it comes to gender. This section considers social aspects of Makerspaces in more detail. Firstly, the concept of bridging and bonding communities is introduced and applied, with special consideration for the concept of safe spaces (6.2.3). Secondly, the section explores which values are found within many Making communities and how these have underlying gender dimensions (6.2.4). As such, it is important in defining closer and in more detail what community means to Makers within this specific morphology.

A conceptual understanding of communities that has already been introduced briefly in the literature review is that by political scientist Robert Putnam (2000) of bridging and bonding social capital. To him, social capital "refers to the connections among individuals – social networks and the norms of reciprocity and trustworthiness that arise from them" (p.19). Making communities clearly fall into this category as they create connections among individuals that interact on a local and global level as a social network in which reciprocity (i.e. the sharing of information and support) and trustworthiness (i.e. establishing of friendships) play important roles. Putnam mentions a variety of different dimensions to

social capital but names the distinction between bridging and bonding capital as the most important (p.22).

Bridging (or inclusive) social capital is outward looking and encompasses people across diverse social cleavages (p.22). As the name suggests, communities within this category build metaphorical bridges. They aim to include people from all walks of life and are, therefore, "better for linkage to external assets and for information diffusion" (p.22). Consequently, they are more likely to create broader identities and reciprocity (p.23). In contrast, communities within the bonding category are more inward looking and "and tend to reinforce exclusive identities and homogenous groups" (p.22). Whereas they also emphasise reciprocity and the shaping of identity, they do so with a much stronger focus on solidarity and more focus on a specific group of people (p.22). This is why bonding social capital might be more likely to create an us-versus-them dichotomy, a "strong out-group antagonism" (p.23).

Putnam clearly encourages both forms of social capital, as both can have "powerfully positive social effects" (p.23). Bridging communities can be political allies who come together in a coalition to form a government or grassroots groups that come together to tackle the climate crisis despite their differences in gender, race or educational background. Putnam states that these "weak ties" (p.23) link people to more distant and different circles and are, thus, good for personal development and for "getting ahead" (p.23). Bonding communities, in contrast, create more solidarity within groups, e.g. ethnic fraternal organizations or groups specifically aimed at women. They are "good for 'getting by'" (p.23). Crucial in this debate is that many groups will have bonding characteristics for some social dimensions and bridging ones across others. For example, the just mentioned collection of grassroots groups rallying around fighting climate change might be bridging in terms of gender, race and age, but bonding when it comes to a belief in human made climate change and exclude anyone who is a climate change denier. Therefore, communities are usually not either-or within this conceptualisation, but find themselves on a variety of spectra in different dimensions (p.23).

The idea of a continuum springs to mind. Instead of being either bridging or bonding, communities might find themselves on a spectrum between these two extremes, defined by how much they encourage or discourage the inclusion of 'the other'. That position would be the aggregate of their positions on a variety of aspects, e.g. gender, race, age, or educational background. Unfortunately, Putnam points out that no clear measures exist to decide on the bonding-ness and bridging-ness of a specific community (p.24). There is no room here to

develop these measures. Still, some indicators from the gathered data help us understand how these categories apply for gender in the MM and, specifically, in Makerspaces in the UK, Germany and Austria.

As a general rule it should be mentioned that every Makerspace is different and there can be no single classification for all spaces. However, some tendencies are identifiable from the available data. A strong indicator for how bridging Makerspaces are in terms of gender is the gender balance in membership numbers. Scholar of peer-production economy Jarkko Moilanen (2012) conducted a hackerspace survey in 2011 and found that out of 250 participants only 25 were female (p.96). Also revealing is the emphasis by Makers that "everyone is welcome" (A051, A037) and "we are all Makers" (Dougherty, 2012, p.11). These statements clearly hint towards a community that aims to be bridging and open to everyone. However, previous chapters have already shown that this is by far not the case and that, when it comes to gender, women are not as included as men. A further indicator could be in how far spaces try to change this. What do Makerspace communities do to become a bridging community? The data chapter highlights approaches that participants in this study have mentioned in trying to increase female participation, i.e. having a contact person for new members or providing gender-stereotypical tools for both genders. While these are positive actions to take in order to improve female involvement, they were mostly mentioned independently of each other and only by a couple of Makers respectively. Not very many spaces appear to have a comprehensive framework in place in order to increase gender diversity in their spaces.

Evidence for stronger bonding dimensions in regard to gender seems to be in more supply. Survey participants were asked to indicate how important certain aspects would be for them if they were to set up their own Makerspace. Over 80% indicated that a strong community would be (very) important to them. In-depth interview participants frequently mentioned the strong bonds they have made within their Making community. They have talked about having found "good friends" (James), "a gang" (Anna) and communities being "like a family" (Heidi) to them, indicating strong ties among community members which is typical for bonding communities. We have heard Felix who welcomes women to the Making community as potential partners but does not think they should join if they criticise gender-related aspects in Makerspaces and the movement. The Makers interviewed by Davies (2017, p.82) have talked about very similar strong bonds: "People told us about meeting partners, friends, housemates and business collaborators through their hacker and makerspaces. […] hacker and makerspaces could offer a sense of belonging that could be transformative."

Moreover, membership processes have been raised as well. Section 2.2.1 has listed literature reporting complex membership procedures, especially for grassroots spaces, which go so far as to have a "formalized period of 'stalking'" (Davies, 2017, p.54) before a new member was accepted. Davies concludes that there is a strong sense within the different spaces that being part of their community was a privilege, not something to be taken for granted (p.54). Toombs et al. (2015), equally, have discovered that entry into Making communities has not so much to do with skill and interest, but with the ability to fit into these communities on a sociological basis (p.637). Toombs (2017, p.1083) analyses that "'Fitting in with the community' is emphasized." Short interview participant A120 (woman, UK, age not known) has observed that "many groups are excluded. It's always peer groups" when talking about Making. Of course, a membership process like this might not mean that women are automatically excluded, but if the premise is to find members that fit in well and align to the values and peer group in the space, one needs to wonder whether a group of predominantly men will choose men over women considering that the former will likely have experienced a similar socialisation and are more likely to portray similar technological interests and values. Some of Davies' (2017) participants actually raise concerns regarding their tight knit community and that their space might have lost its openness and had become "intimidating or exclusive" (p.96). A point that jumps out is that most of the Makers who emphasise these strong ties between their community members are from grassroots spaces and it would be intriguing to test whether commercially run and non-grassroots spaces are more balanced in their gender ratio considering that they have less complex rules around membership and that it is mainly an issue of signing up and paying a fee. Further research is recommended.

Considering these aspects, a further indicator for an emphasis on bonding over bridging characteristics might be a passive approach to including more women. As much as some spaces actively pursue a more balanced gender participation, others do not. Some study participants contested the idea that their space would be responsible for making an active effort to include women. Frank, for example, has mentioned that his space does not locate the responsibility for this with the space itself. On similar lines, the infamous post by Powell (2013) mentioned previously signifies the same approach and makes women themselves responsible for being included. This approach does not automatically fall into the category of a community prioritising strong ties (bonding) over weak ties (bridging) but it can be an indicator that inclusiveness, here specifically of women, is not something these spaces actively pursue and value.

These deliberations help illuminate how community is understood, especially in grassroots Makerspaces. The concept community in our devised Makerspace morphology, then, is likely shaped by understandings of strong community bonds between like-minded people who might be protective of that community and will be careful of who they allow to join in. This might likely be someone who is enthused by digital technology and by engaging in the community to share knowledge and improve their learning. Introducing the concept of inclusiveness, as done in section 6.3, would not necessarily change the importance of community, but contest the concept in a different way; a way that emphasises bridging over bonding communal activities, for example, or one that simplifies membership procedures. Again, this might not apply to every single Makerspace, but there appears to be a tendency that makes these observations likely to fit many spaces.

Feminist Makerspaces have an intriguing position within this debate. They openly revolt against male-dominated Makerspaces and their tendency to exclude women, but simultaneously set up spaces that actively and openly exclude men. Thus, in their response to regular Makerspaces and their inherent male-biased bonding communities, they establish gender-bonding communities of their own in which women engage with similarly digital technologies as men. As seen in section 4.4.3, Anna who is part of such a space defends this step: "They [regular spaces] don't make it explicit but if you look around those spaces – there are mainly white middle-class men … totally by accident [ironically]." She was one of the few who were also interviewed in a short interview, where she said:

> Most spaces are dominated by men and you just stand out as a woman. You are often the only woman in the room and that's not always negative, but it attracts attention and people look especially at what you're making and hacking in peace is just not possible. […] It's [feminist space] just a space where you don't have to constantly prove that you have the right to be there which is the case in the other spaces.

Nancy thinks back on her women-only workshops and states that the friendly environment of these spaces creates a safe space for women to Make without being surrounded by men. The existence of these women-focused initiatives shows how Makerspaces are not neutral spaces but socially (and physically) constructed. It becomes clear that there is not only one obvious set up for such a space, but a multitude of possibilities which include a variety of constructions of gender and gender relationships to technology.

The idea of a safe space originates from the women's movement in the late twentieth century (Roestone Collective, 2014, p.1346). The Roestone Collective (2014), made up of

geographers Elsa Noterman and Heather Rosenfeld, reconceptualised the notion of safe spaces which shall assist here in taking a closer look at Makerspaces as such spaces. Firstly, they point out that "In feminist, queer, and civil rights movements an understanding of safe space has developed that is associated with keeping marginalized groups free from violence and harassment" (p.1346) whereby violence does not only refer to actual physical attacks but also "systematic structural violence" (p.1349). The authors note that what is considered safe and unsafe is socially produced and dependent on context. They highlight that some scholars criticise women-only spaces for being exclusive and enforcing gender binaries. Others support them as creating opportunities for fostering a shared identity and building coalitions (p.1355). In fact, the Collective asserts that "The work of producing safe space entails continually facing, negotiating, and embracing paradoxical binaries: safety/danger, inclusivity/exclusivity, public/private, and so forth" (p.1355). They, thus, see these spaces as continuously transformative and reconfiguring binaries (p.1358). They attribute a special role to objects in this process: "Safe spaces can be created through the introduction, removal or rearrangement of objects. The resulting 'soup' of a felt environment is, for the most part, fluid" (p.1359). As such, these objects help to reconfigure "existing and context dependent social norms" (p.1360).

The term safe space has appeared a few times during the data collection for the present study. The physicality of a space – where it is located and how it is set up – has been shown to have gendered aspects, for example in that women might not feel save to access it or be part of it. Furthermore, Anna describes her feminist Makerspace as such a safe space and a bubble where members can go and feel safe and belong to a group of like-minded people. She talks about regular spaces in which women do not feel safe and comfortable but as soon as events are put on specifically for women and non-binary people these women have the courage to step forward and participate. In feminist Makerspaces, they do not have to prove their right to be there. She points out specifically that in Berlin, where she lives, there are various Makerspaces and Makers will automatically pick one that aligns with their interests and values. Almost automatically then, communities are built with shared respective values and interests, thus creating safe spaces for the members of those communities. Heidi talks similarly about her Makerspace. She uses the term "core-bubble" to describe her community in which everyone shares similar interests and thoughts. She says: "And often we do not cope well with the world out there. No kidding, […] I don't know of any other event[12] where so many therapy hours come together." When asked whether she views her space as a safe

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[12] She is talking about the Chaos Communication Congress, an annual hacker conference in Berlin.

space and a refuge from the world, she emphatically agrees. In contrast to Anna and Nancy, the binary opposition she refers to is not that of men and women, but of the outside and the inside world. Her safe space understanding relies heavily on the physicality of the space as shielding her and her community from the challenges and struggles that the outside world confronts them with. Another participant talking about safe spaces is survey participant B227 (man, UK, 35) whom we have met already when defining creativity within the movement. He says

> The focus on diversity […] means that people are always trying to be 'politically' correct. This in itself puts many makers off and they retreat to their own safe spaces. Having an environment where you can be yourself, not be preached at and definitely not expected to fall into some left wing ideology.

He uses the term safe space somewhat contrastingly to Heidi, Anna and Nancy in that it seems as though he wants to be safe and free from discussion about inclusiveness and political correctness and, consequently, from including people other than him. Instead of a safe space for all genders, as voiced by Nancy and Anna, he wants a safe space from a specific left-wing ideology that, to him, interferes with his Making activities. Clearly, not only gender roles and technology are socially constructed, but also the understanding of what a safe space is and what it keeps its participants safe from. The attempt to challenge gendered hierarchies within Making is – to B227 – an attempt to challenge his understanding and, thus, morphological constellation of Making.

Coming back to the conceptualisations as presented by the Roestone Collective (2014), it is possible to locate the elements of a safe space as identified by them within these Makers' views. Anna and Nancy identify women as a marginalized group within Making that wants to be free from harassment and from being treated differently. Hence, the setting up of women-only Maker activities and spaces. Heidi identifies people struggling with reality as the marginalised group that looks for safety. She does not clarify further what exactly it is her community struggles with but mentions mental health as an important indicator. Participant B227 sees himself marginalised by a left-wing activist ideology in Making and wishes to be free of political correctness and inclusiveness. He, thus, turns the original meaning of safe spaces – as safety institutions for marginalised women – on its head and promotes safe spaces for men who might feel frustrated by these discussions. The appropriation of feminist institutions and safeguards through patriarchal views is clearly visible. Despite this appropriation, B227's comments prove a point made by the Roestone Collective, namely that what is considered safe and unsafe is socially constructed and will

differ by circumstance and specific environment. In this instance, the construction points towards hierarchical gender constraints in which women are granted different levels of safety. Men, in contrast, are constructed as negatively affected and threatened in their privilege by political correctness and by women's striving to establish spaces not threatening to them.

Lastly, the Collective mentions binaries of safety/danger and public/private, and an involvement of objects as important in the discussions around enabling safe spaces. These chime with Cockburn's (1997) dichotomies when it comes to women and technology. As discussed previously, she identifies technology/nontechnology, public/private and masculine/feminine as binaries that are deeply interwoven with men being technologically minded and in the public sphere, and women being non-technologically minded and in the private sphere. Setting up public feminist technological spaces that enable women to engage with the newest technologies available to amateurs, gives them the opportunity to show their technological prowess in a safe environment. Enabled by this technology, female Makers challenge the binary understandings of gender-technology relationships.

Returning to bonding and bridging communities, we can say that safe spaces – in any form – are bonding communities in at least one specific aspect: that which they aim to keep safe from. In the case of feminist Makerspaces, strong ties are established via a sameness in being marginalised on the basis of gender. The gender group that is held responsible for that marginalisation is, thus, excluded from these spaces. Heidi's space equally shows signs of strong ties even though she does not clearly say what they are but merely refers to the "outside world". Nevertheless, she emphasises that her community is like family and shares similar topics and values. As Putnam said, bonding communities are good for "getting by" which seems to be exactly what Heidi describes. Her community members support each other in dealing with the outside world. Thus, people not adhering to their topics and values seem likely to struggle to be included in this community. Short interview participant B227 appears to connect strongly to people of non-left-wing political beliefs and his safe space evolves around not having to be politically correct and inclusive. His strong ties appear to lie with people who think like him politically and do not make extra efforts to include people who are deemed 'other'. In their respective ways, all four Makers talk about bonding communities when talking about safe spaces, not merely a space where they go to create technological objects, but on top of that a space where they can escape marginalisation, harassment and systematic structural violence.

Toombs (2017) has analysed different tropes and values from main threads on the global hackerspace.org discussion list. One of these referred to safe space policies within Makerspaces. He calls the discussion one of "the most contentious" (p.1084) of the threads he has observed. Many fears and worries were voiced by members of the list when someone inquired about safe space policies. One of the more prominent answers evolved around hackerspaces not welcoming any sort of rules as they might censor members and "signal to outsiders that the community was already rotten" (p.1084). One person was arguing that a policy against harassment would "artificially empower those who are willing to appear vulnerable/disadvantaged/non-privileged" (p.1084) – a stark example of how different people construct different realities around the same issue. Another one questioned the original poster's understanding of what a hackerspace is and why they think they can bring their "social revolution" into the space, or whether they just did not care about their hackerspace and used it to "further [their] own shit. In which case you are a terrible person. Don't be that person" (p.1084). These arguments are reminiscent of study participant B227 who wants to be free of rules regarding political correctness. Opposite voices contested that these viewpoints stemmed from a position of privilege and that they are not enough to counter any discriminatory or harassing behaviour in spaces. Here Anna and her views on regular and feminist Makerspaces come to mind. This discussion shows how contested the issues of inclusiveness and safe spaces in the community are. In light of these comments, it does not surprise that women have started setting up their own feminist Makerspace in which they can Make safely without fear of discrimination and harassment.

Summing up, this first section on the social dimensions of Makerspaces has introduced the concept of bonding and bridging communities and applied it to Makerspaces. The concept of a safe space within that context has been introduced and shown to be an indicator for bonding dimensions within its communities. Recalling the morphology of this particular kind of Making indicates that the importance of community here is especially seen as the importance of bonding communities and strong ties among Makers within those communities. The notion of safe spaces introduces a connection to gender and a wish for bonding communities that are safe for women and other non-male participants. Realising that this appears to be the main way of how community is defined within our devised morphology illuminates just how much this understanding would change if the concept of inclusiveness was added to it. Even though inclusiveness is named as important by many, in practice it does not appear as though many active efforts are undertaken to tackle related challenges. Worse still, some appear to be against inclusiveness and it playing a role in their Maker world at all. Making inclusiveness an active part of Making and someone's

morphology would create a constellation that emphasises open and easy access to communities without having to give up the tight bonds between Makers in Makerspaces. Rather, room would be made for different sub-communities that co-exist. It is important to remember that this analysis predominantly relates to grassroots Makerspaces. Davies recalls Makers of grassroots Makerspaces telling her that commercial spaces such as TechShop did not fall into the same category as Makerspaces with a strong sense of community as they are lacking this sense of community – "it wasn't all the same animal" (2017, p.82). Potentially, a different morphological conception would apply to commercial spaces, then; one that does not emphasise community as much as grassroots spaces.

Study participant Nancy has said that, almost automatically, the more you try to include everybody, the fewer of these strong community ties you will have and the less you can cater to the needs of specific people. She describes Makerspaces that say "Everyone is welcome! Please come!" but, as a consequence, "had less of a community because people didn't feel like they had anything in common with the other people." Creating Makerspaces, especially grassroots ones, in which not only Making itself is important but also having strong ties to other Makers is a priority for many Makers. Establishing these social groups that are at least on some level bonding communities is not a problem as such. In fact, as Putnam stated, both forms of community can have powerful positive effects. In the case of bonding communities, these can be strong identity formation and solidarity among members of that group. Nevertheless, they are also likely to create a stronger sense of 'the other'. This becomes especially problematic when the out-group is already marginalised in society and in the specific field of the activity. Just the fact that people do talk about safe spaces and that this issue is hotly contested shows the imbalance within diversity and a certain confusion of how to encourage more of it within the values of the community. If the gender balance was fairly even, there would not be an issue. However, this is not the case and raises the question whether women are 'othered' and, therefore, not as included in Making communities as men. The call for a safe space for men is troubling in this regard as it would undoubtedly increase the exclusion of women. Of course, the desire for a strong community is not the only reason women find themselves on the outside of Makerspaces. But it is a contributing factor.

This section has shown how the important concept of community is contested and defined in many grassroots Makerspaces and, thus, within the morphology underlying this analysis. It is a community often defined by strong bonds, with complex membership processes and inclusiveness issues that go beyond isolated phenomena. Together with the heavy focus on digital technology, underlying masculine dynamics are prevalent. Bonding communities that

form around digital technology are, within our current society, almost automatically male-biased. This section has, thus, provided a very good example for the social construction of reality within this research project and in general. We have seen how technology usage, safe spaces and communities are constructed differently by different actors and how this, partly, depends on equally socially constructed gender roles. Those individually constructed realities of Makers taken together shape and construct Makerspace communities and a general understanding of what Making is and who should engage in related activities.

6.2.4   Social Space – Masculine Cultures

Having established that Makerspaces appear to have a focus on strong ties and bonding communities, this section takes a closer look at values and attitudes that one is likely to find within these bonding groups and how these might be connected to gender. Davies (2017) is one of the few who considers a variety of values within and characteristics of a typical Makerspace (pp.60-74). However, she does not draw onto gender differences within those values. Wajcman (1998), in contrast, examines the culture of a male-dominated field, namely management. This section combines the two and analyses the culture of male-dominated Makerspaces according to gender aspects. Attention is given to confidence, bragging/competitiveness, Making with purpose, sexist environments, and language/communication. It, thus, shows in detail how community is contested within the Makerspace morphology in Germany, the UK and Austria. A differentiation between these values within specific kinds of spaces cannot be attempted due to not enough data from the variety of Makerspace set-ups. Most of the data from this study is from grassroots spaces.

6.2.4.1 Confidence

An attitude that has surfaced regularly during the in-depth interviews is confidence. Female interviewees in particular but also one male participant, remarked on the role of confidence in Making and how it might affect women negatively. They agree that women tend to be more hesitant and less confident when it comes to Making. Nancy states:

> […] women do have a tendency to be more tentative. […] I see this in myself and some of the women around me, that we want to kind of have everything planned out before we start and we want to know exactly not only what we're doing but also the how we're going to do it, the process itself whereas men are a lot more 'let's just go for it, try it, if we fail we just try again, it'll be fine' and I think that kind of tentative element when it comes to machinery can feel quite…can basically put you off very easily.

