Human Creativity and Invention

Exploring the stimuli of invention within the German Makers Community

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Declaration of Original Content

I declare that the work in this thesis was carried out in accordance with the regulations of the University of Gloucestershire and is original except where indicated by specific reference in the text. No part of the thesis has been submitted as part of any other academic award. The thesis has not been presented to any other education institution in the United Kingdom or overseas.

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Carsten Skerra

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Abstract

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> ‘A piece of wood becomes, in the child’s mind, a wand. A building block becomes a mobile phone. The child plays at being the mother in the home corner,’ (Smidt, 2009, p. 105).

The research on human creativity and the talent for the invention are long studied phenomena in the history of human evolution. Nowadays these two terminologies are often substituted by the notion of innovation. The work presented here, first of all, examines the question of how historically and culturally a distinction was drawn between invention and innovation. The work examines ancient German documents from the late eighteenth century, explores and defines a concept of the invention that is exempt from economic thought, and thus distinguishes the term invention from the form of innovation in use today, which was principally characterised by Joseph Alois Schumpeter in the 19th century in the age of Industrialisation. Therefore, the thesis is focusing on past, and contemporary research on the definitions of the invention to come up with a preconception for stimuli of invention. The work uses the process of the hermeneutic circle that moves from a precursory understanding of some parts to the whole the topic of human creativity and invention and a global understanding of the whole context back to an improved understanding of each part, i.e., the invention concept and the meaning of stimuli of invention. The invention concept has been developed further according to themes, in which historical and contemporary research findings on creativity, invention and innovation are incorporated. The invention concept will be placed according to time and structure, and deficiencies will be identified in present-day societal and cultural considerations because of the much expanded, economically shaped objectives. Also, a methodical approach will be used to define and apply the stimuli of invention, using the Systems Model of Creativity (SMoC) of Mihaly Csikszentmihalyi. While the systems model in its origin describes the information flow and the transformation of information between the three

systems domain, field and the individual, the modification here includes the transactions of the three systems by implying factors that stimulate creativity and invention. New insights of contemporary creativity research then extend these number of stimuli of invention and the stimuli of invention are studied in the German Maker community. In general, the German Maker Community is about individuals that share their knowledge and ideas openly. Moreover, even if there is a focus on Makers living in Germany, these people are globally interconnected, and distribute and gather their knowledge from an engaged, global community supported by contemporary information technology. In addition, the context of the Maker community as an internationally recognised global movement for innovation and experimentation follows the thread to have potential people that give an insight about the stimuli motivating them to participate, contribute and share ideas, inventions and innovations in the Maker Movement, its communities, or its subcultural communities. The demarcation of the Maker Movement is still one of the open issues, therefore, the focus of the investigation was on people immersed in the 'Community of Making'. As a result, the descriptions included in this thesis may illuminate the issues why people are deeply devoted to the invention in this community, even without remuneration or economic benefit or even of own cost. The research question, which factors facilitate inventions in the German Maker Community, is being answered. On the assumption that the German Maker Community belongs to the international Maker Movement, the study illustrates that the German Maker Community has partly other roots according to the cases investigated. Nevertheless, the objectives, practices and concerns have converged to the extent that a comparison between research results on the international Maker Movement and the German Maker Community can be drawn. Based on the comparison and the detailed investigation of distinctions, new insights into the socio-cultural structure of the Maker Community have been obtained, which also serve to explain how the Stimuli of Invention (SI) operate within the maker community. In the last section, the question of how German Makers can improve their skills to invent is discussed in more detail. On the interrelationships of the three systems Domain, Field and Individual in the Systems Model for Creativity (SMoC), additional themes are presented which

deliver answers about the German Makers and possibly also for the international Maker Movement how these individuals continuously improve their skills to invent to the better for upcoming generations.

> ‘Ensure that you continue to offer children many opportunities to follow their passions and interests as the interaction with others, use cultural tools and solve problems,’ (Smidt, 2009, p. 116).

The profound insight about learning and education in this context of the German Maker Community is that the relations and interactions described by Mihaly Csikszentmihalyi’s Systems Model of Creativity (SMoC) and the opportunity to influence these interactions by the usage of Stimuli of Invention (SI) are accelerating the processes of learning and education. The Maker Community itself offers the play area for young people and young at heard adults to live and foster their curiosity, and stimulating young people and their adults to be inventive and innovative in the long run.

Keywords: Human Invention; Creativity; Innovation; Maker; Making; German Makers; DIY; DIT; Community; Movement; Stimuli of Invention

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Acknowledgement

This professional doctorate has been a journey with lots of insights. Moreover, I would express that there were more highlights than lowlights. From my point of view, the importance lays in that I had started, made the first tipsy steps, became alive of the importance of my work to keep on moving. This journey might never be started if the individuals around me would not support it.

Let me express my gratitude to the professors, teachers and students that accompanied me on this journey. Special thanks go to Professor Dr Jürgen Polke, Dr Philippa Ward, Dr Keith Donne, and Dr Robin Bown their courage in professional doctorates, bringing this DBA program to action, their faith and confidence in the people that are starting and ending this journey. The right amount of humour and the right point in time for a hug that is what these four makes them brilliant to me. ‘You can question me everything, but not write your thesis`, Philippa, Doctoral Colloquium 2017.

First and foremost, I would like to honour and thank my supervisors Professor Dr Tony Gear (25th July 1938 - 2nd September 2017), Dr Tracy C. Dathe and Professor Neil Towers at the University of Gloucestershire for the guidance, the ideas, the corresponding fruitful discussions and motivating comments. My special thanks to Professor Dr Gerald ‘Ged’ Watts for his insightful motorbike tours into Cotswolds history and Michael Fass for his forthrightness and for impressing me with his passion for his life work.

Special thanks to Professor Dr Markus Brandenburger who played a significant role in giving value advice from the beginning. Furthermore, he is advocating my lectures in combining theoretical knowledge and practical experience at the Baden-Wuerttemberg Cooperative State University Mannheim (DHBW). My work with these students is inspiring, fun, and is well-founded to excellent outcomes and successes for all participating.

Primarily, I would like to thank Andrea Weber and Michael Schäfer, my action learning set, as they shared their insightful knowledge and experience with me throughout my research work. Secondly, I would like to thank Heinzpeter Kärner, Ruth Weber, Hagen Peschke, Holger Minning and cohort Munich 11 they are all inspirational for me as they merit the doctoral colloquium and foster this community.

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Finally, my family is to be thanked for their love and inspiration. Firstly, Kerstin beloved for her unconditional love. Secondly, Leonard who gained my confidence that he will master his life with the same endurance as his parents do. Linus, as highly sensitive people from time to time struggle but they are inspiring others, creativity is something special, and it is a gift. Thanks to my parents, Horst for giving me the purpose of all these technical insights and supporting my curiosity, and Birgit with her tremendous support and mother's trust.

Thank you all.

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Personal and Professional Impact of the DBA Journey

This DBA thesis was born out of a desire for further progress into academia. Since 2011 I am a lecturer at the Baden-Württemberg Cooperate State University located in Mannheim. There I started as a lecturer in the program 'International Business' and hold lessons for 'Economathematics' and 'Project Management'. The Baden-Württemberg Cooperate State University is a legal entity of public law and simultaneously a state institution. It is the only institution of cooperative education being listed in the top-ten national ranking for business studies by the Wirtschaftswoche, a leading German business magazine. Over the time my number of lessons increased as I now am a lecturer in the program 'Economic Development' as well, and I participate in other activities as oral exams, Bachelor exams, I supervise students for projects with companies and during writing their Bachelor thesis's. As this started part-time it becomes more a full-time as working with students and other colleagues is fun, open-minded people, and this was the point in time I was asked if I might become a professor.

At the beginning of this DBA journey, I thought it would be part of writing up the experience I made during 25 years of professional life, experiences from significant organisational change initiatives I led as project manager. Experiences from numberless assessments I conducted over an organization of 300.000 employees, twenty-five business areas, all levels of from employees, management, and C-level. Seeing organisations starving because of the consolidation of employees and managers caused by technological change, the absence of even adapting business models, the missing attitude to start new things. Today we would call this the lack of an innovation culture, but these days as a technology-driven company everyone looked at the research and development organisation staffed with engineers for doing progress.

As a short conclusion about my DBA journey; it was a time-consuming investment in personal transformation, I started years before in computer science, becoming an economist over time, and now writing a thesis in the

tradition of sociology. So what? - The DBA was about making things different, thinking different, getting new perspectives into the various sectors of life, meeting many people I would not have met. Also, it was extensive input about what methodology is about, how it changes the outcome. As being DBA representative for nearly two years now it gave me further insight into the UK educational system, and the several weeks lasting travels to Cheltenham allowed distance from German culture and additional insights about values in the United Kingdom; not to forget ongoing endless debates about the Brexit defeat.

However, I have to say DBA is an offer for an opportunity, for this DBA journey including discipline, personal learning, accountability and commitment and profoundly personal ambition.

The DBA experience has therefore been unique because it has served not only to develop my research skills and competencies; it changed my worldview, the ability to see with different eyes.

Beyond the DBA, my aim is now to be successful on one of the professorships positions I applied for, in response to the personal investment I made so far. The joy of thesis completion signposts towards the beginning of a new chapter and a new journey.

Carsten Skerra

Content

Abbreviations

ABS	Antilock Brake Systems
ALU	Arithmetic Logic Unit
APA	American Psychological Association
ARM	Advanced RISC Machines
CBA	Center for Bits and Atoms
CCC	Chaos Computer Club
CEO	Chief Executive Officer
CHI	Conference for Human-computer Interaction
CNC	Computer Numerical Control
CR	Chief of Revolution
CSCW	Computer Supported Cooperative Work
DBA	Doctor of Business Administration
DC	Doctoral Colloquium
DHBW	Baden-Wuerttemberg Cooperative State University Mannheim
DIY	Do-It-Yourself
DIT	Do-It-Together
DSM	Digital Special-purpose Machine
ECU	Electronic Control Unit
ESP	Espressif Systems Processor
FOSS	Free and Open Source Software
GDPR	German Data Protection Regulation
GMD	Gesellschaft für Mathematik und Datenverarbeitung Society for Mathematics and Data Processing
GMC	German Maker Community
GMM	German Maker Movement
GPS	Global Positioning System
GUI	Graphical User Interface
HCI	Human-Computer Interaction
HR	Human Resources
IBM	International Business Machines Corporation
IFD	Individual-Field-Domain
IP	Intellectual Property

ISEF	Intel Science and Engineering Fair
IST	Information and Software Technology
IoT	Internet-of-Things
MBA	Master of Business Administration
MINT	Mathematik, Informatik, Naturwissenschaft und Technik
MIT	Massachusetts Institute of Technology
MM	Maker Movement
MMS	Manufacturing Message Specification
NRW	North Rhine-Westphalia
NSF	US National Science Foundation
OPC	OLE (object linking and embedding) for Process Control
PCB	Printed Circuit Board
PGG	Patente, Geschmacks- und Gebrauchsmuster
	Patents, Taste and Usage Pattern
PSI	Preconceptions of Stimuli of Invention
PSQ	Personality Factors Questionnaire
RISC	Reduced Instruction Set Computer
R&D	Research and Development
SAIC	School of Art Institute of Chicago
SEZ	Special Economic Zone
SI	Stimuli of Invention
SID	Sustainable Interaction Design
SMoC	Systems Model of Creativity
STEM	Science, Technology, Engineering and Mathematics
TD	Transcript Detail
TED	Technology, Entertainment and Design
UA	Unit of Analysis
UK	The United Kingdom
US	The United States
VDI	Verein deutscher Ingenieure
	The Association of German Engineers
3M	Minnesota Mining & Manufacturing Company

Colour Coding for Figures and Numbering Schemas

Colour	Content
	Structural Information
	Sub-Structural Information
	Information, Themes from Literature
	Systems Model of Creativity (SMoC)
	Interpretation of SMoC systems/ Coding
	Stimuli of Invention (SI)
	Contemporary Research on Creativity
	Additional Themes (ATx)/ Findings

Numbering	Content
A-K	Themes from Literature Review
P1-P7	Principles used for Research Conduct
UA01-UA15	Unit(s) of Analysis (UA)
I/F/D	Individual (I) / Field (F) / Domain (D)
FA/ SO/ CU	Coding Family (FA)/ Society (SO) / Culture (CU)
SI01-SI06	Stimuli of Invention (SI)
SI07-SI10	Extended Stimuli of Invention (SI)
I/F/D-I/F/D-SI	Type of Stimuli between SMoC systems
AT01-AT10	Additional Themes (ATx)/ Findings

Figures

Artefacts

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Introduction

1. Introduction

This first chapter begins with an introduction to the overall research background of Human Creativity and Invention (chapter 1.1), followed by the vision and motivation for my research (chapter 1.2 Research Focus - Vision and Motivation for Research). Next, the research objectives and research questions documented with the demarcation of the research area (chapter 1.3 Aim and Research Questions). Finally, this introduction is closed with an overview of the structuring of this thesis (chapter 1.4 Organisation of Thesis).