When asked why she thinks that is, she suspects deeply ingrained cultural tendencies that are hard to put your finger on as they are "just everywhere". She continues to use herself as an example and explains that in her university Makerspace she was still not as confident after four years of attending it than male students at the start of their time in the space. Heidi and Rose similarly remark on the confidence it takes to enter and participate in a space. As seen previously, Rose remembers a negative experience of going to a Makerspace and talks about what was not right for her:

> Predominantly, white males late 30s social interaction. It wasn't the relaxed and supportive makerspace environment that I'm looking for. If I said that to them they'd be really surprised. I'm confident enough in my own inability in a couple of times to confidently ask for help. If I wasn't as confident, then there wouldn't be eye contact and it would be very difficult to go in as an individual person.

Rose not only identifies the confidence to make, but also the initial confidence to join into a space. Anna, who organised a Maker activity specifically aimed at non-male genders, recalls how they welcomed people who had never dared to attend such events before. She attributes it to the climate among the group of participants which was different to a typical Maker event. This, she says, encouraged people who would otherwise never have attended this event to join in.

Robin and Karl also talk about confidence. Robin, initially, does not directly connect it to gender but to skill-sets which, indirectly, are gendered. When talking about repair, they state:

> […] because of education, women will have been taught more sewing skills and things like that, so they will actually be far more confident when it comes to anything to do with repair and reuse of clothes and all those kind of things. Whereas, men will have been pushed more towards other types of mechanical repairs, but I think this is all shifting.

Later on, however, they add: "I think men are encouraged to be confident about everything, all the time." For them, "Confidence is a major trigger". Especially when first approaching a space, it can be difficult to see many Makers engage in a lot of incredible projects and one automatically assumes they are very confident in what these Makers do. They are convinced that "if you don't feel like that within yourself, it's going to be very difficult to try and approach them and to try and have that conversation". Karl, on the other hand makes a direct connection to gender again and describes his observations:

> When you make electronic tinkering stuff, most of the time boys will throw themselves onto and hijack these things. Or something with computers […], boys will pounce on that. Even with a little bit of scrambling with elbows and very quickly girls are in the background, that's what it's like with young children. […] Many women, whom I know, even those in software development, say: 'Well, I'm not really good at that.' Even though they would be as good. And then you have men who say: 'I'm the best'. And you just think: Actually, no, you're not. […] But it's the elbows and 'I'm here, let me do this, I've operated a computer before'.

He traces these differences in attributes back into childhood. He emphasises later on that his wife as well as his daughter have a more tentative element about them, they are not as confident when it comes to Making or fixing things: "This 'just doing it' attitude and if it breaks, I'll somehow fix it, that is missing in the women in my environment. […] they always have someone, a boy, who says: 'Well, I'll do it, give me that thing'."

Davies (2017) describes the ethos within a Makerspace and recalls a story very similar to Robin's observation of the first impression people can get when entering a Makerspace. Keira, her participant, explains that at first sight "There was so much going on, and so many people who were so expert at so many different things, that your own interests and skills could seem unimportant and negligible. Everyone seemed so confident and in control […]" (p.97). When Keira experienced a 'melt-down' with her own project, she was told that other Makers were experiencing these too. This surprised her as "The culture of the space seemed to promote confidence and to encourage hiding the insecurities members were feeling" (p.97). This social construction of self within a group highlights how the perceived culture of a community impacts individuals and how, in this case, the male Makers of the group constructed themselves as technologically able and confident which put the female Maker in a position of less confidence and insecurity. A few pages earlier Davies describes how the spaces she visited were governed. She terms it do-ocracy (p.48). The term describes a process of organization and operating that prefers action over discussion. It is not about democracy and consensus, but about doing something. Whatever was done, was better than not doing anything at all. She cites a participant: "The person who is doing it is right. The person who is bitching is wrong. If you don't like it, wait until he is done doing or help him, and then do it yourself" (p.49). Besides the intriguing political connotations of this form of organisation, it assumes a certain level of confidence to 'just do' instead of coordinating with others and discussing issues. The lack of cooperation and compromise in this approach portrays an attitude of individualism. "Done is better than good" (p.64), Davies writes. But if the participants of the present study are right, then women will be much more hesitant and less confident in just doing something without thinking it through beforehand and having a

well-thought-out plan. This might be seen as being insecure, as Keira has explained. Overall, this is potentially an atmosphere which women might not find as comfortable as men.

Quite a few more general studies underline the assumption that there are differences in confidence between genders. For example, economist Leonora Risse and her colleagues (2018) have explored gender gaps in confidence and their effect on gender gaps in wages. Among a variety of traits that have been proven to be connected to success rates in finding a well-paying job are a high hope for success, its opposite a fear of failure, and agreeableness (both latter traits decrease chances of increased earnings). In their analysis

> men generally display higher levels of the personality traits that connote a stronger sense of confidence in their capabilities and a stronger focus on their own agenda: higher hope for success, weaker fear of failure, and lower agreeableness (akin to stronger self-centredness) (p.940).

Women showed a higher fear of failure which is indicative of lower confidence. Also, in an environment where a trial and error approach contributes greatly to learning, a fear of failure can be highly detrimental. Additionally, "women tend to be more agreeable than men [which] also translates into a statistically significant endowment effect that disadvantages women" (p.932). These findings, in relation to the study at hand, do not only show women being less confident compared to men, but also being more prone to being more agreeable. The authors define agreeable as "the tendency to act in a way that is cooperative, tolerant, forgiving, trusting, altruistic, compromising, and unselfish" (p.920). Agreeableness, thus, stands in stark contrast to the by Davies described do-ocracy where cooperation, compromise and unselfishness were rated less than ideal.

Other studies looked closer at confidence in different genders in regard to abilities in science and maths. Whereas these fields do not directly map onto Making activities, they are very closely related, especially with Making's focus on coding, digital technology and electronics. Social scientist Niklas Jakobsson (2012) states clearly that confidence is "important for aspirations, motivation and preferences for challenging tasks and may affect career choices and education" (p.1058) and shows that even though boys do not appear to be overconfident when predicting their exam results on a maths test, girls are underconfident – a finding that carries over to grown women studying macroeconomics (p.1058). Although requiring more research, an assumption that could be made is that women are underconfident about their abilities to Make and get involved in spaces that centre around technology. Another study (Guimond & Roussel, 2001) has shown how these levels of confidence are affected by

gender stereotyping. They tested confidence levels of men and women in their science and language abilities, the former being associated with men and the latter with women. When confronting the test subjects with those stereotypes before a test in the respective field, they scored worse in the field that was not associated with their gender. The authors state: "Our results suggest that beliefs about the abilities of men and women may have subtle and often damaging implications for the self-evaluation of men and women" (p.289). This finding would support the claim that if socially constructed stereotypical gender roles indicate that women are less able to handle digital technology, that this belief might influence their confidence in even considering joining a group or activity of that kind. A self-fulfilling prophecy. This is yet another example of the political dimensions of the social construction of reality. The construction of specific ideas and beliefs about certain groups of people can be damaging and inhibiting to those people, no matter whether this concerns gender or other groups of people.

The authors suggest a connection with Social Dominance Theory in which "stigmatized social groups may internalize negative stereotypes and come to evaluate themselves as dominant groups wish them to do, that is, negatively" (p.290f). This would not only suggest that women are less confident in joining a Makerspace due to being negatively impacted by stereotypes, but that these stereotypes are fabricated by men who wish to remain dominant and superior in the field. We have come across a few of them in the present study. Nevertheless, this is a sweeping and very general claim that needs much more attention in order to be justified. Still, within Making, in general, it seems as though confidence is an important attribute to have and it will be challenging to fit into a community if someone is not as confident as the people within that community.

Studies as well as data from the research at hand have shown that women's confidence in general is lower than men's. Therefore, creating a community in which confidence is important in order to fit in will more likely exclude women than men. This finding, again, explicitly describes how a strong focus on digital technology and technological prowess in general in our morphology influences and shapes community. The community is not independent of what it engages with and of its surroundings, but considerably shaped by digital technology and those who feel confident in using it. It is, thus, formed and defined predominantly by men as they are more confident in using this type of technology. In order for a more feminine culture to take hold within which women would feel more confident the focus on digital technology might have to be lessened. Or, women's confidence in using digital technology would have to increase. Even though Makers alone cannot be held

responsible for women's lack of confidence in this area, they could be held responsible for fostering the status quo instead of contributing to an alleviation of the here described inequalities.

6.2.4.2 Bragging and Competitiveness

Two attitudes closely connected to confidence are bragging and competitiveness. Both are elements that surface in some interviews. Robin talks of some Makerspaces where

> It's about who knows the most, who's got the most experience about the most cutting-edge technology. It becomes very jargon-led. If you don't know the right words then you don't fit into the crowd kind of thing. I think that kind of setup can be very men-driven. It can be quite discouraging for women because I think there is something around the way men and women are brought up in terms of their confidence. […] women, they're not pushed to brag in that way and that bragging style is very off-putting.

They clearly show the connection between confidence and being in competition with each other about using and understanding the latest technology. Karl can relate all too well:

> Especially if you have a lot of men, you have the feeling it quickly evolves into dick-comparison. I can't be arsed with that at all. Especially because I often think as arrogantly 'I can simply do it better'. I'll be quite arrogant then. […] And I don't want to get involved in the whole goading each other thing. Or that I myself then say 'I can really do it better' and someone else says 'Well show me'. It's silly, I can't stand that at all.

Karl, despite saying of himself he can be quite arrogant about his own skills, does not enjoy the culture in some Makerspaces where skills are compared and everyone wants to be better than the rest. Tellingly, he identifies this as a male characteristic when talking about 'dick-comparisons'. Other Makers do enjoy the bragging. Survey participant B400 (man, UK, 45) lists his main priorities when choosing a project to work on and, among others, says he aims for "having something to show off to friends and other makers". These iterations provide a clear gendered contestation, again, between digital technology and community within the morphology. Not only the level of confidence influences this connection, but also the desire to brag about achievements and stand in competition with other Makers and their digital technology prowess. A somewhat contrasting connection arises when considering the aspect of learning and bragging. If making mistakes is looked upon negatively, learning is discouraged and only those who already know a fair bit might feel comfortable. This can be detrimental to women who would like to learn more about digital technology.

SSL Nagbot (2016), a pseudonym for three authors writing on feminist hacking, locate the strive for competition and merit at the heart of Making and hacking:

> The meritocratic tendencies of hacker culture run on the cultural codes of competition and transgression such that we consistently find that these communities are typically gatherings for Euro-American men. Previous research has shown how discourses of meritocracy in many other domains […] often result in masculine domination. These discourses of merit calcify into invisible structures that bar non-conforming others from participation.

Davies (2017) raises the notion of bragging-rights within the community. These bragging-rights were achieved through the object and a Maker's creativity:

> A project was cool when its originality or quirkiness was something that you brought to it yourself – when it was something that you thought of, or designed, or tweaked in a new way. As such, it might become a 'trophy object' or win you 'bragging rights'. It earned you respect because your innovation or skill was invested in it (p.116).

Here she identifies the concept of creativity as connected to bragging and competitiveness. These, to Davies, are inherently connected to gender and exclusion of women. She has come across an account by two women who attended a Hackathon[13] and said: the event was "full of bragging and aggression, [it] even smelt male" due to the majority of the students participating being male and apparently not washing over the duration of the weekend-long event. Therefore, creativity and community in the morphology are equally contested by each other in a way that encourages gender-bias in our morphology. Creativity needs to be acknowledged by one's community and, ideally, be praised. Davies found an awareness of these dynamics only in spaces specifically set up for women and minorities, but not in regular spaces; something she finds rather telling of the problem itself. She concludes:

> […] it's clear that hackerspaces (and tech culture generally) do tend to have a problem with diversity, and that the cultures that are promoted – even through small things such as an emphasis on 'bragging rights', assumptions about what kinds of people are interested in what kinds of hacking, or a simple lack of awareness that the world contains people who are different to you – can be profoundly off-putting to some individuals and groups (p.100).

Reflecting on the reasons why women are reluctant to come forward, Nancy also sees this as a larger problem that is systemic:

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[13] An event that aims to find the solution to a problem (through software or hardware) within the time of the event through the effort of the attendees who contribute creative ideas from different fields.

> You know it could be women are less competitive or less willing to put themselves in situations they're not confident in. It could also be that women are told they are not going to be as successful as men and therefore get that in their heads. How you know what that is, is very difficult, it's a very systemic problem.

Broader academic literature supports the hypothesis that men are more competitive than women. Social and decision scientist Silvia Saccardo and her colleagues (2017, p.1552), for example, look at the connection between gender, competitiveness and the labour market and find that "although women might choose to select into environments characterized by a moderate degree of competitiveness, they might opt out of highly competitive environments." Thus, careers that demand a high level of competitiveness are projected to attract fewer women than men (p.1552). This does not only support the point just made but could also imply a gendered connection between entrepreneurship and community within the Making morphology. Starting to make a living with one's projects will automatically entail entering a capitalist market with those projects and, thus, becoming subject to competitiveness and having to stand out. If men are, on average, more comfortable and confident to put themselves in these environments, then a focus on entrepreneurship as for example promoted by prominent Maker Anderson will likely encourage male-bias as well.

Microeconomist Thomas Buser and his team (2017, p.125) make a connection to STEM fields and maths-intensive career choices: "gender differences in study choices are partially determined by the well-documented gender gap in willingness to compete." To the authors, the lack of competitiveness partly explains why women are less prone to choosing highly competitive STEM fields and, thus, also lose out on earnings. A study by economist Steffen Andersen et al. (2013) compares competitiveness and gender of people in young ages between patriarchal and matrilineal societies. They show "that girls become less competitive and boys more competitive around puberty in a patriarchal society, whereas this difference never arises in the matrilineal society" (p.1441). Even though the universality of this claim should be questioned, to the authors socialisation is a major force in determining individuals' level of competitiveness. These studies equally underline the fact that women, in our Western patriarchal society, are on average less competitive than men which, in turn, appears to foster the fact that they do not feel as comfortable in Makerspaces as men do.

Before moving on, these values' connections with the morphology shall be highlighted. These values more closely explain the culture within Makerspaces and, thus, what influences the concept of community in them. They shape the community aspect which, in turn, might

affect other concepts. Three connecting concepts can be identified. Firstly, Davies spoke of a Maker's creativity gaining them their competitive edge. Therefore, the more creative someone is, the more they might suit the culture in the space and the more appreciation they will gain. Secondly, competitiveness is likely linked to digital technology. The newer and shinier the devices are that Makers work with, the more they will be able to show off with them, thus gaining more confidence and bragging-rights. Equally, men often appear more confident when engaging with digital technology, thus making them more likely to join Making activities surrounding these. Lastly, entrepreneurship and innovation are entangled in competition and confidence. Quite logically, if Making becomes about generating money, the Maker and their project must prevail on the capitalist market which is heavily infused with competition and innovation, especially within digital technologies. Confidence and competitiveness, thus, are important aspects to consider when analysing how social interaction within communities is socially constructed. They affect and shape quite a few important concepts of Making, specifically digital technology and community. Through more deliberation, more connections could be explored, i.e. learning. This thesis argues that this plays an important part in shaping a masculine culture that is not always welcoming to women and makes the morphology, therefore, masculine and patriarchal.

6.2.4.3 Purpose

A further gender difference that arises within Making is that of purpose-driven Making. Three participants, two women and one non-binary, remark on women being more purpose-driven and, thus, not being attracted by narratives of 'just tinkering' or 'playing around'. When recalling how her Makerspace lost its female Makers, Jane talks about a woman "who says she needs a project". Rose goes into much more detail and talks about how, in her role as consultant for Makerspaces, she tackles gender imbalances:

> Using real-world problem-solving. We do activities that are aligned to the UN sustainable goals, so including the environment, that we know those activities are going to appeal more to women. […] we're using language but doing something for creatively solving real-world problems, because we know that that will help to address gender imbalance. […] It got purpose. It's something that they can explain to somebody else. I went, I made a project and this is why I did it. It's because this is impact that it's going to have. It can change, it can alter, it can positively impact on something and that can be a driver for making, which women respond to positively.

She explains that their activities are never technology-led because that mainly attracts men. Robin, who also works as a consultant for Makerspaces, says something very similar. Instead

of "being technology-driven, we were design-driven. The idea being that it was not about the specific technology that you were interested in, but it was more about what you were trying to make and finding the best way of making it." They continue to explain what we have already read previously, namely that technology-driven spaces can become very "geeky" and "jargon-led" and create a competitive environment in terms of who knows most and best. Again, the focus on digital technology appears to sharply shape the concepts of community in the morphology and including inclusiveness would not only influence the concept of community but also that of digital technologies and their importance. The moment that focus is lessened and out on other aspects, i.e. positive social or environmental impact, female participation seems to increase. Davies (2017, p.97), while talking to her participant, also encounters two women who were hesitant about joining a Makerspace because they wanted to do something useful and found Makerspaces "self-indulgent". Rose's and Robin's approach is an example for how these Makers actively and purposefully construct their activities. Instead of constructing them as something focusing on technology and, thus, invoking all the stereotypes attached with it, they use different language and framing to construct a form of Making focused on design which, to them, is less gendered and attracts a broader variety of people. They are, thus, challenging the masculinist morphological construction of Making by shifting technology to a less important position and introducing concepts with less patriarchal connotations.

There is survey data that provides evidence in support of this gender difference. When asked why participants engage in Making activities, 77% of women and 88% of men say they enjoy tinkering, and 69% of women and 74% of men enjoy working with digital technology. This is not strong evidence, but points towards men being more motivated by tinkering than women. Going back to Rose's point that women are more attracted by solving real-world problems, such as environmental sustainability, this also finds support in the survey data, namely that 34% of women and 29% of men are motivated by reducing humanity's impact on the environment. We need to remember as well that the gender-balance of survey participation in itself was highly skewed towards male participation. Thus, the closeness of the numbers might be due to the fact that the few women who do participate in Making might enjoy the tinkering aspect of it, but they are far from being a substantial part of Maker communities. When surveying a more general population, these numbers might be more significantly different.

Not a lot of research has been found on this particular theme in regard to gender. A study by Allan Fisher et al. (1997), however, has explored motivations of undergraduate students in

computer sciences and found gender-related differences. Whereas male students were much more likely to be interested in the actual processes of computing, female students were more inclined to be motivated by what they could do with computing skills: they "contextualize their interest in computer science, instead, within a larger purpose: what they can do in the world" (p.106). This point is intriguing and needs further research, especially when women are often more connected to service roles and men seen as project-driven. A similar study (Krieger et al., 2015) specifically examines differences in tinkering between genders. They found that female students were more concerned with the purpose and goals of tinkering whereas male respondents were more focused on the details of tinkering (p.106). They conclude their paper:

> As females appear to see tinkering more as an open-ended pursuit, devoid of a tangible purpose, they may be less apt to tinker. […] Ultimately, if females viewed tinkering as having tangible, meaningful effects, with specific ideas of what it entailed, they may be more inclined to tinker (p.106).

Tinkering is described here as exploring hardware and software through deviating from instructions with a lack of reliance on formal methods of learning and instructions, and the use of trial and error techniques (p.104). This can easily apply to Making activities and their findings, thus, to women and Making activities. The previously mentioned fear to fail which appears to be more prevalent in women supplements this finding well. One study that could be seen as providing further evidence is that of Charter and Keiller (2014) in which they compare hackerspaces and Repair Cafés through a survey. The respective survey participation for each category varies heavily in gender. While the ratio for Repair Cafés was 60:40 (men:women), it was 90:10 (men:women) for hackerspaces. Repair Cafés aim to help people fix broken household items and, thus, avoid waste and CO_2-emissions. This goal could be seen as more purposeful and more tangible than that of hackerspaces and therefore add to an explanation of the significant difference in gender balance.

Equally, a report by Intel Corporation (2014) found that for female Makers "technology is often a means, not the end" (p.7) and that they are "particularly motivated by social-service aspects of making. Among those surveyed, female makers [were] more likely than males to be motivated to make because they want 'to help or to give'" (p.7f). This motivation by social-service aspects might be an explanation why the women in the present study are much more likely to provide Making services instead of selling products. In terms of the morphology, then, the outcome or effect of a Making project appears more important to female Makers than to male Makers. The concept of learning and community are shaped

differently here. For men, the learning aspect appears to be closer connected to the possibilities a technology has to offer, irrelevant of its usage. For women, the usage and purpose of a project appear to be more important. Thus, they do not necessarily want to learn about all the possibilities of a technology, but only the ones that help them realise the assigned purpose. Consequently, activism might also be gendered and contested differently if inclusiveness of women played a bigger role. Not just because inclusiveness itself can be considered an activist notion, but because of the goals and purposes some women would bring to Making as well. Despite little evidence and studies specifically focusing on this gender-related aspect, the data provided here emphasises the assumption that purpose-driven Making might much more likely attract women into the field and that, contrastingly now, Making and its communities are more likely to focus on tinkering and playing around with technology.

6.2.4.4 Sexist environment

A further issue that arises within the atmosphere of a Makerspace can be a sexist environment. A lot of the related issues have already been listed in the data chapter, so is only touched upon here briefly. Firstly, two of the in-depth interview participants, Heidi and Frank, have remarked on pornography being shown in their Makerspace. Both reiterate that these "porn images" (Heidi) and "porn movies" (Frank) were shown openly/communally within the respective spaces. Whereas Heidi's space projected porn images onto walls, Frank's space showed a porn movie via an old television device that started showing the movie automatically the moment the device received power. Heidi's reaction to this is unambiguous: "I don't want that and it bothers me." Frank is a bit more reserved: "it could be deterring" and leaves room as to whether he is opposed to this happening in the space or not.

Other participants talk about instances where women are seen as different or difficult. Previously, we have heard from Nancy who describes the Makerspace technicians' reactions to female students approaching them for questions as annoyed: "they would look a little bit 'oh here we go…this is going to take quite a lot of work'." She remarks that, as time progressed, she became quite good friends with the technicians but was not made feel welcome initially due to these gender-related stereotypes. Megan also remembers situations involving stereotypes. She has witnessed a lot of training sessions in her space and talks about the facilitators' unconscious gender-bias:

[…] the guy would assume they were going to do the lifting. Or they'd talk over the women and all this kind of stuff. You need a very, very careful facilitation. You need a facilitator who's aware, and it doesn't matter if they're male or female.

Even though here women were not necessarily made feel unwelcome, there still appears an underlying bias in perceptions of what women can and cannot do which determined the way workshops were conducted. Especially if women were talked over, the atmosphere did not seem appealing for them. Lastly, Lisa, as seen previously, describes how the atmosphere in her space was weird for her:

> As a woman I was made feel welcome, they were all very happy when I showed up. But I did sometimes have the feeling that I was treated differently than everyone else. Not even in a negative way, but just because I was a woman and they partly didn't know how to treat me. That was a bit weird sometimes.

Even though Lisa points out that she did not necessarily feel negatively affected, her statements imply that women were seen as 'different/other' and not treated like the men in her group. Later, it transpired that some Makers were, in fact, trying to flirt with her. She remarks that she did not realise this but that "it felt really, really strange. […] I found this kind of attention repulsive." She explains that it lasted for about two months before it stopped, likely due to her friend going to Makers and telling them to stop. Felix has provided a view from the other (heteronormative) side. As already touched on in section 4.4.2, he explains that women are very welcome among hackers and nerds, not only because so few share these interests, but also because male hackers want a girlfriend: "of course, it's also this 'maybe one of them will be right for me because I would like to have a nerdess' thing." However, if women are critical of a male-biased hacker scene, then he does not welcome them because "They are just a bit different". Women are welcome if they do not criticise the movement or people in the movement.

Dougherty's online criticism of female Maker Naomi Wu adds to the impression that women are also seen as less capable than men. Naomi Wu is a Shenzhen-based Maker (China) who is outspoken about her femininity and women in technology. In 2017, Dougherty accused her on Twitter of being "a persona, not a real person, […] She is several or many people" (Meyers, 2017). The incident caused outrage both from Makers and the wider online community and led Dougherty to apologise to her two days later. Even though the apology did not take long, this incident shows once more that women are not always considered as Makers but as outsiders who pretend and do not necessarily understand what they are doing.

Wu, on her Twitter profile, sums this up sarcastically: "It's all about merit until merit has tits" (Wu, 2019). Not only does her statement point towards women's exclusion within Making, but also towards the competitiveness, meritocracy and the inherent gender-biases that have been discussed previously.

A sexist environment, or rather women's second-class status within Making, finds ample evidence in academic literature as well. In 1984, Steve Levy writes about *Hackers: Heroes of the Computer Revolution* and their relationship to women back then:

> Not only an obsession and a lusty pleasure, hacking was a mission. You would hack, and you would live by the Hacker Ethic, and you knew that horribly inefficient and wasteful things like women burned too many cycles, occupied too much memory space. 'Women, even today, are considered grossly unpredictable,' one PDP-6 hacker noted, almost two decades later. "How can a hacker tolerate such an imperfect being?" (2010, p.62)

Of course, Levy is talking about Hackers in the 1980s and not Makers in the 2010s. Nevertheless, it has already been mentioned in the introduction that the MM partly originates in these described hacker cultures and that, thus, their culture is at least partly shaping Maker culture. Tanczer (2016) considers cultures of hacktivism today in which she defines hacktivism as "a conflation of hacking and activism […] hacktivists use the same tools and techniques as hackers, but for political means" (p.1600). The discourse she describes appears very closely linked to the results found in the study at hand. She writes about a *Male Oblivious Discourse* (p.1602ff) in which male hacktivists subconsciously marginalise and suppress female activists by construing gender as being a non-issue (p.1603). This reminds of arguments presented by Toombs (2017) about hackers discussing safe space policies and claiming that the only rule a space should have is "Be excellent to each other" (p.1084), thus also negating any kind of deeper biases and issues. Tanczer finds that "male hacktivists put themselves in the subject position of being the standard or norm. […] Their hacktivism is related to masculinity" (2016, p.1603). Glimpses of this have been found in the present study as well, for example when Hans emphasises that it is not his or his space's problem if women do not show up on their doorstep. This, too, makes gender a non-issue for them, even if they might acknowledge the problem. It is not theirs to tackle. Equally, Tanczer's assertion of male hacktivists seeing themselves as the norm resonates with just examined data, i.e. Dougherty's accusing Wu of not being a real Maker or Felix condemning women who criticise a male-biased movement.

Anthropologist Dawn Nafus (2011) has taken a closer look at F/LOSS (free/libre/open source software) culture and its idea of openness related to gender. She writes similarly: "programming cultures sustain certain forms of masculinity which make women concerned about being 'unfeminine' in their connection to technology or 'too feminine' by attracting unwanted male attention" (p.671). This tension has not been observed as clearly within the present study but some women, i.e. Heidi and Megan, have indeed stated that they adjust to the masculine culture in Making in order to fit in – their femininity clearly being something that prevents them from fitting into the community and being accepted as a full Maker. That some of them still attract unwanted male attention has been shown by Lisa's account. Cockburn (1999) writes about workshops more generally and states: "The all-male workshop fosters and develops masculine patterns of relationships, it is the home of camaraderie based on the exchange of anecdote and slander concerning women" (p.128). Even though she writes two decades ago, this rings true with some Makerspaces today: most have only a few female members – if any at all – and the culture within them is one dominated by masculine values and strong bonds that make it difficult for women to get involved without changing their identity. These dynamics can be mapped onto the bonding communities that were discussed earlier. If these strong bonds within Makerspaces are partly established due to creating an atmosphere that objectifies women, then the morphological concept of community is inherently male-biased. Thus, objectifying women through the open display of pornography, sexist jokes and unwanted personal advances strengthens this culture which has led to women setting up their own Makerspaces and/or staying away completely from regular spaces.

6.2.4.5 Language/Communication

A resulting aspect to consider is that of gendered language and communication. The interlinks between gender and language are complex and often contested, especially in languages with strong ideas of feminine and masculine forms engrained in their language, e.g. German. Analysing the use of language within Making is a study in and of itself. Nevertheless, due to Megan, Robin and Rose specifically talking about language and inclusiveness, this aspect is considered. Megan hints at language subtly. She explains that on the website of her Makerspace the first thing people will see is a woman engaging in Making activities and that her picture will be bigger than that of the man next to her. When giving an introductory tour to the space, she finds it important that "you're talking about how important women are in the space, not in a 'Women are important in the space' way but

in a 'just part of the narrative way'." Her approach is very much focused on ensuring that women are included and specifically mentioned in communications regarding Making.

Rose and Robin have slightly different approaches. Robin, as we have already seen, emphasised design-driven communication instead of technology-driven communication in their Makerspace. The technology-led communication, to them, quickly "becomes very jargon-led […] that kind of setup can be very men-driven." Being more design-led meant that "it was very much about what you were trying to make. It could be any type of motivation and meant that it was more open to everyone." This connects to women seemingly being more purpose-driven when it comes to Making. Instead of communicating the technology and details of it, Robin's Makerspace was focused on communicating purpose-driven ideas which ensured more diverse participation. Rose is most engaged when talking about language and gender inclusiveness in her work. Her Maker activities are "always social need, first of all, wherever we do sessions. The technology is always hidden. It's the tool to reach the end point." Whereas communicating Making through technology results in an enthusiastic uptake by men, purpose-driven language gets "the diversity that we're looking for, it's changed it around." To her, this purpose is especially linked with the environment which is discussed further in Chapter 7.

Studies on language and gender are plentiful. It has been shown, for example, that including women specifically in communications positively increases their response. Social psychologists Lisa Kristina Horvath and Sabine Sczesny (2016) have shown this in relationship to job adverts and that including the female as well as the male form of a job title (in German) significantly increases applications by women. Similarly, a study by social psychologists Jane Stout and Nilanjana Dasgupta (2011) has shown that even the smallest linguistic cues, such as using 'he' to mean 'he or she', can lead to women excluding themselves from referred to activities or communities. Both these studies seem to apply more closely to Megan's approach in which women are mentioned more specifically. However, Robin's and Rose's approaches also appear logical. If an activity and a group around that activity shows a clear and specific masculine culture, then it seems obvious that communicating these activities through more feminine values and attitudes will attract more women. For example, we have established that women appear to be more inclined to join in with Making for a specific purpose, so communicating through such a purpose can be assumed to increase their participation. Unfortunately, no literature on this has been found, but it appears obvious that in order to change a masculine culture into a less gender-biased one, one needs to communicate and choose language appropriately to a different kind of

culture. Again, analysing language and communication within the MM and Makerspaces is a mammoth task that requires more attention than can be provided here. What is crucial to point out is that, as mentioned earlier, using a different kind of language in order to communicate Making activities is an active attempt to change the way communities around the activity are socially constructed. The male-biased social construction of many grassroots Makerspaces is actively challenged here and presented with an alternative way to think and talk about Making.

6.2.5   Women coping

Before moving on, the way some women deal with these cultural challenges shall be mentioned briefly. The data chapter has already introduced the idea of 'tomboy-mode' and adapting to the masculine culture by incorporating/internalising its values. Heidi, Jane, Rose and Megan all talked about how they were either already "a bit of a tomboy" (Jane) or "square peg" (Rose) before getting involved in Making, or how they were simply seen "as a guy with tits" (Heidi). Megan, as seen previously, goes on to describe

> a tribe of Maker women. […] You've got your dyed hair, your big beats. There's a kind of toughness. There's a tough femininity thing. There's a lot of gay women in that world. I think a lot of gay women naturally got a little bit of a tomboy in them if you know what I mean. I think there's a tribe of dyed hair, tattooed, bootied, but still flamboyantly feminine women.

She continues to estimate that around 50% of women in Makerspaces adhere to that profile. To her, these women communicate: "There's something about the tribe thing that says I'm a maker, so don't even question me". To the knowledge of the author, no studies exist that examine gender, sexuality and Making, and it is troublesome to make more general statements about Megan's observations without any evidence. Recalling the gender-balance of the survey, however, reminds of an over-proportionate amount of non-binary people who participated and identify with the Maker label which might support Megan's theory. It could be hypothesised that those who do not solely identify as woman (or man) might be more likely to adopt a mixture of stereotypical gender characteristics and values which, in turn, might make it easier for them to fit into either stereotyped environment, i.e. masculine Makerspaces.

Despite a lack of data for this specific hypothesis, there are studies showcasing how women do sometimes have to assimilate into a masculine culture in order to become part of that culture and advance in it. Wajcman (1998), for example, writes:

[…] ironically, it is a male model of equality that women have had to adopt in order to challenge the status quo. My research confirms that to achieve positions of power, women must accommodate themselves to the organization, not the other way around. Women […] therefore pay a high price for venturing into male-dominated territory. For most women the price is too high – requiring them to sacrifice major elements of their gender identity. No equivalent sacrifice has been expected of men (p.160).

Even though this is a statement about women in managerial positions and within organizations of a masculine culture, it could be read fully in the light of Makerspaces and their masculine culture. The women in the study at hand who seem to be agreeable towards adapting more masculine behaviour/values, e.g. being more confident, are Heidi, Rose, Megan and Jane, partly because they have already identified with these before they started engaging in Making. Lewis' study (2015) points out that adopting masculine characteristics might, however, potentially be detrimental to inclusiveness:

a male-dominated environment may be even more intimidating with the presence of only one or two very confident female members; rather than acting as role models and assisting women to see themselves as part of the community, this may further exaggerate the perceived level of expertise and confidence required for a woman to be accepted into such a community (p.9).

This seems crucial when including women in Makerspaces. Merely making them adapt to a masculine culture and adjust their identity to it is likely not going to help more women in joining but foster an atmosphere within which only very confident and skilled women can be part of a Makerspace.

Other women in this study have recalled sexist experiences and, oddly enough, none of them are part of a regular Makerspace (anymore). Nancy delivers her own inclusive workshops, Anna is part of a feminist Makerspace, and Lisa does not attend her former space anymore (partly due to time limitations, partly due to existing conflict in the space). Robin, equally, does not attend a specific space but is a consultant for spaces and ensures they are inclusive. The only exception is Klara who does not only regularly attend a Makerspace but is co-founder and leader of a live-in eco-hackerspace. This is, however, where her case also differs from the typical Maker: her Makerspace has not been set up to predominantly tinker and play with technology, but to re-build an old house and create autarkic and sustainable living conditions for the people in the house. Thus, it does not fall into the category of a typical grassroots Makerspace. The only two female participants of a regular Makerspace within this study are Heidi and Jane, and the latter has said she mostly sees herself as "the mother figure" and undertakes care-functions instead of Making something. Therefore, we arrive at

a point where most of the women in this study are somehow involved in Making and Makerspaces, but few as regular members. If they are, they adopt masculine values in order to fit in. The others are much more involved in delivering inclusive Maker workshops and/or support in setting up Makerspaces.

What does that mean for the underlying morphology of Makerspaces in the UK, Germany and Austria? It implies that the morphology and its dynamics show how the here described dynamics are inherent to the understanding of Making within those spaces and that they are, in fact, male biased. Thus, as long as those structures and dynamics remain the same, including more women will likely not be achieved and if it is, they might likely have to give up part of their identity, as Wajcman has indicated and has been found in this study. Therefore, a different, more feminine morphology is needed to achieve true inclusiveness.

6.2.6   Summary

Within this section, we have explored how the physicality of Makerspaces and their social setup can influence the gender balance within this space. Not only do the locations of such spaces potentially impact women's involvement, but also their interior make-up and decisions on which tools and technologies to include. Additionally, it has been shown that grassroots spaces in particular are often tight communities, or bonding communities, which can increase obstacles to becoming part of such a community. Furthermore, analysis reveals that the culture in these spaces is often dominated by masculine values and features to which some women adapt in order to fit in. Throughout data collection, some participants have said that, in the end, inclusiveness and its success depend on the space and the efforts its communities undertake in order to make it gender-inclusive (Megan, Nancy, Robin).

However, considering that the overall gender balance of the movement and Makerspaces in particular is still clearly leaning towards men no matter where one looks, implies that there is an underlying culture that makes it difficult for women to become part of these spaces. Exceptions to this are, of course, feminist Makerspaces that aim specifically at including non-male genders and, thus, get to challenge the totality of the masculine culture in their spaces. Apart from those spaces, the researcher has not come across a single Maker talking about a regular Makerspace in which female participation outweighs male participation. Of course, this cannot solely be connected to a masculine culture in the space but must also be considered within wider societal and structural phenomena, some of which have been

explored in section 6.1 of this chapter. Nevertheless, it can safely be assumed that the masculine culture that exists in the majority of spaces contributes to these numbers.

Section 6.2 has helped in drawing out much more clearly how some of the most important concepts in the morphology as devised in section 5.4 are interwoven with a male gender-bias. The community that is emphasised as important by many Makers appears to be one of very tight connections and, for some, a safe space. Whereas this is not necessarily a problem, it does present as a problem in the case of Makerspaces if they foster connections between the already dominant gender in society while excluding (and sometimes patronising) more disadvantaged genders that already face more challenges in getting involved in Making. With inclusiveness not being one of the concepts in this particular morphology, a gap is left that is often neglected by male Makers. The culture that develops – or rather, is socially constructed – within that community appears to be shaped by confidence and bragging, a sexist environment and technology-driven projects. In contrast, women in this study have suggested ways of making spaces more inclusive, starting from more inclusive language to non-discriminatory practices. Introducing inclusiveness into the morphology would change the dynamics in communities and shape them differently. It would also positively affect the concept of digital technology which contributes to the heavily masculine culture. Taking focus away from it and broadening the spectrum of what technologies Makers can engage with would likely attract a broader variety of people. Due to community and digital technology being such dominant concepts in this Makerspace morphology, other concepts are automatically affected by this masculine culture as well. Activism, learning and creativity, for example, are all interwoven with the two concepts and, therefore, also contested by a masculine bias. This section has, thus, not only shown that different constellations in Making are possible, but therefore also that the activity itself with all its surrounding aspects is socially constructed and not a neutral aspect of people's lives. Makers' beliefs very much shape their communities and interactions, just as much as those beliefs themselves are constructed through the social environments they were created in.

6.3   A new constellation: women-inclusive Makerspace morphology

The chapter thus far has shown that Makerspaces are heavily geared towards masculine values and interests. Not only that, but spaces themselves might be set up in a way that is detrimental to women. It has been revealed how these aspects are, in fact, interwoven in and with the morphology that was previously developed for Makerspaces in the UK, Germany

and Austria. Therefore, the morphology has been shown to be socially constructed as inherently patriarchal and masculine. However, the female participants of this study have shown possibilities for a constellation that is constructed differently, i.e. more inclusive. This present section then sets out to develop a morphology for Makerspaces that is more women inclusive. Figure 6-3 shows the related visual of this more feminine morphology. Again, important connections are visualised through lines. The grey ones are important in general, but not directly related to community and inclusiveness. The connections that have been discussed as important in this chapter are shown in colour. In what follows, the changes to the more masculine conceptualisation (circled green) are summarised according to the previous analysis.
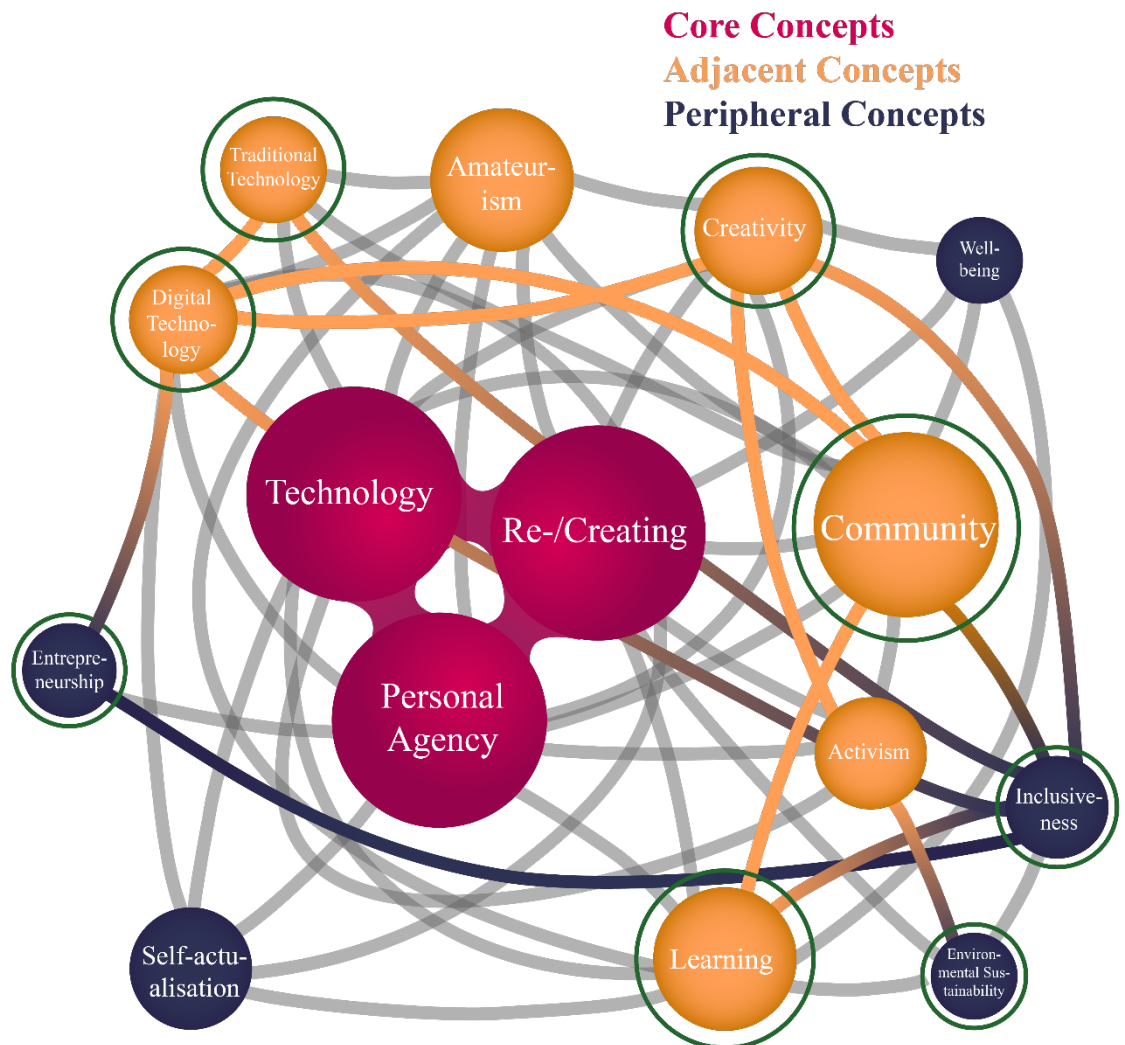
Figure 6-3 Women-inclusive Morphology. Makerspaces in the UK, Germany and Austria (changes to Figure 5-9 circled in green).