1.1 Research Background - The Science of Human Creativity and Invention

The Science of Human Creativity and Invention describes the interdisciplinary approach to combine the three successive waves of creativity research - the personality approach, the cognitive approach, and the socio-cultural approach. The researchers on creativity can be grouped into two major traditions: an individualist approach and a socio-cultural approach (R. Keith Sawyer, 2011).

In the 1950s till the 1960s, the first wave of creativity research was focused on studies about personalities of exceptional creators. This kind of research goes back to the 5th September 1950 at the national psychology conference as Dr Guilford, president of American Psychological Association (APA) had chosen to talk about creativity for further research to be dealt with - at this time exceptional creativity was thought to be a by-product of high intelligence.

The basic concept for this research was the individualist definition of creativity. So, these individualist approaches studied individuals while they were engaged in creative thought or behaviour. The individualist approach was associated with personality psychology, and it is built on one of the oldest theories in psychology: associationism from Alexander Bain (1818-1903).

The individualist definition of creativity is ‘creativity as a new mental combination that is expressed in the world.’ - Thus, creativity is (i) new, (ii) is a combination, and (iii) is expressed the world. Firstly, most people will

mention that the most basic requirement of creative thought or action is that it must be novel or original. Activities are non-creative if they repeat already behavioural patterns. Secondly, the definition of a combination expresses that all thoughts and concepts are combinations of existing thoughts and concepts. Moreover, this combination of two or more thoughts has never been combined before by that individual.

Thirdly, creativity is expressed in the world; nightly dreams are not creative because they stay in a person's head and are never expressed (R. Keith Sawyer, 2011). In other words to communicate your ideas to others is something essential.

In order to this approach, per definition, this includes the myriads of people's problem-solving in their daily lives. This is the reason why this approach is also called 'little-c' creativity. As long as you solve it by yourself for the first time, it is 'little-c' creativity. Imagine how creative a baby is - and indeed it is. Creativity is a permanent companion during the maybe first months and stays as a hopefully frequently used companion beyond this point.

The research studies during this 1st wave were coined to define creativity through assessments, results to be mentioned as a 'good' test for measuring creativity might be the divergent thinking tests or the Torrance tests. These tests are still common practice to the Science of Human Creativity and Invention.

In the 1970s till the 1990s, the 2nd wave takes place, triggered mainly by the aspect of whether creativity is domain-general or domain-specific? - This question draws the attention onto the cognitive approach but still having the individualist approach as its origin of thought. It just directs the research if a person's creativity is universal and the person's creative potential is seen as general and could be scored in any field, or if this person only scores in a specific sphere of activity or domain (R. Keith Sawyer, 2011, p. 58).

In the 1990s till today, the 3rd wave complements the personality approach and the cognitive approach to the socio-cultural approach. A socio-cultural approach is an interdisciplinary approach that focused on creative social

systems: groups of people in social and cultural context. Therefore, the researchers on creativity were joined by the socio-cultural tradition researchers like the sociologists of science and arts and anthropologists who study art, ritual performance, and verbal creativity in different cultures. To conclude, contemporary research on Human Creativity and Invention focus on socio-cultural approaches to explain the complicated relationship between individuals, and groups, cultures, and organisations (Csikszentmihalyi, 2014; R. Keith Sawyer, 2011). Furthermore, John E. Sawyer and others stress that innovation emerges from collaborations among individuals - from small sparks, tiny ideas and that individuals come together in effective teams and social networks (Teresa M Amabile, 1996b; Woodman, Sawyer, & Griffin, 1993).

Mihaly Csikszentmihalyi published the first report of his studies of creativity in the year 1964. He observed the behaviour of artist students during discovered problem situations at the School of Art Institute of Chicago (SAIC). Later on, he conducted further empirical and theoretical exploration of the personality of young artists at SAIC applying Cattel's 16 Personality Factors Questionnaire (PSQ). Another critical study was called 'Creativity in Later Life' and involved person over 60 years of age who made significant contributions to a domain - means he interviewed several Nobel Laureates and Pulitzer Prize winners. The interview questions addressed several broad issues like career and life priorities, relationships with other people, working habits and insights, and attentional structures and dynamics. In this context, Csikszentmihalyi developed the Systems Model of Creativity (SMoC) in his 40 years lasting researchers career. The Systems Model of Creativity (SMoC) is based on the contemporary socio-cultural approach (Csikszentmihalyi, 2014, p. 163).

Now the historical development in creativity research, especially the various approaches, are described. Now, therefore, formal definition of the terms creativity, idea and invention are specified for further use, also referring to the encyclopedia of creativity gathered by Mark A. Runco (Runco, 2014, p. 405).

As a definition Creativity is a form of human capital. Creativity is the potential of humankind to adapt to new realities continually. Creativity has a relationship but is also distinct from other significant human capabilities and behaviours, such as invention, innovation, imagination, and adaptability. Consequently, the social sciences and behavioural sciences are often the first sources of research on creativity while the creative process is multi-faceted and challenging to define; contemporary creativity research will be used as a starting point to familiarise the concept of Stimuli of Invention. The ancient conception of an idea lies in Plato's philosophy as the pure concept of things underlying the phenomena. Nowadays definitions refer to the idea as a concept of something at a high level of abstraction, or the model that determines someone's thinking and acting. In the creative sense, we understand by the idea the thought, the imagination, or the good idea.

The terms ‘good idea’ and ‘invention’ are closely related to the zeitgeist during the Industrial Revolution and to the work of Joseph Rossmann and John C. Huber in the 19th century. Joseph Rossmann based his work on the patent system and, on this basis, questioned 700 inventors. As a result, he defined the invention process, which, in addition to preparatory activities such as information retrieval, analysis and critical examination, postulated the primary activity as the "birth of the new idea - the invention". John C. Huber examined different patterns of inventivity, but his data resulted in a random pattern of the invention whereas he came up with a distinction between creativity and inventions based on his definition of patented inventions. Formerly a patented invention had to be new to the world. The relevance for a domain was no longer sufficient; to be useful it had to show economic merit.

Discourse

This discourse is about the first two waves of creativity research that was mainly defined by psychologists, the term innovation till today is driven by economists, the research itself defined the discovery in the eras of Nikolaus Kopernikus (1473-1543), Johannes Kepler (1571-1630), or Isaac Newton (1642-1727). In research terms the invention may be the less laden one, but

as you could imagine there are definitions for an invention which is the reason for this discourse to give insight about the following questions: How Creativity leads to invention and innovation, and what is the distinction between invention and innovation?

In general, starting with the more obvious point, creativity is needed to create new products, new services, and new business models on which the company's economic principle of growth and sustainability is based. It is Innovation if a company can profit from these new, origin ideas. Latest Joseph A. Schumpeter tied the notion of innovation to commercialisation and entrepreneurship (J. A. Schumpeter, 1934). Other authors point out that Richard Cantillon (1755) in his work the Origin of Economic Theory was the first who defined entrepreneurship (Cantillon, 1755).

The definition of the invention might be more complicated. Starting with the work of Joseph Rossman (1964) his definition of invention 'is not necessarily limited to developments in the physical sciences and the industries, as it is ordinarily assumed. The term invention embraces all new developments in the social, administrative, business, technical, scientific, and aesthetic fields,' (Rossman, 1964). However, Joseph Rossman's work was based on 700 inventors holding an average of 39.3 patents. Later I will come back in a historical context to the development of the patent system, but to cite John C. Huber (1998) explanation to the creativity and patents, 'to be new, the invention must be new to the world, not just new to the individual, but new to the domain or new to the field. To be useful, it must have some economic merit, not just relevance to the domain,' (Huber, 1998).
Claiming for Joseph Rossman's definition, I would refuse the conception that invention must be based on economic merit. Therefore, I would question if an invention has to be useful, effective or can be fancy absurd. Maybe Joseph Rossman introduced the 'some' into his wording to show a potential question mark about the reasoning for economic merit. Today the understanding of economics is much driven by its synonyms like monetary, financial, commercial, profitable, cost-effective, trade and industry - may be too much.
I leave this open at this point in the thesis as were are still in the introduction. I will come back to this discourse in the chapter the definition of the

invention, and from the experiences, I made within citizenship projects like Repair Cafe, Feinstaub-Project, 1$-Glasses which are grown or showing up in the Maker Community.

End of Discourse

As you could see, the Science of Human Creativity and Invention is the interdisciplinary approach to combine 70 years of research, the mixture of different traditions, a significant number of authors, a range of results over time and insights evolved as the interdisciplinary path to socio-cultural approaches. Moreover that is only a contemporary aspect of research to be considered. As technology enables new ways into neurosciences and new insights about the functions of the brain, the research results from the first and second wave will be scrutinised, as new insights of the quantum research have questioned the theories in the domain of natural sciences. Also to question the third wave theories like the Systems Model of Creativity (SMoC) under social change circumstances like the postmodernity and additional effects of technologies like the internet on our social behaviour within society and culture. Maybe we have to carefully start a fourth wave led by the qualities and dis-qualities of technology and replace the economic drivers for other long-term, positive effects on Human Creativity and Invention.

1.2 Research Focus - Vision and Motivation for Research

Firstly I will start outlining a few of the themes and systems models I found from different academic sources published about the topics of invention, innovation and the solutions that people are searching for problems they are facing within the organizational development. I also state where and when the idea of the stimuli of invention evolved. Moreover, as earlier mentioned the definition of the invention is complicated, it becomes a fundamental element of this research.

It is starting with techniques and tools that assist in problem solving and invention. As there is a myriad of papers available about it, I will choose one as exemplary for the others at this point in writing.

Victor E. Ross, in 2006, published a journal article in Science Direct, titled thinking skill and creativity. Victor E. Ross describes his model of inventive ideation. He states that there is a dilemma as to the creative thinker there is a decision to be made which of the plethora of options about tools and techniques to choose and that this would require more skills from the thinker to produce such novel ideas. Ongoing, he explores his idea about the mechanisms that are used by these techniques. In his conclusion, he suggests that ten generic thinking strategies, or mechanisms, that are applied either in sequence or parallel, to different problem attributes can be described in his model of invention ideation (Ross, 2006).
Is it that easy? The invention as a process of use, substitute, and replace mechanisms? If you read his article more carefully, he mentions elements of fun and experimentation as well as a vital ingredient of a successful creative endeavour.