A first big change is the decreased importance and focus on digital technology. The chapter has shown the connection of this focus with a variety of other concepts and their masculine nature. Digital technology has been demonstrated to be stereotypically connected to men which results in a variety of aspects. In school and society in general boys and men are more likely to be taught skills relating to digital technologies. They, thus, are more likely to build up strong levels of confidence in handling those technologies. Due to the nature of these technologies being more modern and at the forefront of innovation, men are also more likely to be involved in related dynamics, for example digital technology entrepreneurship. Available data has also exhibited that men are more likely to brag and compete with others. In relation to digital technology, this means an increased culture of technical prowess within Makerspaces. The communities that form around digital technologies, which is most grassroots Makerspaces, are therefore much more likely to attract and encourage male participation.

With that decrease of digital technology comes an increase – in fact a jump from peripheral to adjacent concept – for traditional technologies. Data from study participants as well as available literature has shown that women tend to be more connected to and more interested in less digital technologies. Focusing more on these technologies through providing relevant tools and related workshops is likely to give women more confidence in engaging with Maker communities. This would open up communities to a bigger variety of projects and tools, and therefore to more variety within their Maker demographics.

Together with a decrease in digital technology is a decrease in entrepreneurship as a focus. The competitive nature of Making one's own products to sell appears to be less appealing to women than to men. This seems partly due to the nature of selling items which includes a competitive environment. It needs to be kept in mind though that women do indeed make items and sell them, as the example of Etsy – whose sellers are mainly female – shows (Clement, 2017). The decisive element here might be digital technology. Products on Etsy appear much more focused on more traditional technology, i.e. sewing, paper craft and jewellery. A further study is necessary to explore the connection between gender, technology and entrepreneurship. Creativity itself has also been allocated a slightly smaller position due to its connection to a bragging culture and innovation. No doubt creativity is also important to women. But it has been shown that creativity is seen as an indicator of competitiveness for men. Therefore, it is given less importance in the feminine morphology.

Two new concepts have been added. Firstly, inclusiveness itself plays a role. It has been highlighted that men do not necessarily see an inclusiveness issue. Women are much more likely to identify problems which is no surprise considering that they are affected by dynamics of exclusion. Connecting inclusiveness to the concept community contests the latter in a much different way than if it does not play a role. The communities, which often follow dynamics of bonding social capital, would make a bit more room for also facilitating bridging dynamics, thus allowing others to join in more easily. More generally, including ideas and goals of inclusiveness would likely affect other concepts, such as the just shown traditional technology or a more inclusive understanding of creativity. The second newly introduced concept is that of environmental sustainability. Its connection to gender and inclusiveness is shown in much more detail in Chapter 7. It has already been included here due to the voices stating that women are more likely to get involved if they have a purpose, a real-world application. Rose, for example, has pointed towards environmental motivations as being more motivating for women than for men.

A last aspect to be mentioned is that of community itself. The size, or importance, of community has not changed. Nevertheless, the way it is contested has changed dramatically. Communities in this morphology are shaped with a focus not only on digital technologies but also traditional technologies. Their bonds are likely leaning towards more bridging dynamics due to an emphasis on inclusiveness. Equally, women appear to be much more likely to form and shape community beyond that of a local Makerspace. Through workshops and providing Makerspace services, they are more likely to connect different spaces, communities and people. Consequently, the connection between community and learning is also a slightly different one. While women are just as likely to ask someone for help, whether online or in person, their emphasis on spreading Making and inclusivity practices defines this link in a slightly different way than it appeared for men.

6.4   Conclusion

This chapter has shown how women are not only excluded through a masculine culture within Makerspaces in the UK, Germany and Austria, but also through more systemic and wide-ranging dynamics which go beyond Making and what Makers can hope to tackle. In order to understand the dynamics better, one might view the MM and its spaces as a socio-technical system itself that is socially constructed. As a technology, Making relies on an infrastructure (Makerspaces, online communities, magazine, gatherings) that help share knowledge and foster connections between different groups. This network of Makers

employs skills, machinery and certain forms of organisation in order to function and fulfil its purpose. Viewing Making as a technology might make it appear neutral to people – something that is there to be used by anyone because "we are all Makers" (Dougherty, 2012, p.11).

However, when considering the social aspects of this system and how it is merely a socially constructed reality among many possible ones, its non-neutrality becomes obvious. Who was this system built by? It was and is almost exclusively established and promoted by men. Who was it built for? Something made by men is likely to appeal more to men and the culture they foster is easier to access for men than for women. Thus, the system is built to work mainly for men, not for other genders. How is it used? The system is used in a way that makes it more difficult for other gender groups to join in. The focus on competitiveness, confidence and digital technology appeal less to women and, thus, make Making less appealing to them. What do people need in order to use the system? Financial possibilities, time to spare and access to a Makerspace, all of which might be more difficult for women. Recalling Wajcman supports this point:

> In contemporary Western society, the hegemonic form of masculinity is still strongly associated with technical prowess and power [and has led to] 'the construction of men as strong, manually able and technologically endowed, and women as physically and technically incompetent' (Cockburn, 1983, p.203). Entering technical domains therefore requires women to sacrifice major aspects of their feminine identity (Wajcman, 2010, p.145).

In conclusion, this socio-technical system is "a process by dudes, for dudes" (Bean & Rosner, 2014, p.27). Making and its spaces as described here are therefore not built in a vacuum but socially constructed by their various actors and promoters. The developed morphologies, thus, tie in well with the underlying ontology of social constructivism of this research study.

Of course, not all communities adhere to the dynamics and issues described here. In fact, it is unlikely to find a community that ticks all the boxes of the raised problems. Each community is different, but the gathered data provides evidence that there are overall tendencies that appear to exist in many spaces. Similarly, this chapter is not meant to blame men and victimise women. Rather, the evidence and arguments brought forward are making the point that, in general, most Makerspaces struggle with including women in one way or another and that there are underlying and systemic reasons for that. Adding inclusiveness considerations to ones' practice reveals a lot of these dynamics and would alter a community profoundly. This, importantly, also signifies that merely including more women in the

movement might not lead to a more open and diverse movement. We have seen that quite a few women seem to adopt a male identity when participating in a Makerspace. Thus, rather than being able to disrupt the masculine culture, they become part of it. Scholar of technology dynamics and healthcare Nelly Oudshoorn and her team (2004, p.54) examine Gender and Design Cultures in Information and Communication Technologies and come to a similar conclusion:

> the gender issues involved in design are too complex to be solved by just 'adding women and stir' (Harding 1986). They also require a transformation of the dominant cultural image of technology, a drastic change of the technology push oriented routines and practices of current design communities, and a renegotiation of gender identities in relation to technology.

It is important to note that neither developed morphological constellation can be identified as the masculine or feminine Maker morphology. The models developed here specifically look at Making in Makerspaces in the UK, Germany and Austria and suggest constellation-specific dynamics. Models that would define specifically what it means to be a masculine Maker compared to a feminine Maker would have to be developed separately, although even then problems might arise as the meaning of what it means to be masculine or feminine might vary greatly between different cultures. Nevertheless, the here developed models appear to come close to what feminine and masculine Making might mean in Makerspaces in the UK, Germany and Austria.

Figure 6-4 Community and inclusiveness link with gender-specific influences.

Figure 6-4 provides a visual representation of the morphological link between community and inclusiveness as it would be shaped under gender considerations. This chapter has shown that exclusion of women starts with structural exclusion that might stop them from approaching a space in the first place. But even if circumstances allow it, the physical space itself with its location, tools and interior set-up might pose challenges. The social space as well with its combination of masculine culture and bonding communities are likely to make integration very challenging. It appears as though the findings of the present research on space in these countries accord with wider cultural and systemic structure that, in general, make access for women to more masculine cultures a particularly challenging endeavour. It might not only make them feel unsafe and subject to sexist behaviour, but require them to change their feminine identity. Therefore, this chapter has concluded with devising a Maker morphology that is likely to be more inclusive for women. It would consider all the raised aspects and likely allow them to keep their identity when being part of a Makerspace while not requiring them to be overly interested in digital technologies. This chapter has examined gender-inclusiveness issues and in order to answer the research question the next chapter examines the links between gender-inclusiveness and environmental sustainability within Making more closely.

Chapter 7   Women and the Environment

"We all live on one planet and if someone can't be arsed what happens to that,

then that's reckless."

(Lisa)

The research question aims to examine whether including more women into Makerspaces in the UK, Germany and Austria would contribute to an improvement of positive environmental impacts of Making practices in those spaces. In order for this question to be answered with a yes, it would have to be shown that women's Maker practice tends to be more environmentally concerned than men's and that they are more likely to behave in an environmentally friendly way within those Makerspaces. This chapter examines just that. Figure 7-1 visualises the examined link, namely that between inclusiveness and environmental sustainability.

Figure 7-1 Inclusiveness and environmental sustainability link.

Before diving deeper into the data, however, it is necessary to briefly expand on the term environmental concern and how, within this study, it is related to environmentally friendly behaviour and positive environmental impact. Xiao and McCright (2017, p.169) define environmental concern as "perceived seriousness or worry about specific environmental problems". It hints towards a subjective and socially constructed nature of the term: concern reflects how an individual perceives a certain problem, not how it is seen universally. It should be added that environmental problems themselves can be seen as constructed. What one person sees as a problem (e.g. planting of monocultures which drive out other species), another might see as positive development (e.g. planting of monocultures to increase profits). The focus in the present study is on how interviewed Makers construct environmental concern in their practice in connection with gender.

The research question does not focus on environmental concern, however, but of positive environmental impact. Similarly, the related morphological theme is listed as 'Environmental Sustainability'. This study's primary interest is not in actual measurable effects of human Maker activity on the natural environment and their long-term sustainability – different methods would be necessary to explore these aspects. Some of these potential effects have been noted by other studies, as listed in the literature review (section 2.2.2.2). Researchers have identified potentially positive effects (i.e. repair and recycling or local production processes that minimise transport) and negative effects (i.e. recurring purchases of new gadgets, wastefulness of prototyping). The present study is much more interested in environmental attitudes and behaviours that aim to protect the natural environment as these are indicative of actual environmental impact. They are perceived as important if any measurable positive effect is to be achieved because even though not all attitudes and behaviours lead to the intended impact, they are seen as a good predictor for positive action (Eom et al., 2016). Thus, when this study speaks of positive environmental impact and environmental sustainability it speaks about attitudes and behaviours that are geared towards lessening negative environmental effects of human lives on the natural environment.

Survey data in the present study has given first insights into how environmentally concerned Makers in the UK, Germany and Austria are. While 75% consider themselves environmentally concerned persons, only 62% overall claim to include that concern and apply it to their Making practice. Every fourth participant engages in Making partly because they want to reduce human impact on the environment and a handful locate environmental aspects on top of their priority list when making decisions about their project and process as

we were able to observe among in-depth interviewees. Equally, however, there are Makers who do not consider the environment at all in their practice. Between 10%-33% of survey participants chose non-environmentally friendly answer options for each of the statements regarding environmental impacts of a project, materials and waste (see Table 7-1). Some in-depth interviewees also fall into this group and do not think Making should concern itself with environmental considerations.

Statement	(Strongly) Agree	(Strongly) Disagree
If the process of making a project or the final project itself are likely to have negative environmental effects, it shouldn't be made.	40%	28%
When choosing materials, a Maker should always consider its environmental dimensions (i.e. recyclable, environ. friendly, etc.).	54%	20%
A Maker's project should not concern itself with its environmental impact. That's not what making is about.	19%	61%
If a project produces too much waste, it shouldn't be made.	41%	33%
It doesn't matter how environmentally friendly a material is as long as it suits a project.	26%	39%
When working on a project, waste shouldn't be a concern.	10%	72%

Table 7-1 Survey: Environmental Likert Statements, pro-environmental answers underlined (excluding neutral answer option).

It is not enough to view attitudes and behaviour as one and the same thing. Attitudes concern what we think, behaviour is what we do, and both might not always align with each other. As is well documented by now, knowledge and concern about environmental issues does not always lead to positive environmental behaviour (Torkar & Bogner, 2019, p.1). This is all too prevalent in our current society in which the causes of climate change are widely accepted to be human-made, yet widely accepted counter measures and behaviour differ and there is not always consensus about how to lessen those causes – a good example for the socially constructed nature of the field. Nevertheless, if pro-environmental behaviour is encountered, it is likely that it is preceded by concern for the environment: "attitudes are regarded as important predictors and vital determinants of behaviour" (Torkar & Bogner, 2019, p.2). Equally, we can recall from section 4.3.1 that Makers appear to be more concerned about environmental issues than the general population. Therefore, concern for the environment is partly the focus of this chapter.

Attitudes are a focus in the present study. They are an indicator of how Makers construct their world views and, thus, their realities. The previous analysis has already relied heavily on Makers' attitudes, i.e. when devising the MM morphology in Chapter 5 and when exploring views towards gender in Chapter 6. In this present chapter, attitudes towards the environment and gender will be explored. Do the interviewed Makers perceive a connection between environmental concern and gender? This connection, if present, might be important when wanting to tackle inclusiveness and environmental impacts within Makerspaces and could help facilitate more comprehensive approaches in advancing both. But first, we need to explore if such a connection is part of Makers' wordviews.

Behaviour is then the next step and will equally be of interest in this chapter in order to discern environmental concern and impact. The reasons for why behaviour can be an indicator for concern have already been explained: attitudes are seen as strong predictors for behaviour in an economic system that is not rooted in fostering positive environmental impact, but in increasing financial capital (Fulcher, 2004, p.14). Specifically in this study, often when participants were asked for their levels of environmental concern, they used examples of their behaviour to illustrate their answer. Therefore, both the attitudes towards environmental concern and behaviour are the focus of analysis here. Especially when it comes to gender differences, looking at attitudes and behaviour provided a somewhat different picture.

This chapter, then, is divided into two main sections: firstly, Makers' attitudes towards a potential connection between gender and environmental protection are examined (7.1). The way Makers perceive this potential connection points towards the different ways in which they construct their reality and, thus, understand their Maker practice. In order to answer the research question, these attitudes are important. The question is asked in order to support Makerspaces in becoming more inclusive and environmentally concerned. If a connection between gender and positive environmental behaviour can be seen, then it is important to know if Makers acknowledge this connection. If they do not, acknowledging such a potential connection could steer a space towards a more inclusive and environmentally concerned practice. As we will see, some Makers do perceive there to a be a connection between gender and the environment whereas other do not: this is yet another manifestation of differing Making constellations.

This is where the second part of this chapter comes in: whereas the first part looked at Makers' attitudes towards a connection, the second part looks at their environmental behaviour

specifically and compares that of the female Makers with that of the male Makers (7.2). It aims to explore whether the attitudes as seen in section 7.1 align with the actual displayed behaviour. For this purpose, an environmental profile is developed of each interviewed Maker based on their environmental behaviour and concern both of which provide evidence for female participants, indeed, appearing more environmentally concerned than male participants. This will not only show discrepancies between attitudes and behaviours, but also help understand different Making constellations and how, indeed, considering gender more in-depth might also improve environmental impacts of a space. The chapter therefore also shows how the previously developed Makerspace morphology is inherently patriarchal and not overtly pro-environmental. It, consequently, demonstrates as well how the more inclusive morphology developed in 6.3 is inherently more environmentally concerned.

7.1   Attitudes towards gender and the environment

This section sets out to review the variety of data collected regarding attitudes towards a potential gender-related difference in environmental concern and behaviour within Making activities. Section 7.1.1 starts in analysing participants' answers that support the claim that there are no gender-related differences. It finds, though, that some of the aspects participants raise as being influential on their environmental concern have gender-related differences themselves, despite participants not acknowledging these. Thus, the arguments participants have provided are not always in line with their attitude that gender and environmental concern are not connected. Section 7.1.2 then continues to go into more depth regarding those participants who do believe there are gender-related differences. Specifically, language and approach, old versus new technologies, and care and empathy are explored. Taken together, both these sections show the different believes of Making realities in which Makers operate and, also, a slight tendency for women apparently being more environmentally concerned in their practice within Makerspaces in the UK, Germany and Austria.

7.1.1   Arguments and evidence against gender differences

This section engages with study participants' views which support the claim that there is no gender difference in terms of environmental concern and behaviour. In morphological terms, no gender differences would mean that even though the more men-focused and more women-inclusive morphology differ in certain aspects and how these inform each other, environmental aspects would not be affected by this. As is shown later, however, that does not appear to be the case.

A quick recapitulation of the collected data assists in fleshing out the arguments that do not identify gender-differences in regard to environmental aspects. The survey found little gender difference in environmental concerns and behaviours with the only significant result being obtained relating to the question whether Makers consider the environment in their Making practice. 88% of female participants affirmed this, compared to only 59% of male participants (significant p-value of 0.003). The gender of a person appears to influence the role environmental concern plays in a person's Making practice which is looked at more closely later. When inquiring about differences in material usage, waste generation and a project's general environmental impact, however, no significant gender differences were observed. Of the in-depth interviewees, ten (5 women, 4 men, 1 non-binary) state that they do not see a gender difference when it comes to environmental concern. Out of those, four (2 women, 2 men) did not further specify their answer. The remaining six listed a variety of aspects that are more likely to influence differences in environmental concern: education and culture, levels of confidence in certain areas, and motivations that divert from the environment. In what follows, these aspects are looked at briefly and it is shown that despite assumptions of gender-neutrality, these aspects are actually likely to have gender-inherent dynamics themselves.

Jane and Klara are both supporters of the theory that education and culture are much more likely to influence someone's environmental concern and behaviours. Jane gave herself as an example when describing her friends and herself as having a "kind of a hippy mentality. Left of centre, we're all kind of geared to that kind of alternative growing up in the sort of 60s/70s/80s…all a bit left-wing and so on." This argument is not difficult to follow. After all, cultural upbringing and education are automatically shaping and fostering a person's understanding of the world. For example, some studies confirm the connection between environmental values and education. Environmental social scientists Laura Barraza and Alfredo Cuarón (2004, p.22), for example, examine how school education not only influences a child's environmental understanding but is crucial in fostering their environmental knowledge and level of awareness. On a broader scale, environmental education scholars Gregor Torkar and Franz Bogner (2019) show how someone's value system can also strongly influence their environmental attitudes and concern. In fact, it appears difficult to make the opposite case, namely that cultural upbringing and education (formal and informal) have nothing to do with environmental attitudes.

Nevertheless, it is crucial to recognise gender aspects within education and cultural upbringing, especially when it comes to values. Section 6.2.4 has already elaborated on a

variety of gender differences in values, i.e. confidence and competitiveness. In Western European cultures, these differences are established early and start with a flood of blue and pink that are imposed on new-born children according to their sex and end with claims that men are inherently better at sciences and women inherently better at caring for others and their surroundings. Women are taught to be more agreeable, open and caring (Risse et al., 2018) which are values that are connected to being more environmentally concerned (Hirsh, 2010). As shown earlier, they are also more likely to be raised to doubt their abilities in STEM fields. Karl mentioned his daughter who actually enjoys maths and is good at it but is being influenced by her friends to not like it. It is reasonable to infer that, indeed, cultural and educational upbringing very much influence environmental concern, but that there are gender dimensions to these aspects that cannot be neglected when considering their impact on dynamics of environmental concern. In terms of the morphological model, this underlines that different cultures, and with that education and gender, significantly influence the model and the interplay between its concepts, just as Freeden's approach suggests. In fact, having developed a different morphological model which would be more inclusive of women, as done in section 6.3, shows once more that there are wide-ranging cultural differences.

That levels of confidence are more decisive in determining environmental behaviour than gender is claimed by Robin and Karl. Both connect environmental Making behaviour specifically to repair and see men as more confident to repair. Robin identifies confidence in repair as important in engaging in that activity, arguing that men, usually, are more confident in engaging in repair of digital and electronic technologies, and women being more confident in textiles skills. This emphasises again the importance of the morphological model that has been developed in section 5.4 and how a focus on digital technology is accompanied by gender differences. Robin relates this bias to education and upbringing and, thus, actually provides a good example for the point that was just made: education and upbringing have gendered differences. Here, however, it stands to reason that male Makers are more environmentally concerned in their Maker practice as they are more likely to fix broken digital items. Karl's claim backs this up. He states a bit more generally that his wife and daughter are both lacking a confident attitude when it comes to repairing things, no matter what it is. Usually, if something needs fixing, they will call on a man to do it. These dynamics, in fact, are inherent in the morphology: repairing something is part of the core concept re-/creating and connects to whichever technology is dealt with. Seeing that the masculine morphology defines digital technology as being more of a focus for men, they are also more likely to repair those technologies. However, the connection is not as

straightforward as it might appear. Section 7.2.2.4 shows that women appear to engage in repair as much as men, as indicated by Charter and Keiller's study (2014).

Chapter 6 has already argued that confidence is a value more associated with and prevalent among men, and heavily connected to Makerspaces and their culture. Science, technology and gender historian Amy Bix (2009) has examined the relationships between women, tool knowledge and home repair from 1920 to 2007 and has found that "women required special encouragement to overcome inexperience and doubt, to begin building. […] The courage women still needed for tool use in 2008 underlines the contested gender of technical knowledge" (p.57). Bix clearly makes the same connection as Karl and Robin have made: confidence is important in repair and women lack it to some extent, especially when it comes to digital technology and general hardware fixes. This relates back to the masculine culture that was analysed in section 6.2.4. It is not only the lack of skill and knowledge that might diminish confidence but also a culture that is defined by being confident and skilled which makes even attempting to repair something more difficult for non-confident people.