Christopher M. McDermott and Gina Colarelli O'Connor, 2004, published a report in the Journal of Engineering and Technology Management, on a 6-year longitudinal study of 12 radical innovation projects in 10 large established US-based firms which are titled ‘the human side of radical innovation’. As this report is headquartered in the context of large organisations, it deals with the human factors that enable radical innovations and how the organization can utilise these more broadly for greater radical innovation success. More than twice Christopher M. McDermott and Gina Colarelli O'Connor mention that circumstances inhibit people's success and it is to care more about these. 'It seems critical to consider mechanisms that work and do not work to leverage these human aspects of radical innovation.' Interestingly, they include a table about the key member's disposition during and after project completion where reasons are given.

Also, not getting into deep into further argumentation at this point. I would question, in an organization independent of its size, - that it is easy to build in mechanisms on 'factors that enable and those that inhibit entrepreneurial people in their efforts to commercialise radical innovations in large established organisations successfully,’ (O’Connor & McDermott, 2004, p. 12).

What if we accept that human factors are vital and we accept a specific skill set is needed; what if we masking the economic drivers and avoiding this approach to utilise the invention and 'play it again, Sam' structures of organisations, called exploitation (Cyert & March, 1963; Martin, 2009; M. L. Tushman & O'Reilly Iii, 1996). At his point, the idea evolved to refine the definition of innovation to the definition of invention and focus to the human's stimuli of invention. This is where we have to go deeper into the literature; this is where the Maker Movement starts to play a significant role and where we have to keep in mind how cultural traditions may drive current thinking. As this idea firstly sounded very new the following literature review figured out that researchers already asked similar questions,

> 'while most economists accept, even if merely for didactic purposes, Schumpeter's depiction of technological change as a linear process of invention, innovation and diffusion, the bulk of their attention has typically concentrated on the later stages of the process. Such a focus has undoubtedly advanced knowledge of the economic dimensions of introducing and developing new technologies; it has, however, shed little light on the topics of invention, technological creativity and knowledge production.' (Magee, 2005b, p. 29)

As research was conducted on the invention, or the process of the invention, reading into this literature revealed that this research is mainly based on the existing knowledge of the 2nd wave of Human Creativity and Invention. The inventor got into focus, exemplarily like the research of Patrick Maggitti, Ken Smith and Riitta Katila that conducted inductive case studies with ten randomly selected inventors that where mentioned by the book 'Inventors at work' (Maggitti, Smith, & Katila, 2013). Within their dynamic emergent model of the search and discovery process of the invention, they define stimulus as something singular, initial for the inventor and something at the starting point of their process model. Neither the less, they already pointed out the complex systems view of the invention process, where they defined the interaction between a changing context, the invention process and the evolving searcher's knowledge, experience, and motivation. As a reference to the earlier research of Mihaly Csikszentmihalyi (Csikszentmihalyi, 1996) is

given, they left the research about his Systems Model of Creativity (Csikszentmihalyi, 2013, 2014) open, maybe because Csikszentmihalyi's book was in press at this time.

Concluding these thoughts with the idea of researching with people that had been inventors in the past or may become inventors in the present or indefinite future. Exploring these peoples with their socio-cultural circumstances and present interactions to potentially identify behaviours, techniques and habits that stimulate their creativity and their predisposition to invent. Selecting a context where I suppose people are largely technophile and preparing technology-based inventions, - hopefully for the better.

1.3 Aim and Research Questions

The research aims to establish preconceptions of stimuli of invention based upon the contemporary research in Human Creativity and Invention, mainly the third wave of socio-cultural research on creativity and invention. It is about exploring an insight into opportunities to influence creativity and to explore the presence or absence of these stimuli of invention amongst the subcultural community of the German Makers.

1. What factors stimulate invention within the German Makers Community?
2. In what ways German Makers could improve their skills to invent?

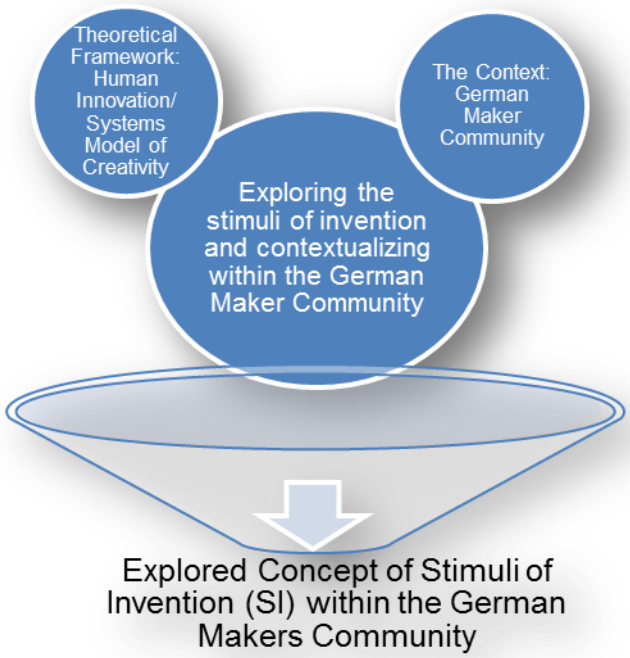

Figure 1. Exploring the Concept 'Stimuli of Invention'

The newness of this approach, or to start with the gap in the earlier research conducted either on innovation or invention is, that there is the belief of the existence of a process which is stable, repeatable, linear and sequential; and there has to be only the right, singular stimulus, often described by the need or an inconvenience, that triggers this process (Maggitti et al., 2013). Also, this process could be discovered, analysed, structured, influenced, controlled and later on established in any organisational context to produce inventions, patents and innovative products and services. My two aspects to focus on

are, firstly, there are a bunch of stimuli, and these stimuli can occur anywhere, anytime. Secondly, to identify the sources and directions, these stimuli come from using Csikszentmihalyi's Systems Model of Creativity (SMoC) as an orientation to cluster into domain, field, and individual; as well as, to follow timelines of interactions like the transmission of knowledge, variation and simulation of new variations, and the selection of new variations and to set standards (see Figure 12. The Systems Model of Creativity, page 109). These interactions should be observable within the domain and field of the Maker Movement and with a focus on the individual Maker and with a focus on habits, techniques, and skills Maker use to collaborate. Using context coding on gathered data should allow further insights that more than one stimulus exist, and the identification of other stimuli, their sources and directions to the invention.

A Doctor of Business Administration (DBA) thesis requires a contribution to theory and practice. My study offers both, while also contributing to the understanding of methodology. All of these aspects are briefly highlighted below and explored in detail in the concluding chapters.

Contribution to theory is achieved by extending the knowledge, as I induce a recent discussion about creativity, invention and innovation that at first-hand gains to de-escalate the overwhelming discussions about innovation. Through a renaissance of the notion of invention, I will uncouple human creativity and invention from the pressure of the economy. Today the concept of innovation is permanently linked to Peter Schumpeter's definitions of innovation and entrepreneurship (J. A. Schumpeter, 1934) or Peter Drucker's concept of the corporate society (Tarrant, 1976). The uncoupling will set aside that all of our new ideas have to be tried and proven for any economic reason. The incorporated selection of ideas that are only filtered by usefulness, effectiveness and meritocracy will limit the comprehensive picture. It has become apparent over the last decades that the technology-innovation-driven thinking destroyed our environment, also part of our humanity and did not only lead to the better.

It is wrong that we use our creativity only in this direction of technological innovation and continuously wasting ideas for the better of the world and society. The latest technological innovation like the smartphone has shot us into the Digital Age and had, has and will have an furthermore impact on our culture and social life. It is the time that we use all of our creativity to invent social, administrative, business, scientific, and artistic ideas, benefits, merits rather than only accelerating an economic race which is founded mainly on technological innovation and monetary return.

Therefore the purifying of ideas about innovation or giving meaning to the invention without an economic hassle is a vital input to today's understanding.

Contribution to methodology is achieved by the construction of a meaning of the stimuli of invention as a collection of factors influencing our skills to invent for a better world and society. This collection of factors is coined from the ideas of a socio-cultural approach to Human Creativity and Invention as the Systems Model of Creativity (SMoC). The insight of Stimuli of Invention (SI) then may lead to further discourse about the Systems Model of Creativity (SMoC) and the use of socio-cultural approaches in organisational settings (Csikszentmihalyi, 2014; R. Keith Sawyer, 2011).

My goal with this thesis as it became more evident over time is to start an academic discussion about redefining the science of Human Innovation as R. Keith Sawyer frames it into the science of 'Human Creativity and Invention - Invent to the better'.

A definition of Innovation following Michael A. West is that innovation involves both the creation of a new idea, and the implementation, dissemination, and adoption of that idea by an organisation (West & Altink, 1996, p. 4). Alternatively, to conclude, 'innovation is not simply the creation of something new. […] Explaining the processes requires an interdisciplinary approach that focuses not only on the individual who originates the idea but also on the entire organisational system, and the complex social and interactional processes that result in implementation, dissemination, and adoption,' (R. Keith Sawyer, 2011, p. 254).

As a contribution to practice, I will review this concept of Stimuli of Invention (SI) in a field where people already consciously or unconsciously make use of the stimuli of the invention. This field has been mainly researched with a focus on technological innovation and economic reasons as crowdsourcing. This field has already been flagged by the notion of the Maker scene, Maker community or the Maker Movement. The Maker Movement started at San Francisco Bay area, maybe the result of a lucky moon shot, but it might be commendable to bring more people up there using their creativity fostered by the stimuli of the invention. Then the contribution to practice is a mental change in society and culture where we ‘invent to the better’.

A definition of the Maker Movement has to revolve around making, the relationships between creativity and making has not been fully resolved so far, although creation is one of the essential characteristics of human life. Firstly, the hands-on creation, the transformation from imagination to something mostly physical is the origin of the individual Maker. In brain research, it has been proven that the use of materials (both physical and digital) and experimenting with these media stimulates someone’s creativity. The fact that this tinkering with novel materials and different media can expand the human mind in its constant effort to become creative. Secondly, the critical aspect is at the identity of the individual who becomes the Maker, as described by author David Lang in a series of stories called from ‘zero to Maker’ about Makers (Lang, 2013), when individuals define their project for their passion and further inspiration. Also to define the individual’s identity as being part of the Maker Movement, the aspects of collaboration, the continuous experimentation, the together learning of skills to create inventions that are mostly based on a common, open source-based thought process. This individual’s identity also includes progressing in an interdisciplinary team, transforming humans experience, and understanding technology as an aid again. The used media are more comprehensively understood like software, data, information, the genome, and biological relations towards new research and further progress in biology. The Maker Movement is therefore really to be understood as a movement in which

individuals, contemporary themes and organisational structures are subject to constant socio-cultural and content-related transformation.

The definition of a Community includes the aspects of individual interests, the way of living together and the shaping of a Community within a Society. At the level of individual interests, it is usually a matter of commonalities, such as general common interests, as well as a common past and social, economic or political interests. Secondly, it may also be the ways of living collectively in a group which forms the Community. Emphasised by professional symbioses, in Germany, for example, the professions or guilds in the craft sector, and to this day the trade guilds and chambers of commerce, in which the professional ethos and their trade rituals are perpetuated. Thirdly, a community can also be linked by a common set of rules, or, as in the early Middle Ages of Germany, by rules that were initially not written down and implicitly implemented in practice, such as the professional honours and ethics of the profession. Nevertheless, it is also possible to create a sense of community in the way institutions such as schools and universities do, and companies and businesses, or more and more expressed with the terminology of building social networks. It should be noted in the definition of Community that in the past the spatial dimension was more strongly manifested in the form of cohabitation, and nowadays the communication via technologies such as smartphones and computers appears to dominate through common interests the creation of a Community. It will remain to be seen to what extent the external environment also is an essential component in influencing the innovation and creativity of individuals and organisations (Teresa M. Amabile & Pratt, 2016).

A definition of the meaning of Space in the Maker Community context is first of all understood as a physical space, as an open workshop. Behind it stands the consideration of free-access to utilities that one might not be able or willing to afford at home to that extent or dimension. Today, utilities such as laser cutters, CNC milling machines, and 3D printers can be found as typical tooling examples in the Makerspaces and Fablabs. Many of these facilities were initially based on voluntary work to set up and run these workshops, but today many of these facilities are based on operator models with

memberships and contributions to the maintenance of the facilities, as for rental costs and supplies. The tools are usually donated to the facilities or made available on permanent lending when private households and workshops are dissolved. These local facilities tend to have a limited, regional group of users; trans-regional events are then again the Maker Faires, at which some of the facilities present their work and results, on the one hand, and attract new members due to the activities, on the other.

In the context of the Maker Community, however, the notion Space should also be understood as an offer and opportunity for people to meet. Here the occasion is created to get in contact, especially noticeable in the Repair Cafes, where coffee and cakes are often offered and where seating is available. With regard to age and gender, the Repair Cafes are initially more geared towards older people and women, and the Australian Maker Shacks have also taken this approach. The Maker Faires offer a wider audience with a particular focus on families with children. For the visitor it is not very obvious to which extent the Makers are cross-regionally engaged in their joint projects, many of them meet on a regular basis at the Maker Faires.

The notion Space may also be put in the context of personal space, including the context of the Maker Community, in other words the handling of distance with other people and things. Here it is noticeable that the approach to each other, the active creation of a meeting and communication, is common to all Makers, but not so much to be extroverted as a personal trait, but rather as a learned and trained behaviour in the Maker Community. The interaction and sharing is a typical behaviour in the Makerspace, as well as at the Maker Faires.

1.4 Organisation of Thesis

This introduction consists of limited illustrations to support the readers understanding for the following preparation of the research design. In this context, the introduction gives short background information about the science of Human Creativity and Invention; what the understanding and meaning of Human Creativity and Invention are today and how understanding and meaning developed over the last seventy years in distinct waves. The introduction unlocks the vision and motivation of my research, the research objective, the research questions and the demarcation.

The content, belonging to the central thesis, is included in part one, two and three as follows: Part one - the literature review, and research design. Part two - research findings and validation of results. Part three - the discussion, implication and conclusion. Every part is linked by a chapter called ‘Looking Back, Looking Ahead’ to summarise personal thoughts and give further guidance through.

The part one consists of the literature review and the research design. The literature review is starting with a historical approach to define a fundamental notion of the invention and the stimuli of the invention for this research context. The literature review is subject to point out the rationale for conducting this research and overcoming flaws of earlier research. For structuring the literature review, twelve particular themes are used corresponding the critical engagement with technology, personal traits of individuals, the role of knowledge in institutions and society, protection and reputation of inventions and inventors. The research design structure is ten chapters beginning with the research methodology, the research methods, the proof of the quality of the research design by a set of principles, the role of the researcher and ethical considerations. The last chapter of part one is the research schedule, before closing by ‘Looking Back, Looking Ahead’.

Part two describes the data collection and data evaluation, mainly the process of immersion with the Maker community in Germany, the primary data that I collected about the German Makers, and to contextualise additionally secondary data from literature about the Maker communities in

other countries like China and US. Part two also includes contemporary data from experts in the field of creativity research that is relevant for data analysis and the validation of results. The evaluation of results is conducted with a set of principles discussed and predefined in the research design.

Part three consists of discussion, implication and conclusion of the findings, evaluation results and limitations. Part three ends with critical acclaim of the research conducted and potential outlook for future research in the field of Human Creativity and Invention or within the Maker community in Germany.

The appendix contains references, a literature review summary and should give evidence of the researched with a subset of artefacts enclosing questionnaires, transcripts, field notes, codebook and intermediate results by the process of concept and pattern coding.

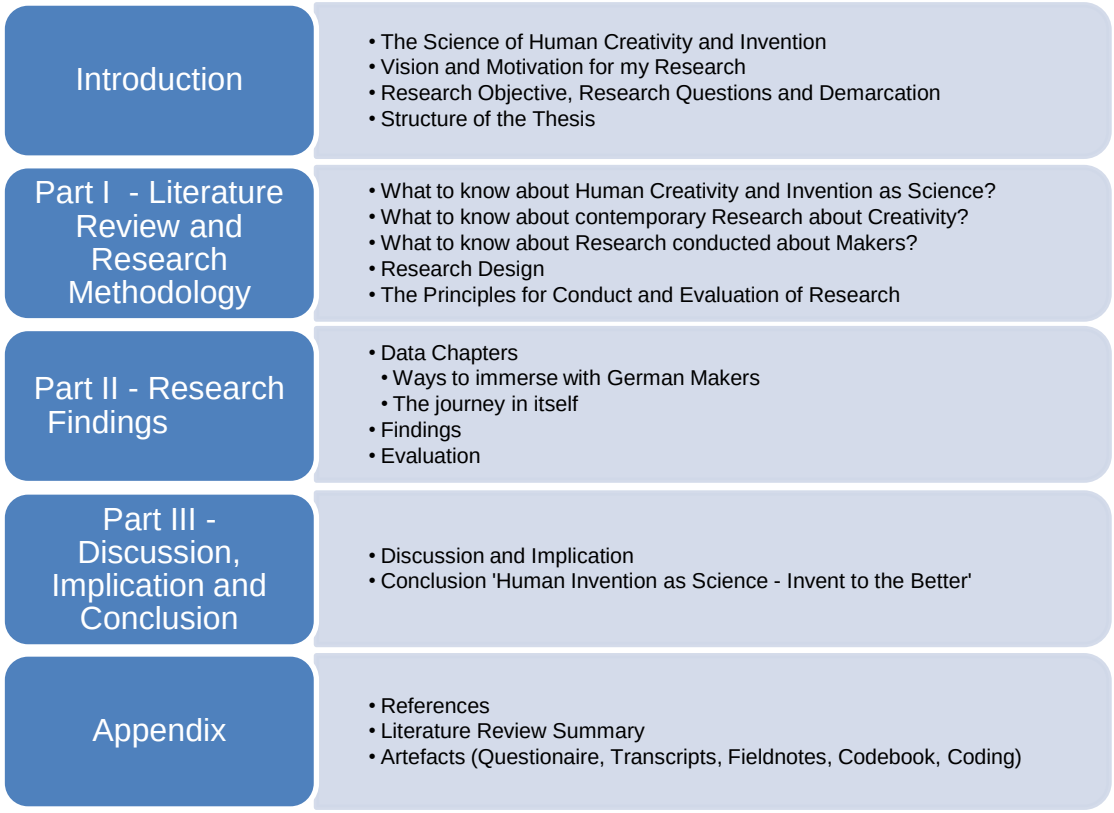

Figure 2. Structure of the Thesis - Overview

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Looking Back, Looking Ahead from Introduction

This introduction should have given you a rough overview, what the understanding of the contemporary science of Human Creativity and Invention is and a glimpse of the kind of research that had already been done during the last decades of creativity and the relationship to innovation. The introduction should have given an insight into my background as a researcher, also to declare my stance that I want to confront the world with my descriptions and explanations emerged from the existence of relationships. Relationships foster our vocabularies, assumptions, and theories about the nature of the world and the way we go about studying or carrying out research. As I follow the concept that individuals constitute society, I believe in the rise of institutions of democracy, public education, and the importance of individual care. The care for relationships is prime.

There is no difference between true or false accounts, or in effect, any description of the world is as true as any other. For me as a constructionist, the research aims to interpret, construct and change the world in valued directions; change all-around thought about innovation into the direction of 'Human Creativity and Invention - invent to the better'.

What is next? - In Part I, I will analyse sources of what people have written about an understanding of the invention. They are telling from their perspective, and they are speaking from a particular standpoint. We will start with a historical thread located in Germany and go on to use contemporary research to make meaning about the utilisation of the notion of invention and relevant themes. As Ludwig Wittgenstein (1889 -1951) proposes, words acquire their meaning through the way they are used.

As through this first preconception, we then get into the cultural tradition about the meaning of the invention; we will then have to step further with a discourse analysis of interviews with researcher and their say about creativity and how to influence creativity. Our objective for upcoming preconceptions is to get a vivid understanding of the invention, and that allows us to make

sense of previous research about the Makers and give us the chance to design empirical research conducted in the subculture of Making.

I can only hope that my approach to this thesis will enable you as the reader to find interesting ideas, useful insights, and possibly inspiring potentials. It is not intended as the last word but as a beginning. As the topic reaches into an area of contemporary social change anyone is invited to participate in this discourse. I am bounded by my life experience as you as reader bring your unique background to these pages.

Social constructionism leads these words. So life experience from a tradition is that good as the new ideas evolving from scepticism, critique and creativity. 'Social constructionism may stimulate growth from the soil of critique, but this does not mean abandoning the past,' (Gergen, 2015).

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PART I - Literature Review and Research Design

2. The Literature Review

The literature review can be understood as a result of a journey, a tidied up version of the research with a clear starting point for the research and the maintenance of additional literature over time. There are also researchers questioning the relevance of the literature review if it does not show the journey of understanding and misunderstanding of the researcher (Wolcott, 1990). For me the literature review is part of my journey and part of a story; it is like a diary for later reflection on the significance of some of my thoughts. Moreover, for you as a reader, it might be first thread to follow and then later contributes to your significant thoughts nurtured by your experience and historical perspective.

> ‘Plausible accounts refer to ethnographic writings that are convincing not only because they pay attention to detail, but because the overall narrative incorporates the viewpoints of multiple actors and ties these together in a culturally coherent and articulate fashion. Many features can contribute to the plausibility of the research narrative including the development of a strong storyline, evidence of the researcher's involvement in the field, a sense of historical context and coherent weaving of disparate events within the field,’ (Prasad 1971 p. 108).

Is this literature review a paved path? - No, it may be sometime become stony and sometimes rocky, as there may be some thoughts left as pieces to be removed or picked-up. However, maybe another researcher hike along and think what a nice one and picks it up. Neither the less, I want to follow the fundamental principle of the hermeneutic circle which I follow on in this chapter and chapter 3.5 Process of Literature Review, you as the reader will find additional underlying aims and methods applied for the literature review. The principle of the hermeneutic circle suggests that all human understanding is achieved by iterating between considering the interdependent meaning of parts and the whole that they form. As the authors Heinz Klein and Michael Myers describe, the idea of the hermeneutic circle suggests that we come to understand a complex whole from preconceptions about the meanings of its parts and their interrelationships. The process of understanding moves from a precursory understanding of the

parts to the whole and a global understanding of the whole context back to an improved understanding of each part, i.e., the meanings of words. Thus the movement of understanding is continuously from the whole to the part and back to the whole building in concentric circles the unity of understood meaning. The study starts with parts which are the preliminary understandings. The whole understanding then consists of the shared meanings that emerge from the interactions between these parts. After some iterations of the hermeneutic circle, a complex whole of shared meanings emerges. - Forming a complex web of interpretations (Klein & Myers, 1999, p. 73).

As I am writing this I reflect what happened from the beginning; I started with three threads, the (i) first thread was driven by my professional background process management and process improvement in research and development organisations. An eye-opener was the book of Roger Martin, dealing with exploitation versus exploration, and why design thinking is the next competitive advantage (Martin, 2009). In 2015 I also participated in Design Thinking Workshops with Thomas Lockwood (Lockwood, 2009) at New York to get a more in-depth insight into what was happening under the direction of the Design Management Institute (DMI). Thomas gave me the advice to follow the ideas of Christian Madsbjerg summed up under the theme ‘the moment of clarity’ and described how anthropologists look at organisations (C. Madsbjerg & M. Rasmussen, 2014; C. Madsbjerg & M. B. Rasmussen, 2014). All of this happened under the focus to change organisations I knew so far from my former profession. When 2016 I visited Cheltenham for the first time I had talked about my current understanding of the topic, and all would be directed into the discussion of leadership in ambidextrous organisations (O'Reilly Iii & Tushman, 2013; M. Tushman & Euchner, 2015; M. L. Tushman, Smith, & Binns, 2011). In the interaction with the supervisors at the University, it became clear that I had to look into additional literature which questioned the kind of organisation I had in mind and how organisations culture could be described and may evolve (Laloux, 2014; Morgan, 2006).