Other studies note the lack of women in their sample (Kim & Paulos, 2011, p.2399; Houston, 2016, p.1408) and emphasise the significant relationship between men and electronic repairs. This observation supports Karl's and Robin's impressions. Indeed, it seems only logical that if a gender group is associated with a specific kind of technology and taught the relevant skills to deal with that technology, that it will also be more likely to undertake repairs in this category. Therefore, if Making is identified with digital technology and men are strongly associated with this technology, it is also highly likely that they will be more confident to repair this technology within the movement. Our morphological models, again, prove to be inherently gendered. This underlines the fact that as long as Making and the way it is promoted focus strongly on digital technology, women will be excluded (unless the social construction of gender-technology associations dissolve). Assuming repairing technology has positive environmental effects, this aspect would actually support the claim that men are more environmentally friendly within Making. Strangely, however, this claim has not been made by a single participant. Potential support for the opposite claim is made further on.

Before moving on, the last aspect that is mentioned as showing that there are no differences in environmental concern between genders relates to the motivations Makers have to engage in Making activities in the first place. James claims that there are no differences because the women who engage in Making do not do so because of environmental motivations, but because of their passion for IT and related activities. James identifies the motivation to

engage in Making activities with the activity's environmental impacts. Whereas this might be the case for some, by and large it has already been shown that despite there being no gender difference in environmental motivations to start Making, there are gender differences in how Makers appear to incorporate environmental concerns into their practice, despite these aspects not being a motivating factor. 88% of female survey participants claimed to consider environmental factors in their Making practice compared to only 59% of the male participants. Thus, initial motivation to engage in Making does not necessarily determine environmental considerations within the practice. James' argument, therefore, does not hold up to scrutiny.

If there were no differences between how female and male Makers engage with the environmental dimensions of their projects, the morphological model would look the same for both genders when adjusted for environmental aspects. It is, however, unlikely that a model that is already quite gendered in certain aspects, e.g. technology, would not be gendered in environmental aspects when the technology itself seemingly affects these aspects. The following section considers potential differences further and fleshes out morphological differences.

7.1.2 Arguments and evidence for gender differences

As previously mentioned, the only significant survey result was obtained when asking Makers if they consider concern for the environment in their Making practice. Women presented as significantly more inclined to this than men. Even though when inquiring about differences in i.e. material usage, waste generation and a project's general environmental impact, no significant gender differences were observed, women usually tended to give slightly more environmentally concerned answers than men. There appears to be a tendency among women to be more environmentally concerned within Making. The survey answers of in-depth interviewees more or less reflect the overall survey statistics in regard to whether someone considers the environment in their Making practice. Seven (88%) of the female participants and five (50%) male participants affirmed this question. One female participant (12%) and one male participant (10%) said they were unsure about this question and three men (30%) and no women stated that the environment did not play a role in their Making practice. One man did not answer the question. Albeit small in absolute numbers, the percentages provide a clear indication that female in-depth participants mirror the overall survey results and appear to consider the environment more in their Maker practice than male participants. The following section explores these statistical indications further within

the qualitative data. It explores the answers given by those in-depth interviewees who do see gender-differences in environmental concern and behaviour within Making. Three areas of difference were mentioned as influencing environmental concern and behaviours: language, old vs new materials and technology, and care and empathy. These are looked at in more detail in the following sections.

7.1.2.1 Language and approach

A few participants have noted that communicating Making through an environmental lens and through solving real-world problems is much more likely to attract women. Consulting relevant literature indicates that this might apply on a more general level. A few studies about gender-related environmental concern have already been introduced briefly in the literature review. Research on this specific question, namely whether there is a gender difference in environmental concern and, if so, why that is, has been inconsistent. Contested aspects relate to differences between concern and actual behaviour (Blocker& Eckberg, 1997; Zelezny et al., 2000) or to different levels of concern regarding local environmental issues (Blocker & Eckberg, 1989; Mohai, 1997). Despite these differences, most studies tend to agree that women, in general, exhibit higher levels of environmental concern (Blocker & Eckberg, 1997; Mohai, 1992; Blocker & Eckberg, 1989; Zelezny et al. 2000; Dietz et al., 2002; Xiao & McCright, 2017). The present study tends to support these latter findings. Female participants are more likely to be concerned about the natural environment and appear significantly more likely to include that concern in their practice, according to survey data.

Two earlier studies (Mohai, 1992; Blocker & Eckberg, 1997) make claims about the gendered relationship between environmental concern and behaviour. Mohai states that even though women appear to be more concerned about environmental issues, men are more likely to engage in activism[14] and pro-environmental behaviour. Scholars of environmental values Jean Blocker and Douglas Eckberg see a similar difference in environmental concern, but do not find a gender-related difference in behaviour. Neither of these results align with the data in the present study. As has been illuminated previously, women do not only seem more concerned about environmental issues, they also appear to engage more in pro-environmental Making activities than men, e.g. reusing of resources or leading

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[14] The author does not define what he means by activism but lists examples such as belonging to an environmental organisation, attending public meetings and signing petitions. It cannot be determined if he refers to activism that does not challenge current structures of society (activism) or that which wants to truly transgress the status quo (activism!) as has been defined in Chapter 5.

sustainability-oriented workshops. In fact, analysing in-depth interview participants' attitudes towards environmental Making supports the claim that women in Making are more likely to consider environmental impacts of their practice than men. Frank, Jack and James, for example, are least likely to focus on the environment in their practice. Frank considers himself generally environmentally concerned but not within his projects, Jack sees Making as understanding technology, not as a tool to actively engage with the environment, and James does not worry much about environmental impacts considering that all his projects are small-scale.

In contrast, the interviewees who are most likely to be concerned with the environment are women. Heidi and Klara would stop working on a project if they saw it as detrimental to the environment, Megan's goal is it to make people aware of the environmental impact of Making, and Rose wants to make people aware that everything we do has an environmental impact. Section 7.2 more closely analyses participants' environmental profiles. For now, it seems safe to say that female Makers appear to exhibit more pro-environmental behaviour than male Makers. This aligns well with two recent studies which state that women are also more likely to engage in pro-environmental behaviour (Hunter et al., 2004; Zelezny et al., 2000). Both have examined gender in relationship to environmental behaviour and concern across numerous countries and found evidence that, almost always, women exhibit stronger environmental behaviours than men. We will see further on in section 7.2 when devising environmental profiles for each in-depth interviewee that this also appears to be true for the women and men in this present study. If this is indeed the case, then making environmental concerns and related behaviour more of a focus in Making and Makerspaces might encourage more women to join in. In morphological terms, this means that letting environmental sustainability aspects have more impact on all the other concepts, i.e. technology or learning, might increase inclusiveness. Equally, it hints towards the women-inclusive morphology incorporating more environmental dynamics. These are explored further on.

7.1.2.2 Old vs new

When talking about women being more environmentally friendly, authors often mention reuse and recycling as examples of these activities (Hunter et al., 2004; Blocker & Eckberg, 1997). Some Makers have equally said that female Makers are more likely to engage in reusing technology and recycling old materials. Heidi compared her own practice with that of her husband's and described how "if something goes wrong, he just starts from scratch

with new materials. He throws the old thing out and starts afresh" whereas she approaches things differently. She reuses and recycles with the motivation that "we only have this one environment, what do we leave behind?" Her husband and "the other boys" do not think like that, according to her. Jack in his role as part of the organisational team of his Makerspace has similarly observed that men appear to be more interested in building new things, whereas "women are a bit more interested in the stuff that already exists, so how do we work with some of that." Whether this observation applies to all forms of technology or just digital objects needs to be explored separately. There might be differences here between modern technology and textiles, for examples.

The authors who have found women to show more pro-environmental behaviour name recycling and reuse as examples, thus supporting Heidi's and Karl's assertions. Mohai (1997) identifies five areas of environmental concern and tests their gender dimensions. He finds that women generally appear more concerned than men, including in the category of resource conservation which can be closely linked to an increased need to recycle and reuse. Hunter et al. (2004) attribute a greener private life to women and mention recycling as an example for this. Lisa's comment about women having to make more environmentally concerned decisions in everyday life through groceries shopping fits in well with this finding. Even though the behaviour mentioned here, namely recycling, is meant in a way that refers to recycling waste when throwing it away, this can be related to reuse and recycling within Making activities whereby waste or pre-used items are repurposed for further projects. The intention is the same as when recycling waste at home except that materials are not diverted to waste management companies but remain with the Maker themselves. This appears to slightly contrast what was found earlier, namely that men might be more likely to repair a (digital) item. One could claim that men are more likely to repair whereas women are more likely to reuse materials from items that can no longer be repaired. It could also be said that women are less confident in doing mechanical, electric and digital repairs, but once they increase that confidence, they might be more inclined to engage in these repairs. Equally, considering the overall research question, it might be said that including more women into Makerspaces in the UK, Germany and Austria would potentially strengthen a focus on reuse, and increasing the focus on reuse might encourage more women to join. It is, thus, likely to improve Makerspaces' environmental impacts if more women were to join the activities and learn more about digital technologies. This finding shapes the way activism is understood in the more women-inclusive morphology. Whereas men might be less likely to reuse old materials for recycling purposes, women seem more prone to doing so and, thus, be preventing more waste.

Section 6.2.2 has shown that women's identity is socially constructed as being more connected to traditional technology. None of the in-depth interview participants have said directly that women are more environmentally friendly due to using digital technologies less, but many of them have claimed that modern and digital technologies can be very harmful for the environment. Considering that these technologies are constructed as more closely linked to men, it can be inferred that people who use these technologies less, in this case women, will act in ways that are less environmentally harmful. Eight interviewees point specifically to the negative effects of digital Making technology:

> We also have 3D-printers, which encourage people to print little plastic, throw-in [*sic*] knick-knacks. […] It's not going to be like, 'Oh, yes. Just give people laser cutters and then they'll be sustainable.' Give them 3D printers and laser cutters and they'll 3D print and laser random plastic crap (Jack).

> I guess in that particular environment I was already painfully aware that the whole thing wasn't particularly environmentally-friendly. Even just like 3D printing, some plastics are better than others (Ryan).

> I love tech but it's just not the most environmentally friendly that you can engage with. I love making too much. […] But especially in tech-Making, lots of things are just not great (Anna).

> 3D printing is an incredibly inefficient way of making things (James).

> Environmental aspects are not the focus. The focus are high-tech aspects (Hans).

> The technology we're using nowadays is just not very good for the environment. If you think short-term (Lisa).

> You have to find compromises. […] For example with 3D-printing, […] I'm not sure it's good with all the fumes that develop. […] Or with laser-cutters. You just vaporise the plastic and it smells strongly burned. If that's so good, I don't know. I prefer my hand saw. Still, I don't want to condemn laser-cutters, but you should consider what you do (Moritz).

> I like using them [modern technologies] but only if they serve a good purpose. You could also say 'Ok there's now a new technology that lets me dig further and deeper for my water but do I really want to do that? Does it harm the environment?' So I'm only interested in new technology that actually fits what I'm doing appropriately (Klara).

Jack, Ryan, Anna and James state, without reservations, that digital technologies are not very environmentally friendly. They specifically point towards 3D-printing. Hans, albeit not directly saying that digital technology is environmentally harmful, nevertheless creates a

contrast between the two aspects when saying that Making is about high-tech and not environmental concerns. Lisa, Moritz and Klara do not per se judge modern technologies as environmentally harmful; they all add qualifying information. Lisa seems to imply that, in the short term, they can be considered harmful, but when considering long-term effects, they might be helpful, e.g. avoiding transport of items. Moritz along similar lines does not condemn these tools from the off, but still prefers his analogue counterparts and emphasises that a Maker should compromise and be aware of the negative impacts their practice could have. Lastly, Klara argues along similar lines when stating she does not use new technologies just for the sake of it, but only when they help her make something for an appropriate purpose. In her case, that will always be an environmentally friendly purpose as she has stated previously.

Of course, none of these opinions actually prove that digital technologies are more environmentally harmful than more traditional technologies. Nevertheless, it appears some Makers perceive them that way. Some authors have considered and compared environmental impacts of digital fabrication compared to traditional fabrication. Sustainable design scholar Jeremy Faludi and his colleagues (2015), for example, have identified that a lot depends on how often a machine is used and how much material waste it produces. 3D-printing, for example, requires a lot of energy, but does not produce a lot of material waste. Dynamic systems scholar Samuel Huang and his team (2013, p.1196) confirm that "once the entire operating procedure is considered, AM [additive manufacturing] might not have an edge over traditional manufacturing processes in terms of energy consumption." Others are more critical and state that "Contrary to the hype, 3-D printing is not an environmental panacea" (Olson, 2013) and that

> this consumer-driven digital maker revolution is just as unsustainable as the digital fabrication revolution in large factories. We've been able to produce everything locally for decades using hand-controlled machine tools. Digital tools only allow us to produce more and faster. And this happens, just as in industry, at the expense of higher energy consumption (Decker, 2014, online).

As shown earlier, Peeters et al. (2019) have identified 22 barriers for recycling of 3D printing waste, ranging from financial to social reasons. Even though this study cannot attempt to find a definitive answer to this question, it is clear that there are issues with the sustainability and perceived advantages of digital fabrication technologies. For the purpose of this study, it is assumed that our participants have a point here as they talk from experience and that there are inherently difficult environmental impacts to 3D-printing and laser-cutting as perceived by participants, e.g. high energy usage.

Again, the developed morphology helps to understand then how these effects are inherent within Making in the researched context as a strong focus on digital technologies increases the risk of more environmentally harmful Making impacts. Equally, Chapter 6 has hinted at men being more inclined to sell digital Maker products and become entrepreneurs which is likely to not make them reuse and recycle old materials but create with new materials. Digital technologies are very important to Makers in Makerspaces in the UK, Germany and Austria. They do not only stereotypically attract a more male-skewed membership but are also inherently less environmentally friendly than more traditionally considered tools and activities. The more inclusive Makerspace morphology is, then, more environmentally friendly as it does not include a strong focus on digital technologies. Therefore, men are indirectly linked to being less environmentally friendly in their Making practice. Of course, some women use these technologies too as we have seen, i.e. Anna and Lisa. But the majority appear to be men and opening up Making to a stronger focus on traditional technologies might not only increase female participation but also decrease negative environmental impacts.

7.1.2.3 Care and Empathy – Participants' explanations for differences

Whereas the two previous sections have considered gender differences in environmental concern and behaviour, this section looks specifically at why these gender differences might exist. The data chapter has already presented the main reasons for why some of the in-depth interviewees deem women more environmentally concerned than men. Karl and Ryan were supporting ideas around care and empathy. Both attribute this to evolutionary/biological reasons. Karl finds mothers in particular more caring and empathetic than the average population. Ryan believes that even before humans existed, female apes already had to be on their guard for testosterone guided aggressive males which made the former more empathetic and careful. He feels that women and men today are both still guided by those hormones which make women more caring and concerned for the environment and our surroundings. Heidi, in contrast, reasons that education and upbringing will be more fruitful in explaining differences in environmental concern: "The way we are raised might have to do with how we care for the environment." The nature-nurture debate that surfaces here cannot be answered by this study. However, different authors and interviewees' views shall be surveyed to explore these positions by Makers and their potential impact on their Maker practice.

Most studies on gender and environmental concern support the view that education and socialisation are decisive in determining women's and men's care for the environment. Xiao and McCright (2017, p.182) consider reasons for gender difference in environmental concern and conclude that this is likely caused by different socialisation, not social roles. Social roles include parenthood, employment or home-maker status. This would disprove Karl's theory about mothers being especially empathetic and caring and, thus, considering the environment more. However, the strongest indicator for environmental concern in women, as defined by Xiao and McCright, is "largely mediated by generalized risk perception" (p.181). In that regard, Karl's statement about his wife caring more for environmental issues since having had children seems more applicable as she might experience higher levels of worry about risks that can stem from environmental issues. Heidi, who is also a woman in a maternal role, continuously asks herself "what do we leave behind?" in terms of environmental problems and speculates that women might think more about the future than men. There is no direct connection here between a perceived risk for her children from environmental damage, but indirectly this worry can be implied from her constant striving to leave behind a better world. The focus on nurture-arguments, especially by men, might be used as an excuse to not act more environmentally concerned. If environmental concern is believed to be a biological trait dominant in women, then men might not feel the need to engage in related activities. It is difficult to analyse whether this belief is common in Making, but it is noted as a potential consequence of this underlying view.

Other authors, similarly, attribute higher levels of environmental concern to certain products of socialisation. They attribute specific values as increasing concern. In the process of socialisation, what a person internalises depends on their cultural surroundings, education, interactions with others and other aspects. Thus, socialisation can be seen as the process whereby a person constructs their own reality as a result of all those influences. Scholar of personality, motivation, and decision-making Jacob Hirsh (2010, p.246), in his study of 2690 Germans, considers personality and environmental concern and states: "greater environmental concern was significantly associated with higher levels of Agreeableness, Openness, Neuroticism, and Conscientiousness." Recalling Risse et al.'s (2018) study (covered in 6.2.4.1) reminds how some of these values have a gendered nature, such as agreeableness which was much stronger connected to women than to men. Hirsh notes that in line with previous studies, his study found women showing more environmental concern than men. We remember female Makers being described as more hesitant and more agreeable than male Makers. This raises the question whether environmental concern is considered a feminine value, and therefore fits more neatly in the more women-inclusive

morphology, whereas it is less associated with masculinity. Zelezny et al. (2000, p.454) found that femininity was positively correlated with environmental attitudes and masculinity negatively associated. Makerspaces have been defined as masculine spaces and according to the just mentioned study could therefore generally be seen as less environmentally concerned. This would heavily influence the developed morphology. As the previous chapter has shown, the current morphology of the examined Makerspaces is very much shaped by masculine values and a masculine culture. Thus, a much more feminine culture, in fact the more women-inclusive morphology, would have to be instilled not only to open up participation but also to ensure a more environmentally friendly Maker practice. This connection of masculinity/femininity and environmental concern is taken up again further on.

Researcher of human ecology and cultural evolution Thomas Dietz and his colleagues (2002) also engage in examining values, gender and environmentalism and find that altruism is the basis for gender differences in environmentalism with women expressing significantly higher levels of it than men. Men and their traditional roles, in contrast,

> emphasize engagement in the market and in activities such as sports that require cooperation only with a limited "in-group" and competition with all others. As a result of these stereotypical roles, women's value of socialisation and life experience places more emphasis on altruism than does men's (p.361).

This mirrors well what has been established in Chapter 6. Men exhibit higher levels of competitiveness and in-group behaviour than women in Making. The authors conclude that "The same theoretical arguments that posit women as more altruistic than men suggest that minorities may also face socialization and life experiences that encourage altruism" (p.362). This argument would lead towards a slightly different conceptualisation: gender is only indirectly influential in determining environmental concern, it might have more to do with a minority status and level of privilege.

This is where Social Dominance Theory (SDT) can assist in getting a better picture. SDT is based on the belief that "all human societies tend to be structured as systems of *group-based social hierarchies*" (Sidanius & Pratto, 2001, p.31) whereby the dominant group(s) possess a disproportionately large share of positive social values and the subordinate groups possess a disproportionately large share of negative social value (p.31f). As already stated in Chapter 6, oppressed groups might internalise negative stereotypes and see themselves according to those stereotypes. The authors state that age- and gender-based hierarchies tend to exist in all social systems, and that other arbitrary hierarchies (e.g. nationality, income) are likely to

emerge within social systems which produce a sustainable economic surplus (p.38). Those hierarchies are the basis for most forms of group conflict, e.g. racism or sexism (p.56). Within research on environmental concern and values, SDT appears to explain women's higher levels of environmental concern due to their less privileged status in society. Kalof et al. (2002) examine race, gender and environmentalism and find that of white men and women, black men and women, and Hispanic men and women the only group that exhibits less environmental concern than all the others is that of white men. They reason

> that the key variable associated with environmentalism and altruism may be membership in the most advantaged social structural or cultural group in the society, rather than race or gender per se. These anomalous attitudes of White men are likely the result of their historically privileged position regarding risk and power in society (p.124).

According to their findings, women are more altruistic because of their less privileged position in society. This less privileged position in regard to Making and participating in Makerspaces has been demonstrated in Chapter 6 and would add to the understanding that the masculine culture in Makerspaces is likely less governed by environmental concerns. It also points once more towards the fact that the European and North American Maker phenomenon and Makerspace culture are inherently masculine and patriarchal. Milfont and Sibley (2016) report similar findings. The more someone endorses social hierarchies, the less likely they are empathetic and, thus, less likely concerned about environmental issues:

> Part of the reason why women endorse more environmental values is because women tend to have *higher* levels of empathy and *lower* levels of social dominance orientation, whereas men value the environment less partly because they tend to have *lower* empathy and *higher* social dominance orientation (p.86).