My curiosity led the (ii) second thread about how we got into this Digital Age we are talking so often about today. When was the start of the computer, Conrad Zuse, Alan Turing, Steve Wozniak? Who were the inventors of personal desktop computers, laptops, mouse, graphical user interfaces, iPods, smartphones and much more, we use today? Where had been the labs, companies and locations these inventions happened, Bell Labs, Hewlett Packard, Palo Alto? - Did this all happen only in the United States? Superficially it may sound like getting into a discourse about innovators versus adaptors (Isaacson, 2014b; Kirton, 1992). However, for me it became more the focus to look at history, to see the timelines and to recognise the bias of current state information. Who would know that Ada Lovelace who published notes on Babbage's Analytical Engine 1843 could count as the inventor of what we call Digital Age today (Isaacson, 2014b)? Who will know the vital role of women as Jean Jennings, Marlyn Wescoff, and Ruth Lichterman for the development of today`s programming (Isaacson, 2014c)? Writers like Walter Isaacson and historians give answers. During this work in historical sources, I figured out that C.H. Beck is one of Germany's oldest publishing firms (established in 1763) and they already published a journal initially been "Erfinder und Unternehmer", inventor and entrepreneur. Interestingly the root of the German word 'Unternehmer' could be understood as 'someone who does or make something'. Within these historical sources, I also got the text from Johann M. Beseke which I analyse in one of the following chapters in detail. However, to conclude this second thread, it was mainly about technological innovation and its historical roots.

The (iii) third thread started with the individual. The artist, his creativity, his personality, his context. The craftsmen, his capability, his education. Source of my inspiration where books like 'explaining creativity' from R. Keith Sawyer (R. Keith Sawyer, 2011) and David Runco's 'encyclopaedia of creativity' and his latest book about theories and themes dealing with creativity in research, development and practice (Runco, 2014). Moreover, two Oxford handbooks firstly innovation management, and secondly creativity, innovation and entrepreneurship (Dodgson, Gann, & Phillips, 2013; Shalley, Hitt, & Zhou, 2015).

I ended up with questions like how is the individual influenced by society, culture? In this thread, I acknowledged the research field of Human Creativity and Invention, identified the Systems Model of Creativity (SMoC) for my later work and a (new) model of forty-two models of creativity that supports my arguments for the selection of the Systems Model of Creativity (Csikszentmihalyi, 2014; Greene, 2001). Not to forget that I had to build knowledge about theories in sociology (Holborn, Langley, & Haralambos, 2013) and cultural-historical psychology (Smidt, 2009).

A rough overview of the content of the current endnote library I am using can be found in the appendix 'Appendix I Literature Review Summary'. In parallel, I get a weekly digest from Academia.edu about invention, innovation, making and design thinking to maintain my library. As well as I search for conference papers, e.g. HCI International Conference on Human-Computer Interaction, and papers from the leading authors identified in this thesis, e.g. Silvia Lindtner for her ongoing research about the Maker Movement. Also, getting feedback about my contemporary research, I made publications at the Doctoral Colloquium 2015, 2016, 2017 and 2018.

The Anticipation of Preconceptions and Context

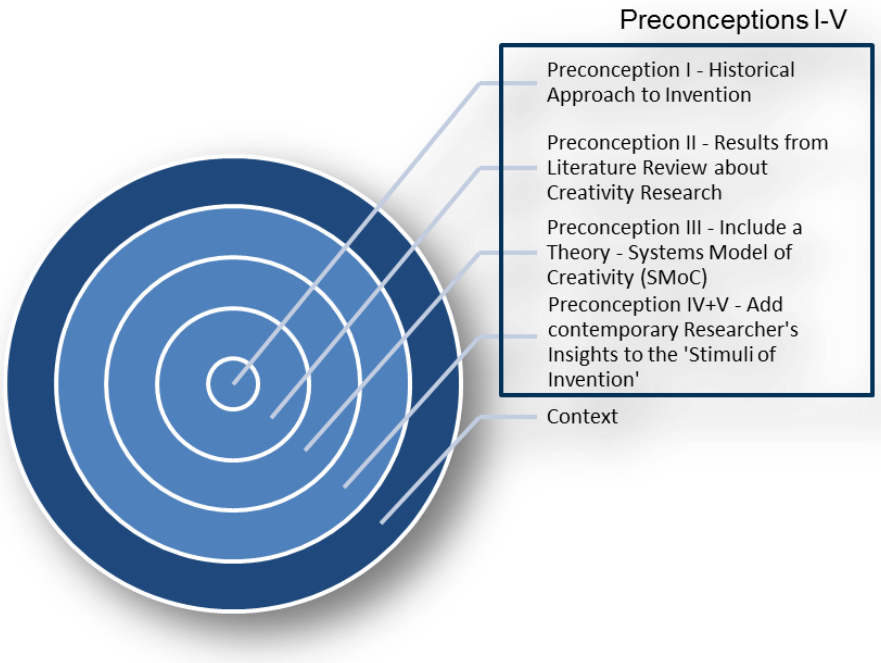


Figure 3. Overview Preconceptions from History to Contemporary (I-V)

So for this literature review, it had been iterated in preconceptions, adding more and more understanding first about the historical perspective on the invention, next to the waves of research about creativity, and thirdly, theories and models to structure the information gathered on this way. As a result, this complex web of interactions has formed the Preconception of Stimuli of Invention (PSI). During the conduction of research, this Preconception of Stimuli of Invention (PSI) will be contextualised in the subculture of Makers and therefore initiate additional interaction between individual Makers and me. The purpose is to use the multiple interpretations among the participants, and the possible contradictions between the Preconception of Stimuli of Invention (PSI) to develop a deeper understanding about and give meaning to the notion of Stimuli of Invention (SI).

To start with the initial preconception of the meaning of the notion invention, given by historical background and categorised by influences of economics and other fields. From my point of view, this is important to get the glimpse of an idea from my understanding why the distance from economics might help to figure out what Stimuli of Invention (SI) are.

2.1 The Definition of Invention - Historical Approach

> ‘Invention, as defined by Webster's Dictionary, is a device, contrivance or process originated after study and experimentation. Another definition of invention comes from the Patent Office, which states that invention is something that is novel and useful: a novel, meaning that someone skilled in the particular field would not know, and useful, meaning that it has some practicability.’ (Hertz, 1999, p. 95).

This definition is part of Mark A. Runco's Encyclopaedia of Creativity. The author Michael Hertz started to draw a picture of what invention is all about, parts of this definition are the evolutionary invention, a mental model, a problem space, revolutionary invention and technological momentum (Hertz, 1999). Michael Hertz tries to avoid any relationship to economics; the only point might be the role of the patent system. He describes the patent system as a patent protecting an invention. The process of obtaining a patent ensure that no two people can have a patent protecting the same idea; no one can use the ideas or processes without receiving some permission from the patent holder; there is a time limit for protecting but afterwards anyone who wishes can use the patented object. Thus Michael Hertz concluded that the patent system not only helps protect intellectual property; it stimulates development. Following his words, he avoided terms like merit, compensation, or in other words; he avoided drawing any connection to economics. An early distinction between innovation and invention goes back to Joseph A. Schumpeter's work ‘The Theory of Economic Development: An Inquiry into Profits, Capital, Credit, Interest, and the Business Cycle’ that was published in 1912. Moreover, later in 1934 where Joseph A. Schumpeter made that distinction between the inventor and entrepreneur; ‘The function of the inventor, or of the technician at all, and of the entrepreneur, are not coincident. The entrepreneur can also be an inventor and vice versa, but only by chance.’ (J. Schumpeter, 1912; J. A. Schumpeter, 1934).

Neither the less, I want to go some further into the history of the notion of invention. In the 17's century, there was still the notion of 'Columbus invented America' to say that there was not a distinction between inventing and discovering. In the 18's century, people at England and France started to

make the following distinction, to invent means: using the own contemplation to create things and ideas which so far have not existed or not used in the same way. Discover means that after a mostly planned search, we can identify or find something outside of us, already existing, but hitherto hidden.

At the digital collection of the University of Bielefeld, I found to my knowledge the oldest German source about 'Selbstdenker und Erfinder' from 1784 by Johann Melchior Beseke (1746-1802). Johann M. Beseke studied theology, philosophy and law at the University of Frankfurt (Oder) and later lectured in philosophy and law at the University of Halle. In 1774 he moved to the Gymnasium Illustre (Academia Petrina) in Mitau where this article had been published (Beseke, 1784). Mitau today is part of Latvia.

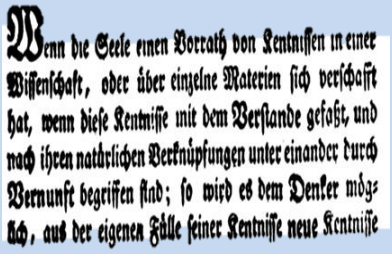
Excerpt Original text	Transcript of Excerpt	Translation of Excerpt
	Über Selbstdenker und Erfinder. Wenn die Seele einen Vorrat von Kenntnissen in einer Wissenschaft, oder über einzelne Materien sich verschafft hat, wenn diese Kenntnisse mit dem Verstand gefasst, und nach ihren natürlichen Verknüpfungen untereinander durch Vernunft begriffen sind; so wird es dem Denker möglich, aus der eigenen Fülle seiner Kenntnisse neue Kenntnisse hervorzubringen.	About self-thinkers and inventors. When the soul has procured a store of knowledge in science, or the individual matter when this knowledge is conceived with the understanding, and by its natural connections are understood by reason; It is possible for the thinker to produce new knowledge from his abundance of knowledge.

Figure 4. Early Definition of Invention in German Historical Sources

You could recognise from this small excerpt that self-thinkers start with an amount of domain-specific knowledge and by understanding and reasoning the self-thinker produces new knowledge to himself.

The complete original version with its transcript and translation is part of the appendix Appendix II Further Artefacts, about Self-thinkers and inventors from Johann M. Beseke. What follows next is the conceptual analysis of the text to get closer to what possibly supportive elements or stimuli of the invention are.

Johann M. Beseke describes two mental stages of an individual, the first stage is being a self-thinker and the second stage is the inventor. The self-thinker makes sense of his knowledge by understanding existing knowledge from science or individual matter. By reasoning and by reflection the self-

thinker create new combinations of concepts, which he recognises for the first time, as a new insight. These new insights, recognised by reflection, not by memory or instruction, are, therefore, really new to the individual. The individual would, therefore, regard himself as the inventor of such a proposition. If no one had ever before discovered and made known the proposition before, the individual is also really the first inventor when really nobody has ever thought of the proposition before. Johann M. Beseke concludes from this 'that every self-thinker, who is not merely concerned with the memorisation of knowledge, is also an inventor; constantly inventor in consideration of his knowledge; and sometimes also an inventor, by the knowledge available in the human world.' This last remark leads to the ideas of the individual approach and could be recognised as the discourse about little 'c' or big 'C' creativity. Interestingly, the next part of Beseke's text leads furthermore to the concepts of the socio-cultural approach.