The connection with SDT very much underlines and emphasises the underlying philosophy of this study. As pointed out previously, gender roles and hierarchies are viewed as socially constructed and learned via the process of socialisation and beyond. In combination with SDT we find that the hierarchies mentioned here are, indeed, also socially constructed. As seen previously, Kalof et al. (2002), for example, base part of white men's privileged position in society on their "historically privileged position", thus that position is socially constructed (not biologically given) and inherited from the past. Milfont and Sibley (2016) add the dimensions of values to this social construction and explain how those gendered values impact environmental concern and behaviour. Social constructivism, thus, helps us again in locating and understanding the issues of the study at hand: not only gender and

technology, but also concern for the environment and connected behaviour are socially constructed. In addition to Freeden's morphological model, we come to understand that these different aspects not only contest each other but construct each other in complex ways that are deeply intertwined. These connections in our specific case help supply an explanation for why women might appear to be more environmentally concerned and display more environmentally friendly behaviour.

These studies and their findings would suggest that establishing a more feminine inclusive culture and feminine values within Making and Makerspaces specifically could increase positive environmental behaviour as it would likely foster a more empathetic community. However, as long as women are socially dominated, this is unlikely to happen. Again, a stark difference between the more male- and more female-inclusive Makerspace morphology becomes apparent. The community and activism concept within the more women-inclusive morphology, specifically, might exhibit much more altruistic and empathetic dynamics than those in the masculine model. These dynamics are likely to affect environmental behaviours.

Whilst there is evidence to support the view that female Makers have a greater tendency to be environmentally concerned, a clear answer within the study's collected data has not been reached. Makers have differing views on the question and neither survey data nor in-depth interviewees opinions on the issue provide a clear and significant answer. While conducting data collection, it has been noted by the researcher that the actual behaviour of interviewed Makers appeared to provide a less unclear picture. In order to avoid researcher bias and conclusions that the researcher herself constructs as suitable in her own worldview but might differ from actual data, this initial impression has not been taken at face value, but investigated in a more structural and scientific way: to explore whether this observation was fuelled by bias or, indeed, something that presents outside the researcher's worldview, environmental profiles have been established for each participant and then compared with each other on the basis of gender.

7.2   Environmental Profile Analysis

This section will now examine the evidence of participants' environmental attitudes and practices themselves and devise environmental profiles. Quantitative data has only provided us with one significant finding whereas qualitative data so far has shown that in-depth interviewees support differing attitudes as to whether women consider the environment more in their Making practice, with a slight tendency leaning towards affirming this statement.

In order to get more insights, then, the study now continues to combine the available data. Specifically, data consolidation is employed whereby qualitative and quantitative data are combined to create new variables and a new aggregate data set. This set is created based on participants' statements on their own environmental concern and how this reflects in their practice. Whereas in previous sections, participants have been asked directly whether they see gender difference within environmental concern and behaviour, this data set now looks at participants' own behaviours and environmental concerns and compares these to each other based on gender. To some extent, this approach can be seen as testing a hypothesis ("Women are more environmentally concerned within their Making practice than men") which might be seen as contradicting the overall inductive approach of this study. However, the hypothesis is tested not only based on quantitative but also rich qualitative data which is more often used for inductive approaches and even though we will receive an answer, it is a complex one that will vary according to different settings and Making constellations. As Giddings and Grant have stated (2007, p.57), mixing paradigms is acceptable as long as one paradigm is used in service of the other. This is the case here.

As described in section 3.3.2.3 of the Methodology chapter, the environmental profiles created for this purpose have been devised in a systemised way through considering a Maker's survey answers and their in-depth interview. Each participant has received a final score between 0.5 and 10 with 10 being displaying the highest concern for the environment. Figure 7-2 provides the scores of each interviewee. We can see that Felix and Hans scored lowest with 0.5 and 2.5 respectively. Heidi and Klara, in contrast, reached the highest scores with 9 and 10 points. It is no surprise that Klara reached a full 10 points. She is part of a Makerspace that evolves around environmental issues and considers environmental impacts in everything it does, from buying dish washing soap to the long-term effects of their projects. The illustration shows a clear tendency for the interviewed women to be more environmentally concerned than their male counterparts. Even though not all adhere to the tendency, it is nevertheless clearly present. The colours (men = green, women = orange, non-binary = purple) give a clear indication that the women in this particular sample appear more environmentally concerned and act more on that concern than the male Makers. In what follows, the different quantitative and qualitative categories, which were devised to create these profiles, are examined further in order to highlight where differences are and why women score higher in their environmental profiles.
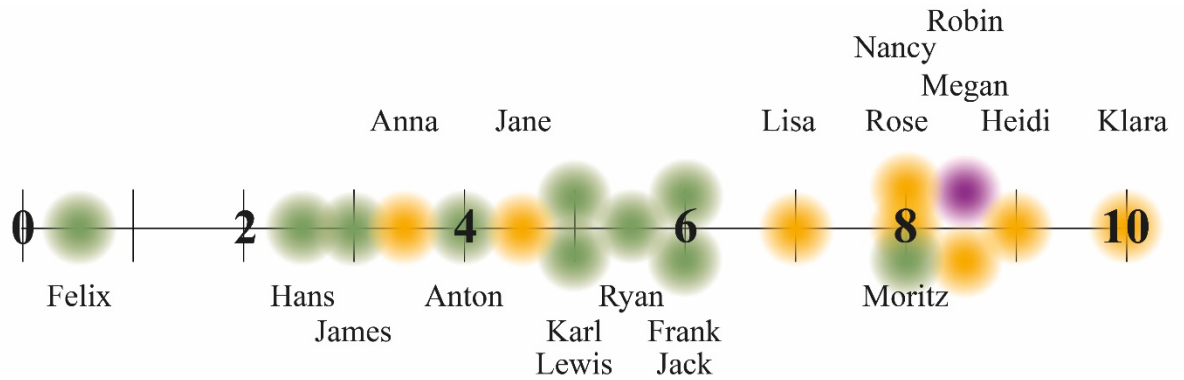
Figure 7-2 Environmental Profiles.

7.2.1 Quantitative categories

The quantitative categories in the profile analysis were taken from the survey and included a participant's answers to whether they consider themselves an environmentally concerned person, if they consider the environment in their Making practice, and their answers to the environmental statements as seen in Table 7-1. Both, the results for considering oneself an environmentally concerned person and for including that concern in one's Maker practice, are discussed in section 7.2.2.1 and 7.2.2.2 together with the related qualitative data. The remaining three quantitative categories are looked at more closely here. Table 7-2 shows each interviewee's Likert scale average for statements regarding the overall environmental impact of their projects, materials they use and waste that is produced in the process of Making. Every value over 3.0 (neutral) has been interpreted as environmentally friendly and, thus, increased a participant's environmental score.

	Overall score	Survey: project	Survey: material	Survey: waste
Felix	0.5	2.5	2	3
Hans	2.5	4	3	3.5
James	3	3	3	3
Anna	3.5	4.5	2.5	2
Anton	4	4	4	4
Jane	4.5	2.5	3	3
Lewis	5	4	4	2
Karl	5	4	3	5
Ryan	5.5	4	4.5	3.5
Frank	6	4.5	2.5	4.5
Jack	6	3.5	4.5	3
Lisa	7	3.5	3.5	3.5
Nancy	8	3.5	4.5	4
Rose	8	4	3	4.5
Moritz	8	4.5	4	4.5
Megan	8.5	4.5	5	4
Robin	8.5	4	4	4
Heidi	9	3.5	3.5	4
Klara	10	5	5	5

Table 7-2 In-Depth Interviewees: survey answers to environmental statements 1 (bright green shade = pro-environmental value).

At first glance, it is easy to see that the higher the Likert scale averages are, the higher the general environmental score of a participant. Almost everyone has a relatively environmentally friendly approach when it comes to an overall project. Noticeable, however, is that the numbers between participants do not vary much. Material considerations appear least important to interviewed Makers with only 11 taking an environmentally friendly approach. In terms of waste, 13 provide pro-environmental answers. A reason for the fact that numbers do not vary a lot between participants is likely the limited amount of answer possibilities and that the numbers presented here are only derived from the mean of two Likert scale answers.

An approach that provides a little bit more nuance is taking the three mean values of each participant and deriving their mean, as seen in Table 7-3. The last column shows the derived means from lowest to highest which provides a more nuanced picture, albeit still not hugely detailed. Nevertheless, we can observe that the overall scores have been mixed up and results are not as clear-cut anymore. Even though most of the five most environmental participants are still three women and one non-binary participant, the remaining Makers have been mixed up more considerably and an equal number of women and men can be considered environmentally friendly within their Making practice according to the assumption that

every score above 3.0 is to be interpreted as pro-environmental. For now, these quantitative findings shall be left and are returned to in the discussion of this dissertation.

	Overall score	Survey: project	Survey: material	Survey: waste	Survey: mean
Felix	0.5	2.5	2	3	2.5
Jane	4.5	2.5	3	3	2.83
James	3	3	3	3	3
Anna	3.5	4.5	2.5	2	3
Lewis	5	4	4	2	3.33
Hans	2.5	4	3	3.5	3.5
Lisa	7	3.5	3.5	3.5	3.5
Jack	6	3.5	4.5	3	3.66
Heidi	9	3.5	3.5	4	3.66
Frank	6	4.5	2.5	4.5	3.83
Rose	8	4	3	4.5	3.83
Anton	4	4	4	4	4
Karl	5	4	3	5	4
Ryan	5.5	4	4.5	3.5	4
Nancy	8	3.5	4.5	4	4
Robin	8.5	4	4	4	4
Moritz	8	4.5	4	4.5	4.33
Megan	8.5	4.5	5	4	4.5
Klara	10	5	5	5	5

Table 7-3 In-Depth Interviewees: survey answers to environmental statements 2, including mean (bright green shade = pro-environmental value).

7.2.2   Qualitative categories

This section examines qualitative environmental behaviour and concern categories further. The categories are: general environmental attitude, environmental attitude in Making and its priority, awareness spreading, and repair. The section concludes that in all five categories women display modestly to significantly higher environmental concern/behaviour than men. It shows that a green lifestyle, attitude spreading, and repair appear to be particularly crucial elements.

7.2.2.1 General Environmental Attitude

Qualitative as well as quantitative data hints towards men being slightly less concerned with environmental issues than women. Seven female and the one non-binary participant consider themselves environmental persons with just one woman not being sure about this aspect. Among the men, six regard themselves as environmentally concerned with four not being quite so sure and/or leaving the answer to this question empty. Qualitatively speaking, this

slight tendency shows in the interviews. Four men do not show significant signs of being environmentally concerned, for example Felix who describes individual pro-environmental action as similar to the selling of indulgences by the catholic church in medieval times. In reality, he believes, it is the state's responsibility to act. No women show attitudes similar to this. The least environmentally concerned here seems to be Jane who does not "feel that strongly about the environment because I think the environment is much stronger […] It's us…it's our ability to live in that world that is under threat." She goes on to describe a quite environmentally friendly lifestyle in which she avoids the needless buying of products, aims to share tools and food, and incorporates a thriftiness to make use of everything, including waste and scrap materials.

The environmentally friendly behaviour described by Jane, in fact, describes the women's environmental behaviour quite well in general. More than half of them talk about their environmentally friendly lifestyles. Lisa, for example, states that she considers the environment in almost everything she does, for example transport and energy supply choices. Megan hates waste and avoids it at all costs because "It feels like everyone's asleep and not realizing the stress the planet is in." To Heidi, it is natural to live resource-efficient because those are finite. "I don't have to think about it, it generally plays into everything I do." The reasons the women give for their behaviour are, as we just saw, a concern for the survival of the species, limited resources and a general concern for the planet: "We all live on one planet and if someone can't be arsed what happens to that, then that's reckless" (Lisa).

Male interviewees are not as passionate about an environmentally friendly lifestyle. We have already heard from Felix who does not see the responsibility lying with individuals. Ryan who also does not consider the environmental impact of his lifestyle justifies this with his main job already concerning itself with environmental aspects, so he does not have to worry about this in his private life. Lewis acknowledges environmental issues but also justifies mistakes of the past with the advancement and progress they have brought to humanity. James considers himself an environmental person and states as an example that he and his community all voted for the Green Party in the last election.

Just as the literature discussed in previous paragraphs suggests, it seems as though the women in this study consider environmental lifestyle choices much more than the men who seem to focus more on political and economic aspects. This could merely mean that both genders are equally concerned but show this concern in different ways. Nevertheless, none of the men speak as passionately about protecting the environment as most of the women do

and together with the tendency within the quantitative data women appear to be slightly more environmentally concerned than men.

7.2.2.2 Environmental Making and its Priority

This section covers two profile analysis categories: if and how someone includes environmental concern in their practice, and which priority these concerns have. Not just in the overall survey, but also within the small group of in-depth interview participants women seem to consider environmental aspects in their Maker practice much more than men. Again, seven women and one non-binary Maker consider the environment, only one woman opts out of answering this question. On the men's side, five affirm to considering environmental aspects in their practice, three negate this and two do not answer the question. As with considering themselves environmentally concerned persons, the numbers might not be strongly significant, but there is a clear tendency. This tendency is also clear in the qualitative data interviewees provide.

Firstly, the only two participants who make environmental concerns a priority in their practice are women. Both Klara and Heidi agree that they would not make a project if there were negative environmental impacts: Klara considers everything – energy source, materials, impact on animals if it is an outdoor project, etc. Heidi says that, at the end of the day, the long-term environmental impact needs to be positive, otherwise she would not support a project. Other Makers, as previously seen, list a variety of reasons why the environment cannot always be their number one priority. Learning effects (Lisa, Nancy, Rose, Robin, James) and finances (Lisa, Rose, Robin, James) are mentioned often. The latter aspect is, for some, connected to sustainable materials being more expensive than non-sustainable materials. Equally mentioned as important to consider are creativity (Lisa, Megan) and the potential for positive social impacts (Megan, Robin).

A theme that comes up for a few women is that of reuse. Jane, Anna, Nancy and Rose all talk about reusing scrap and waste materials in their practice in order to minimise wastage. Nancy, for example, does not find that prototyping is a very environmentally negative activity if old and recycled materials are used, as she does. Many of them, nevertheless, point out that waste cannot always be avoided and sometimes the long-term effects of a project (environmental, social, etc.) are more important than the immediate negative environmental effects of the Making process. This is considered more in the next section. Other areas of environmental Making include using sustainable materials even if they are less suitable than

non-sustainable ones (Heidi) and empowering others to make more environmentally friendly decisions (Robin). Klara is the only one mentioning projects that, in themselves, have the goal of being environmentally friendly, i.e. coding an app that can help companion-planting in the spaces' permaculture garden. More critical voices evolve around digital technology being quite environmentally harmful and Making processes often being quite wasteful (Anna) and other aspects potentially being more important (Jane, Lisa, Megan, Robin).

A similar variety of aspects comes up for men. Repair is mentioned a few times (Anton, Frank, Karl). Frank, for example, views repair as the only environmental aspect of Making, he does not "see other possibilities to be more environmentally friendly." He continues to state that personally the environment is important to him but not in his projects. Karl is another Maker who repairs and does not like throwing things away. However, there is a critical voice as well: Lewis says that repair and recycling are "not the be all and end all". He finds local production of items that are closely suited to someone's needs more important as this will avoid transport of items and make sure the owner of the item keeps and maintains it longer. James agrees when stating that Making things maintainable is more important than Making them with sustainable materials. He is, nevertheless, one of the men who do not appear to care much about environmental effects in their practice. He acknowledges negative environmental impacts but does not see a need to change: "there's a lot of waste, for example. I feel a bit bad about that, but what can you do?" He explains that he is only making small quantities of items, so their impact is not that bad. Hans agrees with this latter position. This position, in fact, surfaces regularly and reminds of discussions around gender inclusiveness where some male participants either did not see a gender issue and/or pointed out that they cannot help women integrate if women do not attend Makerspaces in the first place. Tanczer (2016, p.1603) has termed this *Male Oblivious Discourse* in which men construct gender issues as non-existent. Similarly here, one could speak of an "Environmental Oblivious Discourse" in which environmental issues are made to not exist due to the small scale of the activity. This might also apply to Ryan for whom environmental issues are not relevant during his Maker practice due to considering them at work already.

A few other aspects are mentioned as being considered together with environmental ones: finances come up a few times (Hans, Anton, Jack), cultural and social aspects (Jack) and Making being about learning about digital technology, not protecting the environment (Hans). We have encountered this last aspect in previous paragraphs and, here again, find the apparent opposition of digital technology to pro-environmental impact. Ryan indicates that he does not approve of people 3D-printing items if better environmentally friendly

alternatives are at hand, thus supporting the opposition of digital technology with environmentally friendly behaviour. Anton appears to state something similar when saying that Making something new is as bad for the environment as buying something new, and that only repair will have positive environmental impacts. Two men talk about Making projects that have the purpose of being environmentally friendly: Karl has automated the use of light in his house because his children always forgot to turn it off, and Moritz recounts a long history with solar projects and bee keeping.

Female participants in this category acknowledge and act on environmental concerns more in their Maker practice than men. Whereas the former care more for reusing materials and making use of waste products, the latter do not appear to engage much in these processes. Men appear more doubtful that including environmental aspects in their practice will have a positive impact, or maybe they do not wish to concern themselves with something that could potentially complicate their practice and make it less enjoyable. When recalling Millard et al. (2018, p.19f) who identified an overall lack of ambition in considering the environment in the movement and attributed this to the dominance of "the latest gadgets, technical prowess and playful experimentation which are of strategic importance for innovation" (p.27), one can suspect that they are, knowingly or unknowingly, mainly referring to male Makers with this assessment. Of course, at the moment with the gender balance being as it is, it does not make much of a difference if they acknowledge this gender bias in their data or not. But from what women in this study have said and shown compared to men, it now seems as though the latest gadgets, technical prowess and playful experimentation might be strongly linked to men and their experience of Making, not necessarily that of women. The morphological masculine Makerspace model reflects this clearly with digital technology and entrepreneurship being more important than environmental aspects. Yet again, the morphological analysis is thus able to identify different conceptual structures within Makerspaces.

7.2.2.3 Attitude spreading

The category in which women are by far more active in terms of environmental behaviour is that of spreading pro-environmental attitudes and helping others to minimise their environmental Making footprint. Three women and the one non-binary participant engage actively in delivering workshops that address sustainable Making practices and providing support and knowledge to spaces that are newly setting up in how to be environmentally sustainable. All four women make their living with this. While Nancy and Rose are

providing a variety of Making workshops that encourage environmentally friendly practices, Megan and Robin are earning their living by helping spaces set up and be environmentally friendly and inclusive. In morphological terms, this implies a connection not only between gender and environmental protection, but also with learning and community. Learning and sharing knowledge are both very important to Makers. But maybe there is a difference in how women and men engage in these processes with men potentially sharing (environmental) knowledge more on a one-to-one basis within their bonding communities and women being more inclined to draw in a larger amount of people beyond the boundaries of bonding communities. Dietz et al.'s (2002) study springs to mind which connects higher environmental concern to levels of altruism. This higher level of altruism could be a reason why women are more inclined to engage with others. We are also reminded again of women taking up more interpersonal and purpose-oriented roles than men who are more likely to focus on technological aspects, as shown in section 6.2.4.3.

Among the men, three talk about similar, albeit less impactful things. Jack, who does not consider himself to be very environmentally friendly in his practice, does state that he connects people in his space who share an interest in environmental Making and, thus, strengthens environmental Making. Frank talks about being part of a Repair Café and Moritz delivers workshops although not necessarily with an environmental dimension. Nevertheless, he is the most pro-environmental Maker among the male participants, so it could be assumed that he carries his environmental practice into his workshops. Frank and Moritz are, thus, the only two male Makers who expand their learning and sharing of environmental knowledge outwith a bonding community. A side note: in general, many Makerspaces provide public workshops and due to the heavily skewed gender-balance towards men it must be assumed that they organise a lot of these workshops. This dissertation looks specifically at such activities that are especially environmentally concerned. In this regard, women appear to be much more engaged, especially if considering the ratios within each gender of people delivering these services.

This, in fact, aligns well with the only piece of literature that has been found on the connection between women, Making and the environment, namely Millard et al.'s (2018, p.23) finding that

> Overall, females have a higher focus on social and educational issues, on openness and sharing, skills and quality of life, whilst males focus more on technology, industry/economy innovation and changing regulations, norms, etc. […] In the environmental sustainability impact context, females are […]

more successful than males in relation to sustainable consumption and the circular economy. However, females are marginally less successful than males in terms of decreased pollution, the latter perhaps being a more technically specialist issue.

Although not all of these aspects have been considered under a gender-lens in the present study, a few similarities can be seen. Female interviewees do indeed show a higher focus on social and educational issues. They are more engaged in connecting with others and encouraging environmental and social practices. Equally, we have witnessed one man attributing the responsibility for tackling environmental issues to the domain of the government (Felix) and it also appears that men seem to be slightly more focused on the technology and economical aspects. Even though the latter has not been examined here particularly, no female participant stated anything along the lines of wanting to make a living through selling products, but some of the men did (Jack, James). Millard et al. do not actually define their categories of "sustainable consumption" and "circular economy" but state earlier on that they are "related to […] material re-use and high resource use efficiency of makers" (p.20). They find that women are more successful in these areas which also aligns with the findings of the study at hand. Female Makers mention reuse and recycling more than men. Millard et al. find that a decrease in greenhouse gas emissions and of other types of pollution and an improved biodiversity are "only marginally positive" (p.22). They find a gender difference in decreasing pollution stating that men seem slightly more successful in this area. However, women appear to have the bigger overall positive environmental impact considering that pollution is only marginally considered within Making in general. Of course, with such a small sample no generalising conclusions can be drawn, but as before it appears as though women are not only more environmentally concerned and let that concern impact their Maker practice, they also appear to be more engaged in spreading those practices and encouraging others to follow suit.

7.2.2.4 Repair

Most Makers consider repair as an essential aspect of environmentally concerned Making. Recalling sections further up, when it comes to repair, literature suggests men might be slightly more inclined to repair than women, partly due to men's socially constructed association with DIY and repair work in the home and partly due to their stronger affiliation with digital technology within Making. Makers of the present study have connected this increased willingness to repair among men with their heightened levels of confidence in this area and with digital technology in general. However, the picture is actually not as clear cut when considering the activities of in-depth interviewees of this study. Five women and three

men mention the importance of repair. Two further women, the non-binary participant and two further men are likely to do repairs (as per educated guess) which makes almost all women of this study likely to repair whereas only half of the men engage in this activity. It is, thus, worth considering how women who have found their way into Making have developed their confidence and if they have potentially overcome hesitations to repair. Section 6.2.4.1 has already noted that it appears as though women require quite a lot of confidence to become part of a Makerspace and that those in this study who are part of such a space appear very confident and have obviously managed to make their way in the Maker world. They are, therefore, also more likely to possess the confidence to repair digital technologies, just like their male counterparts.

The kinds of items that are repaired were not discussed with participants. Therefore, the available data is not conclusive in terms of what kind of items interviewees repair or what exactly they include in repair work. For example, in previous sections the gender difference in regard to what kind of items are repaired, i.e. textiles or electronics, has been mentioned. Participants have not mentioned specifically which things they feel comfortable to repair and which they do not. Therefore, it is difficult to tell if and what potential differences exist. Nevertheless, the tendency for women to mention repair more suggests that, once part of the movement, they engage as much with it as men, if not more.

7.3   Conclusion

This chapter has shown different dimensions of how gender and environmental concern and behaviour are connected within Makerspaces. When asked, participants have different opinions on whether there are differences between genders. Negating a connection came with reasons of education and culture being more decisive than gender when it comes to influencing a person's environmental concern and behaviour. This chapter has argued, though, that these two aspects come with their own gender-biases. When affirming the connection, Makers were not always sure how these alleged differences manifest and where they come from. Environmental projects were said to attract more women into Making. Women were said to engage more with older objects instead of new ones and they were also more likely to use traditional technologies, compared to digital ones which are often seen as not very environmentally friendly. As reasons for these differences, some mentioned socialisation, some evolution whereby the employed literature provided support for socialisation and, specifically, embedded this in Social Dominance Theory.

Providing an overview of the individually contrasting statements given by in-depth interview participants about potential gender differences in environmental concern and behaviour, environmental profiles were created which directly considered individual participants' Maker practice and environmental concern/behaviour within that. This mixed methods approach has provided a clearer picture and provided evidence that many Maker women tend to be more inclined to act pro-environmentally. In almost all ten categories devised for the environmental profiles women appeared to act more environmentally friendly than their male counterparts. Their general attitude towards the environment was more pronounced and more engrained in their everyday lives. They seem to prioritise environmental concerns higher in their practice and engage in much more outreach and awareness raising work. Even in repair, an area traditionally associated with men, did they seem more enthusiastic than the men who were interviewed. The strong focus on digital technologies paired with entrepreneurship describes an inherently gender-biased patriarchal system which neglects environmental impacts – *Environmental Oblivious Discourse* – and gender issues – *Male Oblivious Discourse*. The more inclusive morphology as developed at the end of Chapter 6, thus, not only presents as more inclusive but also more environmentally sustainable. The analysis of Makers' behaviours and attitudes within the environmental profile analysis, then, differs from their reflections on it.

Taken together, both parts of this chapter have once more emphasised the need for a social constructivist approach to the overall topic and research question. Not only have we seen how participants themselves construct their realities differently (i.e. about gendered differences) but also how those differences are constructed within the context of environmental concern and behaviour. A person's values, education, cultural upbringing, gender role and environmental attitude are all facets of them that are not only socially constructed in themselves but mutually co-construct each other and underlie deeply complex connections. Figure 7-3 attempts to visualise these findings within a morphological understanding. These results are reflected in the morphology that was developed in Chapter 5.

Figure 7-3 Inclusiveness and environmental sustainability link according to gender.

Chapter 8   Discussion and Conclusion

This chapter discusses and concludes the present study. Section 8.1 combines all findings thus far and explores what these could signify and imply. Section 8.2 makes recommendations for Makerspaces in regard to their inclusiveness challenge and increased pro-environmental behaviour. Section 8.3 provides a brief overview of the study's limitations and what future work could be undertaken to mitigate those and expand on the findings. Section 8.4 concludes the study.

8.1   Discussion

This dissertation has aimed to answer the question whether increased female participation in Makerspaces in the UK, Germany and Austria contributes to an improvement of positive environmental impacts of Making practices in those spaces, or vice versa, whether an increased focus on positive environmental impact by those spaces would encourage more women to join into their communities. Through developing a morphology, it has first been established the MM differs not only on different continents but sometimes even from space to space. Thus, there is not one single understanding of what Making entails but a multitude of socially constructed constellations. The morphology that has then been developed specifically for Makerspaces in Germany, the UK and Austria has been shown to be inherently patriarchal and masculine. Women are not only more likely to struggle with access requirements but also with a masculine culture that might encourage them to change parts of their feminine identity in order to fit in. In fact, developing a more inclusive morphology has highlighted potential gender differences in Making practices and cultures. It has then been argued that, despite Makers not necessarily being aware of these imbalances, the female Makers in this study appear much more environmentally concerned than the men. This appears especially true when it comes to raising awareness for Making's environmental effects and for engaging with technology that might be considered more environmentally friendly.

Drawing these findings together, therefore, might initially lead one to conclude that including more women in Makerspaces in the UK, Germany and Austria would likely make the Making practice in those more environmentally friendly. If the few female Makers who are already involved in Making show higher levels of engagement with environmental issues and ambitions to tackle them, then surely including more women into those Makerspaces and harmonising the gender balance would likely increase environmental awareness and

practices within Making. Equally, increasing environmental practices in spaces might encourage more women to join. One of the study's participants, Rose, even says this quite specifically when stating that "there's a gender thing there. […] We know that with the environment, which is looking at solving real-world problems, will be helpful to get women involved first of all. […] We know that that will help to address gender imbalance." However, during the analysis of this study a few issues have arisen that challenge these conclusions.

Firstly, 'just including women' might not be as straightforward and easy as hoped for. Quite a few of the environmentally concerned women in this study actually do not consider themselves part of a Makerspace community. Rather, they engage in Making activities through their work and through bringing Makers and communities together. They are, thus, good examples of how women might struggle to integrate into the masculine cultures of Makerspaces. It might indeed be asked whether women can only integrate into such spaces if they adopt more masculine characteristics, like a few in this study have, i.e. Heidi. As seen previously, Oudshoorn et al. (2004) have examined gender issues and design cultures and sum up by saying:

> the gender issues involved in design are too complex to be solved by just 'adding women and stir' (Harding 1986). They also require a transformation of the dominant cultural image of technology, a drastic change of the technology push oriented routines and practices of current design communities, and a renegotiation of gender identities in relation to technology (p.54).

This, indeed, applies very well to Makerspaces and the discussed masculine communities. The dominant culture in those spaces makes it very challenging for women to join in without renegotiating their own gender identity. The focus on digital technologies is a particularly important factor that might put women off from engaging with Making or even considering it as something they might enjoy. This, of course, is not only a dynamic visible in Making but generally in the technology sector in our society. But the strong focus on digital technologies by Makers, then, strengthens and furthers the connection of men being seen as technologically able and skilled. This connection is lived out in a masculine culture which evolves around masculine characteristics such as confidence and competitiveness, technological prowess and, sometimes, sexism. Thus, also in Makerspaces in the UK, Germany and Austria, just "add women and stir" (Harding, 1995) will not be the solution to gender inclusiveness issues.

The female sample of this study backs this up rather well. It has been shown that around half of them adopt quite masculine characteristics, especially within Making, and have managed

to adapt to the culture through that masculinity. Whether it is Heidi who is "just a guy with tits" or Jane who has always been "a bit of a tomboy", the reason they might be able to fit into that culture is because they have adopted or already identified with some rather masculine characteristics. We have witnessed Megan who describes a "tribe of Maker women" that exhibits a kind of tough femininity and includes a high percentage of gay women who are more likely to identify with masculine characteristics. She states that by far not every woman falls into this 'tribe', but she would guess 50% do. This seems to align with the data of the present study in which four out of nine in-depth interviewees (Heidi, Rose, Megan and Jane) state that they adopt masculine characteristics within Making. If this is, indeed, the case and 50% of the 10% overall female Makers do this specifically or already somewhat identify with masculine values before joining, then a very small percentage of women who Make can be assumed to be able to do so with a more feminine gender identity that is unchanged. This exemplifies all too well that the masculine culture as analysed here is not welcoming to women, or rather a feminine identity, and, therefore, just adding more women to the mix might not necessarily mean that Makerspaces are more inclusive.

What does this mean for environmental concerns within Makerspaces in the UK, Germany and Austria? The consulted literature suggests that femininity is more connected with environmental concerns than masculinity (Zelezny et al., 2000, p.454) which would indicate that the female Makers who have adopted more masculine characteristics would be less likely to be environmentally concerned or act in an environmentally friendly way. Consequently, including women who adopt a more masculine identity in order to fit in would not increase positive environmental impacts of these Makerspaces. However, three of the four women who portray more masculine characteristics are also the most environmentally concerned (Heidi, Rose, Megan) in this sample. Robin as our only non-binary interview participant, and thus not solely identifying with a female identity, also appears very environmentally aware. The only woman who scores higher than anyone else in the environmental profiles is Klara and she does not talk about adopting masculine values. However, she is part of a space that appears much more inclusive and much less guided by technical aspects. Her space, in fact, works on principles of permaculture and appropriate technology and, thus, confirms that a more environmentally friendly Making culture would potentially attract more women without masculine characteristics to join in, and vice versa.

Two different explanations for this contradiction with the literature can be made. Firstly, these women and non-binary participants might be more masculine in their behaviour and identity which makes them fit in better, but within that they have kept their feminine identity

of being more connected to environmental issues. Due to their confidence which allowed them to find their place in Making, they might also be more confident to promote and raise awareness for environmental issues. The second explanation might be that, in fact, the literature is wrong, and femininity is not necessarily connected to the environment. However, this study has shown that many of the women interviewed here appear more environmentally concerned than the interviewed men. Thus, maybe femininity in itself is not a good indicator of levels of environmental concern but being raised as a woman despite of how feminine one is. According to the available data, it appears as though women tend to be more environmentally concerned no matter how feminine or masculine they are. We can recall Mohai (1997, p.167) who said that environmental concern differs between genders due to "the differing socialization experiences of men and women […], rather than the roles they occupy or other structural factors". Social Dominance Theory springs to mind again as it connects environmental attitudes with levels of privilege in society. Instead of masculinity or femininity it might be the standing of women in society that makes them more environmentally concerned than men and, thus, explains why the rather masculine appearing women in this study are still more environmentally concerned than the men. It could then be argued that the here developed more inclusive and feminine morphology is not representative of all women and their environmental values in Making as there are a multitude of identities women might adopt. Nevertheless, it can be assumed that being raised as a woman will, by and large, instil more feminine values in women than in men. Hence, the feminine morphology and values are still connected to this finding.

Environmentally speaking, this might be considered the ideal scenario – just add women to the mix and environmental considerations will improve. However, it is neither as easy as that nor ideal, because as long as the masculine culture remains what it is, including women will be an extremely difficult endeavour, whether the few that do join increase environmental awareness or not. Thus, unless Makerspaces in the UK, Germany and Austria become less masculine in general, environmental values will not improve. Practices and values within the movement need to change. This will not only ensure that more women feel comfortable to explore Makerspaces and join their communities, but also maybe encourage men to adopt a more environmentally friendly approach to Making. The social dominance that exists in many Makerspace cultures might add to the dynamic of women, as the dominated, being more environmentally concerned than the men, as the dominant. Thus, creating and fostering a culture within which this gender-related dominance does not play a role might not only increase female membership but also environmental concern.

One issue that still needs addressing is the inconclusiveness of in-depth interviewees' opinions on whether women are more environmentally friendly in their Maker practice or not. When asked, participants did not agree on whether there are differences between genders. Some affirm, some negate this connection. Similarly, survey results were, as examined, generally inconclusive. But they showed a significant result for women including environmental considerations more into their Maker practice than men. This has, in fact, been shown by the analysis of interviewees' environmental practices. Still, it remains curious why survey results regarding environmental dimensions of a project, used material and produced waste are less clear than the qualitative data. One assumption could be that women are more inclined to sell themselves short, as shown by a variety of studies (Jakobsson, 2012; Broos, 2005; Greguletz et al., 2019). Thus, despite living an environmentally friendly life and being quite environmentally engaged within their Making practice, they might be hesitant in confidently stating so. Important to remember as well is that, despite not being significant, women did give more environmentally concerned answers in almost all statements regarding material, etc. With a bigger sample size, clearer, and perhaps significant, results would have been obtained. As explained in section 3.2.3.1 on the mixed methods approach of this study, it gives priority to qualitative data because quantitative data within the social sciences leaves much more room for interpretation.

It is also necessary to mention the general issue around gender and it being pushed to the periphery of the movement and not being acknowledged as a problem. Even if male Makers acknowledge that fewer women are involved in Making, they mostly state that their Makerspace doors are always open and that women are welcome. If the latter do not show up in spaces, men cannot do anything. This not only puts the responsibility for gender-inclusion completely on women, but also negates the existence of an actual problem. While the question of responsibility needs to be discussed and, likely, a shared understanding would emerge, negating the existence of a problem and the need for active improvement is an easy escape for something that would likely change the nature of a space if it were to be properly acknowledged and tackled. As this study has shown, true gender inclusiveness does not only require opening doors, but a thorough engagement with what it means to be a Maker and what kind of Makerspace culture would likely make it truly inclusive. Coming back to the Makerspace morphology developed at the end of Chapter 5 and the more inclusive version shown in Chapter 6 both exemplify the changes necessary to create a more inclusive practice. Either Makers are not aware of this deeply gendered culture in their spaces or they do not wish to change their practice as drastically as would be necessary. Likely, it is a mix of both. Either way, the reluctance to acknowledge gender as an issue is telling of a movement that

has, thus far, been so dominated by men and masculine values. It indicates that true inclusiveness is still an ideal and much needs to happen to make it reality, especially when some men even call for their own Makerspaces to be safe spaces within which they do not have to engage with gender issues at all. This indicates that there is a real danger for Making communities to become more bonding over gender issues than bridging.

In theory, then, one might conclude that creating a higher gender-diversity in Makerspaces in the UK, Germany and Austria might automatically lead, by extension, to more pro-environmental behaviour. However, we have seen that it is not as easy and automatic as that. Many more complex factors add to levels of inclusiveness and environmental sustainability, thus creating a much more complex scenario than a yes-or-no question could account for. A lot depends on the space/community and how they define themselves. Also, even though this study has shown that women might exhibit slightly larger pro-environmental concern, this does not mean that all share this concern or that this concern is inherent to them, nor does it mean that no man engages in pro-environmental behaviour. Equally, this dissertation does not aim to imply that Makers in general are all sexist and misogynistic. Far from it. Anti-feminist practices and dynamics are often very ingrained in structural workings and not always easy to identify as such. Makers do a lot of amazing work, including encouraging critical engagement with the objects that surround us, pointing towards misguided global production processes and inspiring an active engagement with the world. The point this dissertation makes, then, is that there is a chance that these positive impacts could be made even better and find more widespread acknowledgement if underlying structural tendencies regarding gender inclusiveness (and likely other forms of inclusiveness) were taken and tackled seriously. Environmental issues in particular would likely be more on the agenda. Women should have the same possibilities to participate in Makerspaces as men if they wish to do so without having to give up or change part of their identity.

8.2   Recommendations

In order to help determined Makers turn their space into a more inclusive one, some recommendations for a more inclusive space and pro-environmental practice are provided. As has just been discussed, none of these recommendations on their own will automatically cause an improvement in inclusiveness or environmental sustainability. However, taken together and alongside an approach that considers gender and the environment in all Makerspace aspects, they might go a long way in improving the situation. Equally, all

Makerspaces differ from each other and the necessary changes might differ slightly from space to space. Some recommendations are:

Inclusiveness

- Encourage usage of a variety of technologies, modern and traditional

- When setting up, do not only focus on digital technology, but make sure more traditional technologies are equally important. Let this be reflected in how the tools are set up (i.e. put these technologies in equally prominent positions as the digital ones)

- Try to create a physical space that is warm and welcoming.

- If at all possible, reconsider your membership processes, membership fees and childcare possibilities.

- Prioritise a culture in your space that discourages bragging and showing off.

- Prioritise a culture in your space that encourages confidence in female Makers. Do not be annoyed if they ask more questions.

- Have female role models.

- Communicate Making activities through the intended purpose, not through the technology used.

- When considering 'practical' aspects, such as membership fees or set-up of workshops, be aware of their gendered nature and what that might mean for your space.

Pro-environmental practice

- Establish a culture in which environmental considerations are automatically part of the Making process by encouraging discussions around environmentally friendly materials and processes

- Set up recycling and reusing processes in your Makerspace

- If possible, determine a member of the board specifically in charge of environmental impact considerations

- Examine your energy and other suppliers for environmental sustainability

- Encourage those involved in upscaling of products, especially for entrepreneurial endeavours, to consider their environmental impact

8.3   Limitations and future work

All in all, then, this thesis has argued that women appear more environmentally concerned in their Maker practice and would likely increase positive environmental impacts of Making if included more into Makerspaces. However, it has demonstrated that just getting more women involved is likely not going to improve women's situation in Makerspaces much, but that a cultural shift needs to happen in order for women to truly feel included and not have to give up some of their identity to fit in. These dynamics have been shown to be inherent in how the MM in many German, British and Austrian Makerspaces is currently set up. Freeden's morphology has helped to show the structural embeddedness of exclusive practices and that these structures need to change in order for Makerspaces to be more gender-inclusive.

Nevertheless, a lot more research is necessary to substantiate and expand on these findings. For example, many studies focus on Making in economically well-off countries. The here developed morphology serves as a robust framework for future studies of Making in other contexts. Nevertheless, a methodological approach of how to devise different constellations would be helpful. This could be done, for example, through content analysis of interviews by Makers according to concepts. The morphology itself as well as other Maker constellations deserve more exploration and refinement. For example, morphologies are necessary for Makers in not so well-off countries which would allow for a more nuanced view of Making activities worldwide. Also Making activities and queer studies should be looked at further, as previously stated. There appears to be a connection between gender, sexuality and amateur technology communities.

Equally interesting would be to just repeat the study at hand. Due to the concern for climate change having taken centre stage in this last year through the Fridays for Future movement and the Extinction Rebellion, environmental attitudes and behaviours might have changed since study participants were asked about them. Exploring the impact of these movements on the MM is a further direction of research to consider. A replication with a different focus within inclusiveness, for example on people of colour, would also offer highly intriguing results and help to further understand the complex nature of communities and the morphological model. Repeating this study would also allow for an examination of how morphologies develop over time. Freeden's conceptualisation allows for an understanding of Making that does not only exist in the present but might develop into different various constellations over space and time. Exploring how they unfold over time whether in a systematic or constellation-specific way is likely to provide further insights.

Fruitful might also be a study that considers Makerspaces not as one single community but explores the shaping of micro-communities within those spaces. A variety of participants have mentioned 'cliques' and 'tribes' in their spaces. In how far these align to different morphological constellations and how they shape the community of a space as a whole might be a significant factor in how inclusive a space is. Also, as with Freeden's morphology, an exploration of communities over time promises intriguing insights into their evolution. More broadly speaking, an in-depth analysis of different Maker terminologies and understandings is deemed beneficial. Whether Makers are part of a movement, a culture, a brand or all of the above is still a rather unexplored question which might be more easily answered if morphological constellations are developed for each and compared. This discussion would likely include a useful differentiation between top-down and bottom-up Makerspaces. Similarly, examining differences between hacking and Making appears overdue. Many studies use the terms interchangeably but about half of the survey participants in the present study have stated that they see differences between the two activities. Equally intriguing is an examination of potential futures of the movement: might the bankruptcy of some Maker companies and a decline of updates on the https://wiki.hackerspaces.org/ list imply a weakening of interest in Making?

Methodological speaking, the empirical nature of this study gives rise to further approaches. The sample size of this study might not be adequate in drawing general conclusion, especially with a rather small sample of female in-depth interviewees. It is, thus, recommended to conduct similar studies with more women in different spaces in order to verify or challenge the findings presented here. This also applies to more overall

inclusiveness and environmental findings. Due to the study being overt in its approach and informing all participants of the study's topic, it might be possible that participants wanted to positively contribute to it and, thus, might have reported on the environmental effects of their Maker practice overly positively. Studies with different approaches are necessary to verify the findings at hand. Also, the survey could be improved in future studies to deliver more precise data. For example, even though the literature review has shown that a variety of Makerspaces with different set-ups exist, participants were not asked what kind of space they are part of or in how many spaces they are active in. Also, the statements regarding environmental practices could be made more detailed and nuanced to further flesh out potential gender differences in their answers.