> 'Without being a thinker, a man might have succeeded in taking a new thought here and there, by chance, but then it was only the tapping of a blind man in darkness. I cannot easily give a more fitting example of such fortunes, fortunate by mere coincidence then the writings of the men who composed the tenth book as compendium from a folio of existing nine books. If such a man is at the helm, once a self-thinker dares to recite a new thought or an idea which does not stand in those ten books, he reproaches him an unbeliever or a rebel,' (Beseke, 1784, p. 39).

Self-thinker and inventors may be hindered by knowledge of the domain itself, and gatekeepers in the domain and field. Johann M. Beseke also describes the role of the self-thinker in the society with structural elements like rules, norms and values and their way to becoming part of as exemplary an educational system.

> 'Self-thinkers are made by much trouble. One has to learn a lot, and also to forget a lot, to get rid of the slavery of the school, to escape from the despotism of the systems and compendia and to freeze in

> the founding of intellect, where, however, one still may occur, and may teach a better one,' (Beseke, 1784, p. 39).

Interestingly, Johann M. Beseke describes events, skills and habits within the process of the invention:

> 'When the learned thinker confronts himself with great and much knowledge quickly and successively, with distinctness and vivacity, he often experiences that thought passes like lightning. The flash passes quickly, but the thinker knows how to find the way again. He strengthens all his powers, imagination, memory, mind, and rationality, and now throws with all his strength onto the objects which the flash had given him in a brighter light. He describes himself the way which he took, took the pen in his hand, and now he slowly arranged in words what had happened so quickly before,' (Beseke, 1784, p. 40).

Johann M. Beseke also describes how desperately the inventor will use his skill, follow his intuition, and learn from failure.

> 'However, even when no flash of light passes through the thoughts of the soul, where no light of the day illuminates the horizon of his knowledge, he knows how to light torches to illuminate the darkness of the night in his face. He suspects there will be something hidden here; after that, he carries his torch, and finds what he sought, or finds nothing where nothing was; in this case, he does not at least repeat it,' (Beseke, 1784, p. 40).

Johann M. Beseke also refers to the role of personal knowledge and the interaction with others that will lead to further insights.

> 'The torch of this inventor is his knowledge; he carries them wherever knowledge still seems to be wanting. Thus he traverses his sphere of knowledge by the sunshine, or by the torch; and because this sphere often conflates with the sphere of another thinker, it is true that the other thinker is already versed in some parts of the world where the other is still seeking,' (Beseke, 1784, p. 41).

Discourse

Objection to this discourse: When was the patent system in Germany established? The first patent law of the German Reich was issued on 2nd July 1877 in the Reichs-Gesetzblatt.

After the foundation of the German Reich in 1871, a public controversy was held about patent protection. In 1864 the German Chambers of Commerce had demanded the abolition of patents because they were 'harmful to the general prosperity'. It was Werner von Siemens who recommended the beneficial aspects of the patent law to Chancellor Bismarck. Werner von Siemens pointed out that German products reputation had been perceived as 'cheap and bad'. Therefore, from his point of view, a patent law serves to strengthen the German industry and to give its products status in the world. At this time Chemnitz was one of the most important industrial cities of the German Reich, and it became the cradle of the German patent law and played a significant role in the creation of German patent law. The suggestion of the inventor and industrialist Werner von Siemens and the then Mayor of Chemnitz Wilhelm André founded the patent protection association. Under the chairmanship of Siemens, patent law was developed. Consequently, in the German Reich, the patent law came into force on July 1, 1877, at the request of the German Engineers Association (VDI), the patent protection association founded by Werner von Siemens, and the Mayor of Chemnitz Wilhelm André. The significant alteration was that patents after this date had to be published. Therefore patents were not only about to protect the merits of the inventor, but they also put pressure on current research and development activities of the industry.

These days many people are convinced that patent or intellectual property law is sometimes or often not having its intended effect. As mentioned, intellectual property law was intended to increase the amount of innovation investment. Today large firms investing in an extensive portfolio of patents, these dense networks of patent claims give them plausible grounds for threatening to sue across a wide range of intellectual property. They may do this to prevent others from introducing superior innovation and demanding

licenses from weaker competitors on favourable terms (Harhoff & Lakhani, 2016).

End of Discourse

What I wanted to show is, that before a patent law was established, there was no romantic view about inventing as Newton's apple sometimes suggest. Also today we are not sure if patent law fulfils its intention. When we read Johann M. Beseke's article carefully many ideas that we will find in today's research are already included. On the other end, today's ideas about invention are infected by the traditional thought that an inventor or often today big businesses have to be protected by patent and copyright laws. So I would argue that we have to be critical if we read definitions of inventions that might be influenced by this kind of thought, or ideology.

The following mind map shows how words, actions and objects of Johann M. Beseke's definition of the self-thinker and inventor may fit the Systems Model of Creativity (SMoC). The mind map is part of that ongoing discourse, and to which anyone - even you as the reader - may contribute. We try to uncover the array of relationships that Wittgenstein would call a form of life. We study the content of Johann M. Beseke's definition to give us insight into earlier historical times and to question our relationship as they favour specific values, either explicit or implicit. The inherent values may merely present our way of doing things. However, values give us insight into culture as it is part of every one of our relationships and also the opportunity to listen twice. We are incorporated in a specific tradition, but to listen twice encounter us with the prospect of suppression, conflict and oppression. To abandon the traditional empiricists' goal to prediction and control, we are enabling us to practice social critique and to liberate.

From this standpoint of listening twice, Johann M. Beseke's definition may lack the knowledge about socialisation and the aspect of nurture. However, in general terms, the importance of childhood and the family compared to the time in which Johann M. Beseke's stated this was entirely comprehensible as it was not yet regarded as essential.

As a result of the text analysis, see Figure 5. Preconception I - Invention. For this figure, I already introduced knowledge about the preconception III that is following in chapter 2.4 The Systems Model of Creativity (SMoC) to structure the information analysed from the translation into the three systems domain, field and individual. Also, I widened out these three systems into their additional meaning of culture, society and family background.

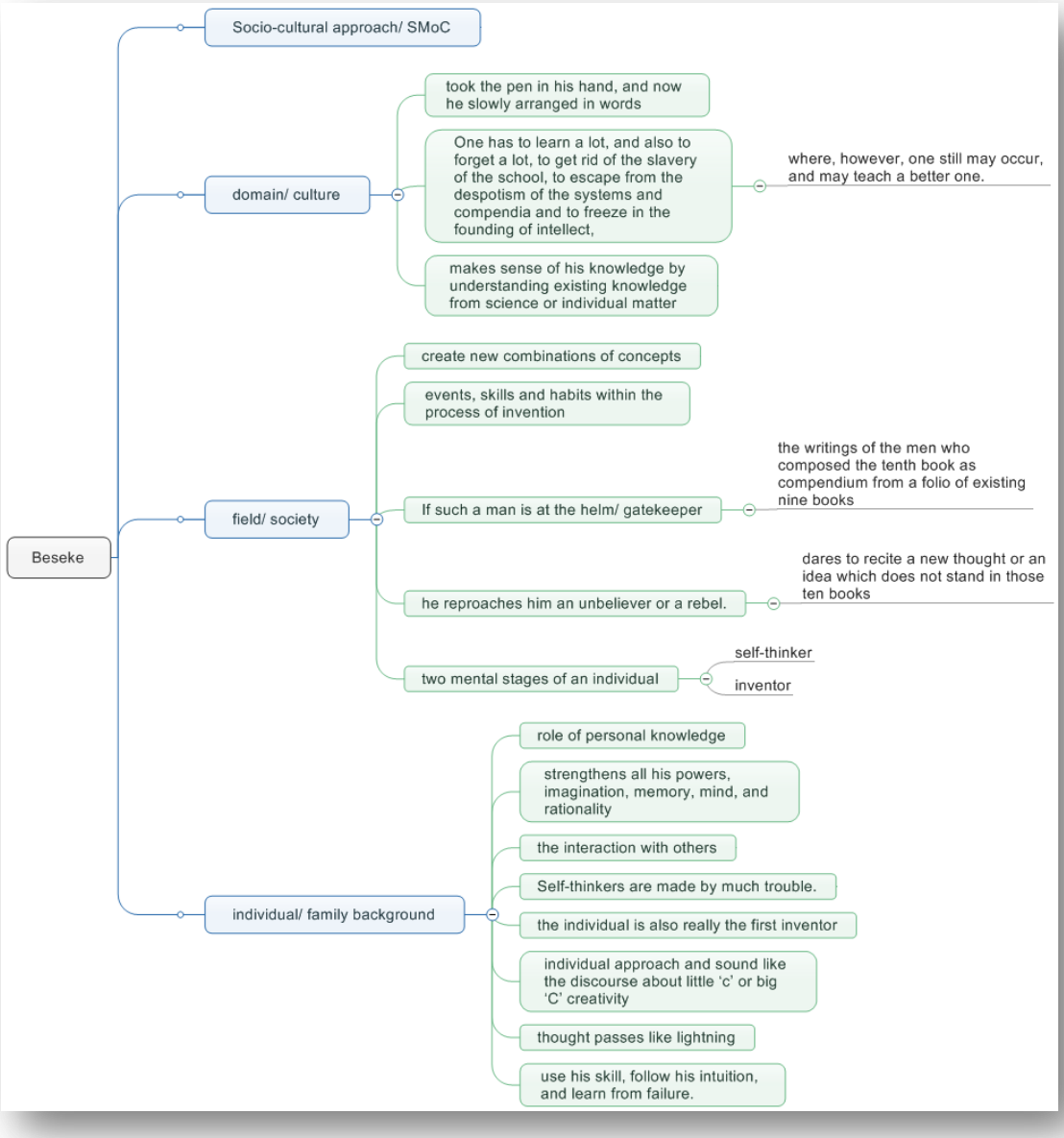


Figure 5. Preconception I - Invention

2.2 The Definitions of Invention by Research - Building Themes

From this historical perspective, we might get a sense of the meaning of invention and how broad the notion of invention could be seen. We now develop major, significant themes and try to get an understanding of the invention of contemporary researchers to build the second preconception.

'Invention is a terra incognita of economics. […] Neither the less, the study of what drives creative thought and makes specific environments more conducive to creativity is an important and worthwhile activity,' (Magee, 2005a, p. 45). I do not fully support Gary Magee's argument because it is not a terra incognita as we will see in the further chapters about research that had been already conducted. However, to seek a theory of invention with some explanatory power, this may be like to begin a journey to the terra incognita, as different research fields have to be interconnected. To name them: psychology, sociology, ethnography, economics, and science itself.

Figure 6. Potential Dimensions of the Definition of Invention

The following chapters add themes of principal authors of the social science disciplines including economics, sociology, and psychology and additional research fields, like human creativity, invention and education; these authors are cited with aspects of their research relevant to the invention process, the invention context or to the continuous development of Preconceptions on Stimuli of Invention (PSI). The first chapter (A.) is on the apparent and mostly cited theme: technology as the principal driver of innovation, but it will question our shared beliefs in the so-called technosolutionism (Silvia Lindtner, Bardzell, & Bardzell, 2016). The second chapter (B.) concludes research conducted by the individual or more specific artists, inventors and innovators. Also here lies the focus in the invention as the research about personal traits will be used widespread today, as an example the big five for giving the selection criteria of strong leaders used by Human Resources (HR) department in companies.

The next three chapters (C.-E.) join the research conducted about knowledge, society and culture focused on the invention.

Chapter (F.) refocuses on the definition of the invention as the organisational view will be introduced, and the discourse about innovation versus invention will be picked up again (chapters F.- H.).

As the chapters (A.) to (H.) are mainly based on ongoing but lasting research topics, the chapters (J.) to (K.) start showing the socio-cultural change about topics like the need for protection, the reputation to the right people, and believe in technosolutionism.

A. The Technology - Critical Engagement
B. The Individual - Personal Traits
C. The Juggling of Knowledge - When Irrelevant Knowledge becomes Relevant
D. The Knowledge Society
E. The Cultural Evolutionary Process - Systems Theory
F. The Inventions - Unwanted Enemies
G. How to Handle Invention in Institutions? - Part I
H. How to Handle Invention in Institutions? - Part II
I. Protection - Intellectual Property and Creative Commons
J. How Reputation is given to People in a Community?
K. Designed Obsolescence and Critiques of the User

Figure 7. Overview of Themes from Literature Review

A. The Technology - Critical Engagement

Technology is foremost seen as the driver of innovation today. From the historical approach, at the beginning of humankind, technology is seen as getting a solution for better fulfilment of apparent needs, exemplarily solutions or tools for hunting, or heating, in short for survival. Today technology leads to solutions, where the apparent need is not inherent anymore for these solutions. These solutions may be only created for their economic merit. Also, as the authors Bernard Stiegler and the author John Tinnell describe this

> ‘as the technocultural evolution is evident throughout history, technical invention became infused with entirely unprecedented levels of resources and investments starting with the industrial revolution, during which economic incentives abounded to transform scientific knowledge from an academic pursuit into a lucrative industrial research and development enterprise,’ (Stiegler, 1998; Tinnell, 2015, p. 133).

If we take into account that the Digital Age is created by solutions that are based on Babbage’s Analytical Engine from 1843 (Isaacson, 2014b), we should run into the question if the development of communicating devices,

called Internet of Things (IoT), solve needs on a conceptual level that are still evident in the world. To conclude with John Tinnell, ‘the industrial technical invention has come to outpace conceptual innovation in other social systems such as law, government, and education’ (Tinnell, 2015, p. 133).

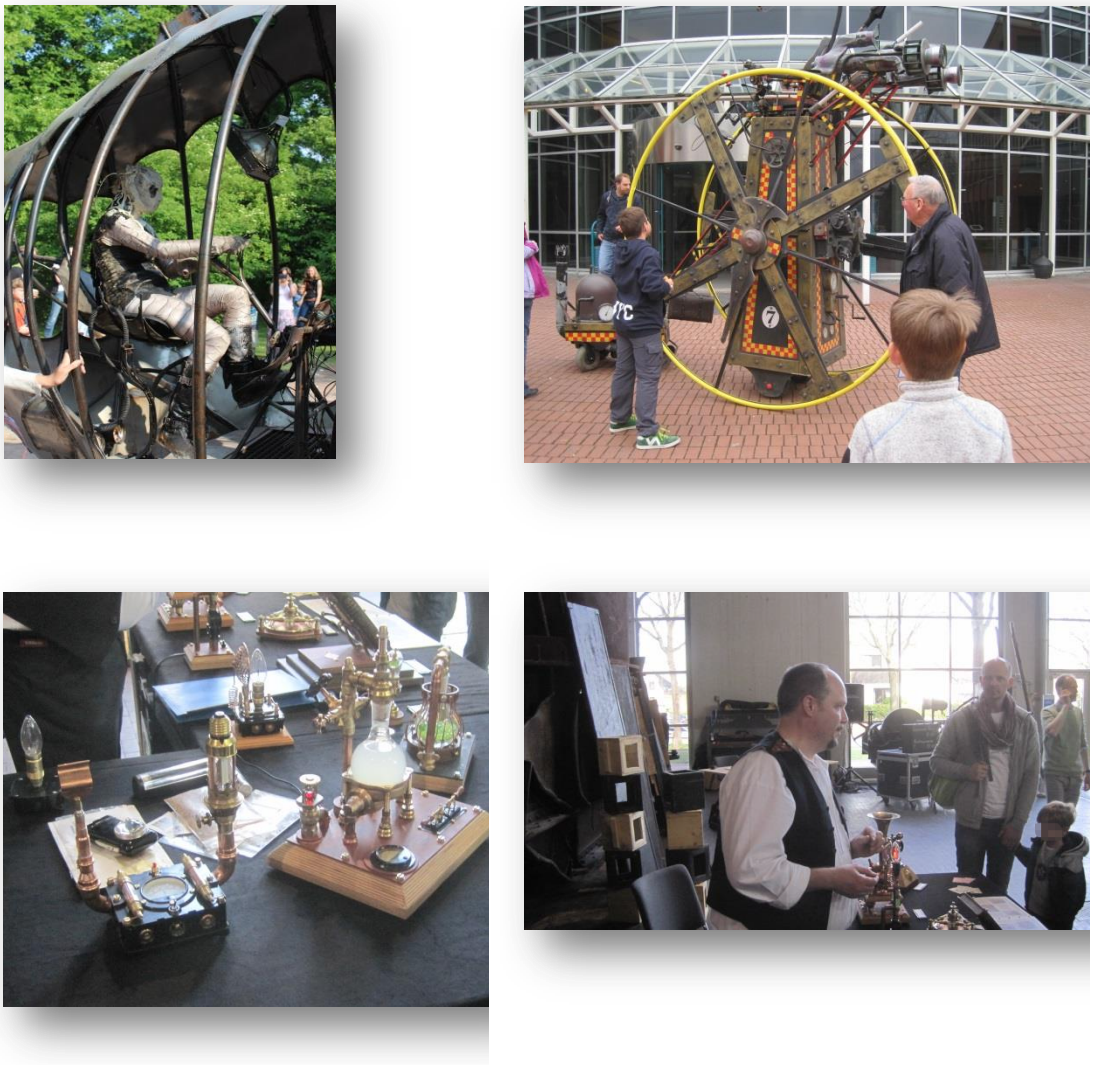
One of the researchers, on the one hand questioning the belief in technosolutionism, is Silvia Lindtner. Moreover, on the other hand, Silvia Lindtner conducted continuous research from the initial and flux development of the Maker Movement since 2006. The prior research focus was the developing Maker community at Shenzen, China. ‘The Maker Movement promises a better integration of society, the economy, technology, and science. The Maker Movement is roped into a powerful vision of change, drawing media attention, political and corporate interest, and investment,’ (Silvia Lindtner, 2015, p. 857).

> For instance, in 2012, US President Barack Obama proposed a US$1 billion investment for the build-up of a National Network for Manufacturing Innovation. Barack Obama’s statement ‘We are Americans. We are inventors. We are builders. We are Thomas Edison, and we are the Wright Brothers, and we are Steven Jobs. That is who we are. That is what we do. We invent stuff; we build it,’ (Silvia Lindtner, 2015, p. 858).

However, more than the high amount of money that is spent for the Maker Movement, in which often the 3D-printer is a synonym for that invention that will revolutionise manufacturing, is that critical engagement with the status quo of the integration of society, the economy, technology, and science. ‘Making has been framed, as an approach to reworking higher education, opening up fields of Science, Technology, Engineering, and Mathematics (STEM) to minorities, and providing a pathway to move out of the classroom and into engaged learning,’ (Kolko, 2015; Silvia Lindtner et al., 2016, p. 858).

As research with sub-communities like the Steampunk community within the Maker community had already been conducted, the research results of Joshua Tanenbaum have to be mentioned.

‘Critical engagement with technology is often characterised by a sense of play around technological norms. The critical engagement was especially evident to us when interacting with Steampunk practitioners, who often use old and appropriated materials to create improbable fictional technology designs that combine high-tech and Victorian sensibilities,’ (Tanenbaum, Williams, Desjardins, & Tanenbaum, 2013, p. 2606).



Artefact 1. Examples of Steampunk in Hannover (2016) and Dortmund (2016,2017)

In summary, this theme can be described as a critical analysis of the areas in which inventions take place. Individual groups in society are critically questioning today's prevailing belief in technology. Future solutions are

increasingly being sought in renouncing products and services to improve the overall quality of life. The role of education in the natural sciences also plays a significant role and interestingly the emerging question to add more ethical principles into the curriculum for the computer sciences.

It is therefore essential to be careful when considering what an invention is and what causes it. Today, the driving forces, especially about peripherals, can lie outside of a community and the supposed culture, and is especially not technology driven.

B. The Individual - Personal Traits

> ‘It is about people who have ideas, who invent, about organisations for which innovation is the elixir of life and whose existence depends on it, about markets that cannot get enough innovation,’ (Weis, 2015, p. IX).

The authors Anna Braun, Harald Mieg and Franz Neyer, stated in 2009 that ‘there are hardly any psychological studies on real inventors. Neither the less, there is a lot of research available on psychological creativity research. Investigations of the ‘Big Five’ with real inventors have so far not been in the literature,’ (Braun, Mieg, & Neyer, 2009, p. 72). Firstly, I would ask, what the definition of a 'real' inventor is? As mentioned earlier the research of Joseph Rossman, I would argue that psychological studies are available, but these select the inventor as an individual that already showed up in the patent office (Rossman, 1931, 1964). Secondly, I would argue that some work of Mihaly Csikszentmihalyi that was based on Cattell’s 16 Personality Factor Questionnaire (Csikszentmihalyi, 2014, p. 21) founded on the experiments with art students may be relevant too.

There are further definitions available to classify the people that may be inventors. According to the definition of Brain Moeran, Andy Pratt, and Keith Sawyer, these people are ‘idea providers’ and can be categorised as, firstly, entrepreneurs; secondly, high-expertise crowds; and, thirdly, low-expertise crowds (Moeran et al., 2015, p. 288). Interestingly these authors label Open source software communities as high-expertise crowds that can provide radical ideas. Nevertheless, aiming to develop and continue their hobbies

(Ren & Kraut, 2011) and to get involved in related online activities, these software developers are not motivated enough to stay alerted and to create radical ideas. Instead, the ideas they make public tend to advance the existing software and are for the most part incrementally innovative, rather than radical (Moeran et al., 2015, p. 289).

Here we are confronted with a mixture of arguments, like the presence of domain knowledge or expertise; a software development community with a specific mindset in democracy; and the motivation people gain by their hobby versus motivation gained by their entrepreneurial spirit, being economically radical and become profitable. Also, the kind of newness is contrasted, as they distinguish between innovative and radical ideas. How many software developers like the inventors of specific algorithms or the development of operating systems show up at the patent offices? Alternatively, are recognised by society? How many people experience that their hobby becomes their passion?

There is a further problem to identify the ‘real’ inventor, here to mention the timing issue; the time lag between when the invention was made and by whom and how long it had been taken to become a recognised innovation, see Figure 8. Excerpt from Devendra Sahal’s Chronology of Major Inventions and Innovations (Sahal, 1983, p. 224). Experts indeed exist in the individual fields and the study of expert journals, the attendance of expert conferences, makes it possible to find the inventors in a limited field, as the collection of Devendra Sahal illustrates. But not in all cases are the historical data so consistent that the inventor or the group of inventors can be determined without any doubt. Also, these disagreements and disputes usually only appear with the financial success of the invention. Also, is there something like the little-i for invention and the big-I for Innovation? Moreover, how many of these little-i are not even recognised by anyone, not even the inventor himself?