8.4   Conclusion

This research project has explored many socially relevant topics: gender, amateur technology creation, environmental protection, and the inherent political nature of seemingly apolitical activities. It has done so through a mixed methods approach in which qualitative as well as quantitative data combined have laid the foundation for in-depth analysis of a variety of dynamics within the MM. In considering a possible connection between gender inclusion and environmental impact within Makerspace communities in three West-European countries and asking how a more gender-diverse community can foster better environmental practices, it has accomplished a variety of objectives.

The first objective of this study was to devise a morphology of Making with core, adjacent and peripheral concepts according to Freeden's morphology of ideologies. Within the Makerspace morphology for the UK, Germany and Austria some concepts have been found to have strong gender-biases and shape Making communities in quite pronounced ways. Digital technologies have been shown to be geared towards and specifically attract men into Making communities. The concept of community itself is, therefore, often shaped by rather masculine values and understanding of communal activities. The study, then, has firstly been able to conceptualise the MM in a way that offers a fairly stable understanding of its activities, while at the same time allowing for multiple constellations and Maker cultures. This allows for a variety of seemingly very different Maker groups to be incorporated under one label while, at the same time, keeping their different foci and ambitions. Secondly, it has done so while using a political theory, namely Freeden's morphology of ideologies, which had not been applied to a cultural movement before. The study here has shown that Freeden's theory is not only apt for conceptualising ideologies, but a wide array of social constructs. Thirdly,

it has furthered an understanding of some Making activities' inherent masculinity. In focusing on dynamics between concepts, the morphology has been able to showcase how the exclusion of women (and other groups) in Makerspaces in the UK, Germany and Austria is not an accident but is ingrained into the way Maker culture has been developed and perceived over the years.

The second objective of the study was to assess how women are included in Makerspaces in the UK, Germany and Austria, and what potential issues exist. This has been accomplished in Chapter 6 which outlined the different aspects that women struggle with in Makerspaces and beyond. The thesis has argued that not only Makerspace internal aspects, such as tools and social dynamics, have an impact on women's participation, but also external, more general societal factors, such as unequal pay and time-poverty. While Makers should not be solely responsible for tackling wider societal gender issues, it is absolutely essential for them to be aware of these and, thus, understand perceived practicalities as inclusion issues as well that might be approached in a more inclusive way. In achieving this objective, this study has explored and analysed a specifically female perspective in typical grassroots Making communities. Research so far has often engaged with women in feminist Makerspaces and their motivations, however women in regular spaces have not been focused on a lot. Secondly, it has shed a light on the external aspects of exclusion which have not yet been considered in connection with gender and Makerspaces in those countries. Thirdly, it has demonstrated that, like in other male-dominated fields, women are more likely to adopt masculine characteristics in order to fit in. This aspect, specifically, has helped in understanding the masculine culture that often reigns in Makerspaces. Fourthly, and as previously mentioned, it has been able to show the structural nature of these dynamics, as portrayed by the developed morphology. Consequently, it has been able to, fifthly, develop a more inclusive morphology which can assist Makerspaces in creating a more inclusive environment.

The third objective was achieved by an in-depth exploration of environmental aspects and their gender-related differences. Chapter 7 has argued that, despite Makers not being aware of this, there appear to be different intensities of engagement with environmental concerns and behaviours between female and male Makers. Developing environmental profiles for all in-depth interviewees has shown that the women in this sample, on average, were more environmentally friendly in their practice than the men. Even though differences in the survey and Maker's subject-related opinions were not always significant, analysing their actual practice according to environmental aspects has shown that there are differences in

gender. In achieving this objective, this study has made a connection between women and environmental protection in amateur technology Making. This connection had only briefly been made by one research paper before and even then as more of a side note (Millard et al., 2018). Secondly, this study has demonstrated that gender and related differences are still something that is not acknowledged by many, which contributes to the perpetuation of gender-related stereotypes.

Overall this dissertation has argued that, generally speaking, including more women in Makerspaces in the UK, Germany and Austria in theory would likely by extension increase pro-environmental impacts of those spaces. Equally, increasing the positive environmental impact of those spaces would likely attract more female Makers. However, these claims can only be made hesitantly and need to be considered as much more complex and varied in real-life scenarios; many limitations and restrictions remain. Firstly, as previously discussed, just adding more women into Makerspace communities is unlikely to change the latter's masculine culture and activities in their spaces, which have been demonstrated to be inherent in the Makerspace morphology in the UK, Germany and Austria. Thus, communicating more environmental values might not be enough to attract more women either. Equally, even if more women were to join, they might feel compelled to adopt masculine characteristic in order to truly fit in. A lot depends on the individual spaces, its members, how they construct Making and how they put Making and community shaping into practice. The studies' underlying ontology of social constructivism underpins this finding. Therefore, the research question can be answered as follows: A link between female Makers and an increase in pro-environmental practices has been shown through empirical evidence. This suggests that Makerspace communities in the UK, Germany and Austria might be able to foster a more gender-inclusive and environmentally sustainable practice by tackling one of those issues. However, it has been shown that inclusiveness is not as automatically and easily tackled as this answer might suggest. Thus, complex and space-specific changes are necessary to truly include more women and increase pro-environmental effects.

This research project has made an important connection between technology, environment and gender. Specifically, it has shown how amateur technology practices within Makerspaces in the UK, Germany and Austria are inherently gendered and, therefore, also potentially more environmentally harmful than they have to be. Through that connection, it has shown a potential path for Makerspace communities to combine gender inclusiveness and environmental sustainability and tackle both together. The study has done so by applying a political theory model to a cultural movement for the first time which opens doors for other

movements and, indeed, social constructs to be analysed this way. Despite the Maker movement often being deemed a hobby and a niche activity in West European culture, it is vital to understand these everyday practices and their wider societal implications. In particular, the movement has the potential to challenge capitalist production processes, environmentally destruction and gender exclusion. This study hopes to contribute to a valuable discussion and potentially help to encourage Makerspaces to become more inclusive and environmentally friendly. It thus contributes to an understanding of the times we live in and of the vital intersections between technology, the environment and feminism.

Appendix

A. Two ethics approvals

B. The English online survey

C. Two screenshots/scans of the calls for survey participation in *HackSpace* magazine and on the German *Make:* magazine website

D. Environmental profiles of in-depth interviewees

A. Ethics approvals

University of Glasgow

College of Social Sciences

15/08/2017

Dear Elizabeth Loose,

College of Social Sciences Research Ethics Committee

Project Title: The Maker movement and the environment – can this new movement affect positive environmental behaviour change?

Application No: 400160226

The College Research Ethics Committee has reviewed your application and has agreed that there is no objection on ethical grounds to the proposed study. It is happy therefore to approve the project, subject to the following conditions:

- Start date of ethical approval: 1/09/2017_____
- Project end date: 30/09/2020_____
- Any outstanding permissions needed from third parties in order to recruit research participants or to access facilities or venues for research purposes must be obtained in writing and submitted to the CoSS Research Ethics Administrator before research commences. Permissions you must provide are shown in the *College Ethics Review Feedback* document that has been sent to you.
- The data should be held securely for a period of ten years after the completion of the research project, or for longer if specified by the research funder or sponsor, in accordance with the University's Code of Good Practice in Research:(http://www.gla.ac.uk/media/media_227599_en.pdf) (Unless there is an agreed exemption to this, noted here).
- The research should be carried out only on the sites, and/or with the groups and using the methods defined in the application.
- Any proposed changes in the protocol should be submitted for reassessment as an amendment to the original application. The *Request for Amendments to an Approved Application* form should be used:
  http://www.gla.ac.uk/colleges/socialsciences/students/ethics/forms/staffandpostgraduateresearchstudents/

Yours sincerely,

Dr Muir Houston College Ethics Officer

Muir Houston, Senior Lecturer
College of Social Sciences Ethics Officer
Social Justice, Place and Lifelong Education Research
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University
of Glasgow

College of Social
Sciences

17/04/2018

Dear Elisabeth Loose

College of Social Sciences Research Ethics Committee

Project Title: Maker Movement and Environment - part 2

Application No: 400170119«Principal_Investigator»

The College Research Ethics Committee has reviewed your application and has agreed that there is no objection on ethical grounds to the proposed study. It is happy therefore to approve the project, subject to the following conditions:

- Start date of ethical approval: 17/04/2018
- Project end date: 30/09/2020
- Any outstanding permissions needed from third parties in order to recruit research participants or to access facilities or venues for research purposes must be obtained in writing and submitted to the CoSS Research Ethics Administrator before research commences. Permissions you must provide are shown in the *College Ethics Review Feedback* document that has been sent to you.
- The data should be held securely for a period of ten years after the completion of the research project, or for longer if specified by the research funder or sponsor, in accordance with the University's Code of Good Practice in Research: (https://www.gla.ac.uk/media/media_490311_en.pdf) (Unless there is an agreed exemption to this, noted here).
- The research should be carried out only on the sites, and/or with the groups and using the methods defined in the application.
- Any proposed changes in the protocol should be submitted for reassessment as an amendment to the original application. The *Request for Amendments to an Approved Application* form should be used:

  https://www.gla.ac.uk/colleges/socialsciences/students/ethics/forms/staffandpostgraduateresearchstudents/

Yours sincerely,

Dr Muir Houston
College Ethics Officer

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B. Survey

Are you:

- a Maker?
- within the UK, Germany or Austria?
- 16 or older?

If the answer to all these questions is yes, please read on, participate in this survey and help me make this project truly based on Makers' – *your* – perspectives!

Within my PhD study I am looking at the Maker movement, its participants and their values. Specifically, differences between genders interest me. I'm giving special attention to environmental beliefs and how they potentially influence making practices and the movement as a whole. The survey will take no longer than 20min and, at the end, you will have the opportunity to volunteer to further participate in an online or face-to-face interview or focus group.

Your answers will not reveal your identity. You can decide to stop participating at any point by simply closing this window. Your data, then, will not be used. If you finish the survey and wish to obtain a summary of the final results, you may contact me to receive a copy once the data is analysed and written up. Besides using your responses for the completion of my thesis, they might also be used to write an article for an academic journal, a book or other publications (e.g. a presentation or blog article).

This study is funded by the College of Social Sciences of the University of Glasgow and has been reviewed by its Ethics Committee. Your data will be kept for 10 years in accordance with University of Glasgow regulations.

If you have any queries or questions, please contact me (Elisabeth Loose: e.loose.1@research.gla.ac.uk) or my supervisor, Prof Sean Johnston (sean.johnston@glasgow.ac.uk). You can contact the Ethics officer for the College of Social Sciences (Muir.Houston@glasgow.ac.uk) if you have any concerns/complaints.

By clicking 'Next', you declare that you have understood and agree to all of the above, and consent to your data being used within the described research project.

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1. Your Making Practice

    a. How did you get into making? (Choose one of the following answers.)
        ☐ Through a friend/family member
        ☐ Through attending my local maker-/hackerspace
        ☐ Through related websites
        ☐ Through wanting to realise a specific idea
        ☐ Through no specific reason, it just happened
        ☐ I can't remember
        ☐ Prefer not to say
        ☐ Other:

b.   How long have you been an active Maker (in years)?

_____ year(s)

c.   Why do you engage in making activities? (Check all that apply)

- ☐   I enjoy tinkering.
- ☐   I enjoy making something from scratch.
- ☐   I enjoy working creatively.
- ☐   I feel empowered by making.
- ☐   It empowers my community.
- ☐   It improves my wellbeing.
- ☐   I'm learning new skills.
- ☐   I enjoy being part of my maker-/hackerspace community.
- ☐   I enjoy being part of the broader Maker community.
- ☐   I enjoy freely sharing ideas and information.
- ☐   I like using modern technologies (e.g. 3D-printers, laser-cutters, etc.)
- ☐   I want to or am making a living with my projects.
- ☐   I want to take back control from companies which produce everyday objects.
- ☐   I want to reduce human impact on the environment.
- ☐   I want to counter built-in obsolescence.
- ☐   I want technology that does/is exactly what I want.
- ☐   I do not agree with the way everyday objects are produced in our Western society.
- ☐   Other:

d.   How many hours a week do you usually engage in making activities? (Please give an estimate/average)

_____ hour(s)

e.   Which kind of making activities do you usually engage in? (e.g. coding, laser-cutting, woodwork, etc.)

_____

f.   When choosing a project, what are your 3-4 main priorities?

_____

g.   Do you think making is important for us as a society?
- ☐ Yes
- ☐ No
- ☐ Don't Know
- ☐ Prefer not to say

g1. Please briefly explain your answer from the previous question.
[This question only appeared to those participants who chose 'yes' in the previous questions.]

_____

h. Which is your favourite place to make?
      ☐ Home
      ☐ Maker-/hackerspace
      ☐ Work
      ☐ Prefer not to say
      ☐ Other:

i. Do you regularly go to a maker- or hackerspace/meet-up?
(Regularly can mean in big intervals.)
      ☐ Yes
      ☐ No
      ☐ Don't know
      ☐ Prefer not to say
      ☐ Other:

i1. Why do you go to a maker- or hackerspace/meet-up? (Click all that apply.)
[This question only appeared to those participants who chose 'yes' in the previous questions.]

      ☐ It's convenient for making things.
      ☐ I enjoy the community in the space.
      ☐ I have access to tools that I don't have otherwise.
      ☐ I have access to help from others that I don't otherwise have.
      ☐ I have access to materials I don't otherwise have.
      ☐ I enjoy the creative and inspiring atmosphere of the space.
      ☐ Other:

i2. What do you mainly do when you are in a maker-/hackerspace? (Choose one of the following answers.)
[This question only appeared to those participants who chose 'yes' in question i.]

      ☐ Work on a project/an idea
      ☐ Socialise with other Makers
      ☐ Help others with their projects/ideas
      ☐ Make sure the space is up and running
      ☐ Look at what others are making
      ☐ Prefer not to say
      ☐ Other:

j. Who should be the main driver of Maker initiatives?

      ☐ Maker-enthusiasts and groups of Makers
      ☐ Maker-related companies
      ☐ Universities
      ☐ Charities

☐ Libraries
☐ Schools
☐ Other:

k. Do you think there's a difference between making and hacking?
    ☐ Yes
    ☐ No
    ☐ Don't know
    ☐ Prefer not to say
    ☐ Other:

k1. In your own words, please describe briefly how making and hacking are different from each other.
[This question only appeared to those participants who chose 'yes' in the previous questions.]

_____

l. If you could set up your own ideal maker-/hackerspace, how would you rate the following aspects in that space? (1 – Very Unimportant; 5 – Very Important)

	1 – Very unimportant	2	3	4	5 – Very important
Tackle societal issues					
Strong community					
Community-based activities					
Empowerment of individual Makers					
Usage of modern technologies					
Pro-environmental/ sustainability					
Empowerment of community					
Opposing current production processes					
Inclusiveness for everybody					
Self-actualization					
Entrepreneurship					
Sharing of tools					
Sharing of materials					

2. Environmental Attitudes and Values

    a. Do you consider yourself an environmentally concerned person?
        ☐ Yes
        ☐ No
        ☐ I don't know
        ☐ Prefer not to say

a1. Please briefly explain how the environment plays a part in your life.
[This question only appeared to those participants who chose 'yes' in the previous questions.]

_____

b. Do environmental concerns (e.g. waste, material, purpose of project, etc.) play any part in your making processes/projects?
- ☐ Yes
- ☐ No
- ☐ Not sure
- ☐ Prefer not to say

b1. Please explain how the environment plays a part in your making practice?
[This question only appeared to those participants who chose 'yes' in the previous questions.]

_____

c. On a scale from 1 (strongly disagree) to 5 (strongly agree), please indicate how much you agree with the following statements:

	1 - Strongly Disagree	2	3	4	5 - Strongly Agree
If the process of making a project or the final project itself are likely to have negative environmental effects, it shouldn't be made.					
When choosing materials, a Maker should always consider its environmental dimensions (i.e. recyclable, environ. friendly, etc.).					
A Maker's project should not concern itself with its environmental impact. That's not what making is about.					
If a project produces too much waste, it shouldn't be made.					
It doesn't matter how environmentally friendly a material is as long as it suits a project.					
When working on a project, waste shouldn't be a concern.					

3. Inclusiveness

   a. On a scale from 1 (strongly disagree) to 5 (strongly agree), please indicate how much you agree with the following statements:
(If you are not part of a maker- or hackerspace/meet-up, please leave out the statements referring to them.)

	1 - Strongly disagree	2	3	4	5 - Strongly agree
The Maker movement is truly inclusive and open to everybody, despite aspects such as gender, educational background, race or age.					
I feel very included in my maker- or hackerspace/meet-up.					
Members of my maker- or hackerspace/meet-up are well included.					
Non-members of my maker- or hackerspace/meet-up are well included.					
Despite being inclusive in theory, I think the Maker movement has still some work to do in order to call itself truly inclusive.					
I value openness and inclusivity in my maker- or hackerspace/meet-up and think it's important.					
Men are very well included in my maker- or hackerspace/meet-up.					
Women are very well included in my maker- or hackerspace/meet-up.					
Transgender people are very well included in my maker- or hackerspace/meet-up.					
Non-binary people (people who don't identify as man or woman) are very well included in my maker- or hackerspace/meet-up.					

4. Political beliefs and standpoints

This project looks at the Maker movement as a social movement with specific goals and aims. It will be very helpful to get an idea of your political ideas to make more sense of the collected data. As mentioned before, everything you mention will be 100% confidential.

   a. On a scale from 1 (strongly disagree) to 5 (strongly agree), please indicate how much you agree with the following statements:

	1 - Strongly disagree	2	3	4	5 - Strongly agree
Government should redistribute income from the better off to those who are less well off.					

Big business benefits owners at the expense of workers.					
Ordinary working people do not get their fair share of the nation's wealth.					
There is one law for the rich and one for the poor.					
Management will try to get the better of employees it if gets the chance.					
Young people today don't have enough respect for traditional values.					
For some crimes, the death penalty is the most appropriate sentence.					
Schools should teach children to obey authority.					
The law should be obeyed even if a particular law is wrong.					
Censorship of films and magazines is necessary to uphold moral standards.					
People who break the law should be given stiffer sentences.					

5. Future of the Maker movement

   a. How do you see the Maker Movement develop over the coming years and decades?

   _____

6. Demographics

   a. Which country do you live in?
      ☐ United Kingdom
      ☐ Germany
      ☐ Austria
      ☐ Other:
   b. What is your gender?
      ☐ Female
      ☐ Male
      ☐ Non-binary
      ☐ Other:
      ☐ Prefer not to say
   c. What age are you?

      ____ years

This survey is only the first stage of the research project. A second stage will involve interviews and, potentially, focus groups with survey participants. If you would like to participate in this, please leave your email-address:

   _____

Do you have any other comments?

   _____

C. Screenshots from calls for participation

Scans of *HackSpace* magazine's 07/2018 issue, title and letter page. Circled item is call for survey participation in German.

HackSpace, 2018. *Title* and *Letters. HackSpace* Issue 07/2018. p.1 and p.24.

Screenshot of news page of *heise* online, distributor of the German *Make:* magazine. Circled item is call for survey participation in German.

heise online, 2018. *Werkstattberichte: Neues aus den Fablabs und der Makerszene.* [online] Available at: <https://www.heise.de/make/meldung/Werkstattberichte-Neues-aus-den-Fablabs-und-der-Makerszene-4049745.html> [Accessed 12 February 2020].

D. Environmental profiles of in-depth interviewees

Methodology: see 3.3.2.3; Application: 7.2. Legend: Y – Yes; N – No; NA – not applicable; in brackets: educated guess

		General Environmental Attitude	Considers Environment in Making practice	Environment priority	Awareness spread.	Repairs	Survey Environmental Maker	Survey Environmental Person	Survey Project	Survey Material	Survey Waste
Felix	0.5	(N)	(Y)	N	N	(N)	N	NA	2.5	2	3
Hans	2.5	?	No	(Y)	NA	NA	N	NA	4	3	3.5
James	3	Y	NA	N	N	NA	Y	Y	3	3	3
Anna	3.5	Y	NA	N	(Y)	Y	NA	NA	4.5	2.5	2
Anton	4	NA	NA	N	N	Y	NA	NA	4	4	4
Jane	4.5	Y	(Y)	(N)	N	Y	Y	Y	2.5	3	3
Lewis	5	(Y)	(Y)	N	N	NA	Y	Y	4	4	2
Karl	5	Y	Y	N	N	Y	NA	NA	4	3	5
Ryan	5.5	NA	(Y)	(N)	(N)	NA	Y	Y	4	4.5	3.5
Frank	6	Y	NA	N	Y	Y	N	Y	4.5	2.5	4.5
Jack	6	Y	NA	(N)	(Y)	(Y)	Y	Y	3.5	4.5	3
Lisa	7	Y	(Y)	N	N	(Y)	Y	Y	3.5	3.5	3.5
Nancy	8	Y	Y	N	Y	NA	Y	Y	3.5	4.5	4
Rose	8	Y	Y	N	Y	Y	Y	Y	4	3	4.5
Moritz	8	Y	Y	(N)	(Y)	(Y)	Y	Y	4.5	4	4.5
Megan	8.5	Y	Y	N	Y	(Y)	Y	Y	4.5	5	4
Robin	8.5	Y	Y	N	Y	(Y)	y	y	4	4	4
Heidi	9	Y	Y	Y	N	Yes	Y	Y	3.5	3.5	4
Klara	10	Y	Y	Y	Y	Yes	Y	Y	5	5	5

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