Products and Processes	Invention	Innovation
Diesel Locomotive	1895	1913
Magnetic Tape Recorder	1898	1937
Float Glass	1905	1957
Silicones	1910	1946
Insulin	1920	1927
Radar	1925	1934
Penicillin	1928	1943
Xerography	1937	1950
Transistor	1947	1951

Figure 8. Excerpt from Devendra Sahal's Chronology of Major Inventions and Innovations

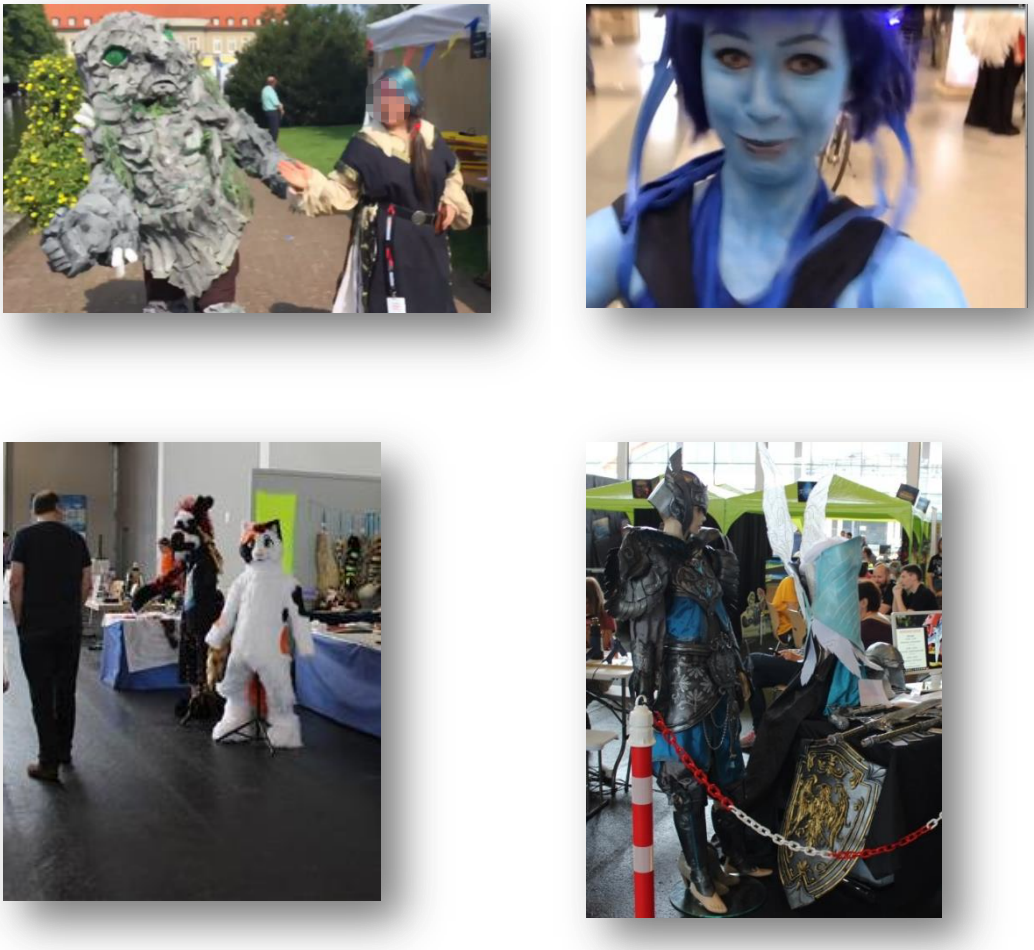
Corresponding to the first wave of creativity research, most of the studies that Anna Braun, Harald Mieg and Franz Neyer mention in their review, are based on quantitative research paradigms and focusing on the individual creativity approach. The following figure summarises what these authors recognised personality traits in creativity research that is relevant for inventors.

Researchers	Variable	Finding
(Biebrich & Kuhl, 2002)	openness to experiences	Most essential personality traits in creativity research
(McCrae, 1987)	openness to experiences	Catalyst for creative processes
(Eysenck, 1995)	5-factor model	Considering creative processes, Eysenck incorporated variables such as inner motivation and unconformity
(King, Walker, & Broyles, 1996)	interaction	Creative productivity emerges only through the interaction between 'openness to experiences' and the creative ability itself
	extraversion	Correlation between creative abilities and the personality 'extraversion.'

(Kwang & Rodrigues, 2002)	extraversion & openness to experiences	Increased values for ‘extraversion’ and ‘openness for experience’ for so-called ‘innovators’ (according to Kirton, 1976)

Figure 9. Personality Traits in Creativity Research compiled from (Braun et al., 2009)

For example, inventors report that ‘an inventor may try to make a hundred of things that do not work, and that gives most people the impression that he is something crazy,’ (Brown, 1988, p. 85). Ideas are often pursued and implemented by inventors over the years or decades. Accordingly, inventors are strongly intrinsically motivated; the inventor's motivation is based on ‘mastery’ and ‘enthusiasm’ (Henderson, 2004, p. 114). This strong intrinsic motivation leads to the mixture of trying on one hand and perseverance in following an idea on the other.



Artefact 2. Cosplayer, Costumes and Medieval Artists at Hannover (2017) and Friedrichshafen(2016)

Are there examples of studies on inventors with a focus on the second wave of creativity research? The second wave is the cognitive wave which distinguishes between domain-general and domain-specific creativity of individuals. This individual, domain-general creativity echoes Csikszentmihalyi's view of personal-creativity, referring to people who are interested, stimulated, and 'experience the world in original ways' (Csikszentmihalyi, 1996). To look at the domain-specific creativity, I would focus on 'making' or Do-It-Yourself (DIY) activities. On a small scale there are two things involved the individual and the material; also, there might be a problem or need to be solved. However, sometimes perhaps it is 'only' an artistic outcome; sometimes it might not be the intended outcome. The quality of the outcome depends on the skills the individual already is capable of and the skills to learn about the nature of materials the individual is using; sometimes it is learning by failure, or making a new experience. In a study of techniques and values of master craftspeople, Bardzell et al. (S. Bardzell, Rosner, & Bardzell, 2012) reiterate the importance of embodied practice with materials, as well as the sorts of material-driven explorations that often motivate democratised technical practices (Tanenbaum et al., 2013). Though 'atoms and bits' are frequently contrasted in HCI discourse as being, respectively, immaterial and material (Ishii, Lakatos, Bonanni, & Labrune, 2012) their interviews with programmers reveal that they consider the material properties of the languages they work with (Tanenbaum et al., 2013). The phrase 'atoms and bits' was connoted by Chris Anderson (Chris Anderson, 2010). It is about the intermingling between the physical world and the digital world; both might become the real experience of individuals. Shortly to mention, Chris Anderson was publisher of the Make Magazine, the writer of the book 'Makers, the new industrial revolution`,(C Anderson, 2012), founder of MakerBot, a commercial 3D-printer selling company, and the curator of TED (Technology, Entertainment and Design) a non-profit organisation that follows a format to share valuable ideas internationally to a broader audience. To conclude about this domain-general and domain-specific discussion about personality traits in creativity, it might be more complex as our cognitive abilities are changing with the perception of 'virtuality,' and the recurring transition between physical and digital worlds.

Neither the less, to answer the question of second wave creativity studies on inventors, I would narrow the search dramatically by picking a specific group of individuals: hackers. Firstly, most of the makers today are historically hackers. Secondly, these people deal with hardware and software issues as they de-construct things, so it is a different skill set but could be defined as a domain-specific capability.

> 'We suspect that the hackers' habituated ability to see objects simultaneously both as wholes and as deconstructable assemblages of pliable materials supports a creative sensibility for perceiving how to 'invest the world with meaning' (Illich & Lang, 1973) both directly with the use of existing tools, and indirectly with the ad hoc (re-) invention of new ones. That is, these objects are instruments in the traditional sense because they give rise to new ways of acting with purpose. They are also tools of communication—both to themselves and the public. To insist such a creative sensibility, along with the practical skills to act on it, appears to be one of the primary purposes of the hackerspace,' (J. Bardzell, Bardzell, & Toombs, 2014, p. 476).

Interestingly Jeffrey and Shaowen Bardzell talk about domain-general characteristic, the creative sensibility, and the domain-specific, the practical skills to act on and as the interrelationship between the individual and the field, the tools of communication to themselves and the public.

When I pick hackers as a specific group of individuals for my research design, I do exclude a significant group of people from the Maker community. Therefore I have done the literature review also on research that follows the concept of Do-it-Yourself (DIY), or in Maker community tone Do-It-Together (DIT). Interestingly that kind of research fills the potential gap between creativity research founded on the individualist approaches and the socio-cultural approaches to Human Creativity and Invention.

> 'DIY communities facilitate personal-creativity by enabling millions of witty, curious, and enthusiastic contributors to share and draw from DIY knowledge. This knowledge affords inspiration and learning, which in turn lead to discoveries and innovations in personal DIY

> projects. According to Csikszentmihalyi, creative outcomes are validated by a 'field of experts' who 'recognise and validate the innovation'. DIY communities provide this mechanism through open sharing and feedback. The 'field of experts' in DIY communities consists of hobbyists and enthusiasts who critique and learn from others' work, giving rise to the expert amateur. With most respondents sharing some portion of their projects with DIY communities and more than half of participants contributing to a community at least a few times a week, sharing is the fundamental process that drives and validates DIY creativity,' (Kuznetsov & Paulos, 2010, p. 302).

This view of the authors Stacey Kuznetsov and Eric Paulos is already coined on the concept of Systems Model of Creativity (SMoC) from Mihaly Csikszentmihalyi (Csikszentmihalyi, 2014) as one of the models of Human Creativity, Invention and Innovation (Greene, 2001) following the evolutionary approach.

However, for me, that text also shows something else as we still talk about personal traits. Where do these people get their reputation from, their merits, their motivation, intrinsic or extrinsic?

Based on the research of Mihaly Csikszentmihalyi together with Nobel laureates, the author Larisa Shavinina (Shavinina, 2012) draws additional lessons from the Nobel laureates' childhood and adolescence.

> 'In childhood, Nobel laureates in science encompassed a wide range of human abilities including the gifted (e.g., Marie Curie or Gertrude B. Elion), the gifted underachievers (e.g., Albert Einstein), twice-exceptional children, and children without any special talents (e.g., Barbara McClintock). Different profiles of abilities and divergent trajectories of talent development led to the same outcome: great discoveries, which means that those who made them possess exceptional abilities. In the end, all the various trajectories of talent development led to the same result: astonishing scientific achievements. Extracognitive abilities refer to: specific intellectually creative feelings: feelings of direction, harmony, beauty, and style,

> including the sense of ‘important problems,’ ‘good’ ideas, ‘correct’ theories, elegant solutions; and feelings of ‘being right or being wrong’; specific intellectually creative beliefs and intentions (e.g., belief in elevated standards of performance); specific preferences and intellectual values (e.g., the ‘inevitable’ choice of great mentors); and intuition (Marton et al., 1994). It is useful for future innovators to know how extra cognitive abilities helped Nobel laureates to be innovative,’ (Shavinina, 2012, p. 60).

In summary, the subject of personality can be described in this context as follows, many of the earlier studies are based on quantitative research, often with the objective of selecting the right people for a given domain. Mihaly Csikszentmihalyi had opposed this problem of prognosis by making successful individuals the subject of his research. It is interesting to note that Mihaly Csikszentmihalyi is not looking for an answer to a status quo and the prognosis of a potential successful personality profile in the first step. Instead, Mihaly Csikszentmihalyi interviewed these successful individuals about distinct areas of their life and their personal reflection on how the temporal development of their personality took place, how specific events in their lives took a specific reason, and how their relationships with others in the settings of family, society and culture have ultimately led to their success. This approach by Mihaly led me to adopt his structure of the questions. The evaluation of this qualitative information should then guide how people are stimulated to invent things.

C. The Juggling of Knowledge - When Irrelevant Knowledge becomes Relevant

Does knowledge supports or hinders invention? That could be another title to this chapter. Considering the processes that link past learnings to innovations, it is first useful to clarify the role that existing knowledge plays in generating new insights (Baker & Obstfeld, 1999). This discourse is also connected to the domain-specific, domain-general discourse we had about creativity in the second wave of creativity research. Alternatively, as Johann Melchior Beseke (1784) mentioned ‘to get rid of the slavery of school, to escape from the despotism of systems and compendia’. The process of

learning and unlearning mental schemas. According to Piaget (1970, 1974) and Flavell (1967), the process of assimilation contributes to the change of mental structure (called ‘accommodation’) in the following steps, with an increasing deviation from previous knowledge structures. That accommodation entails seeing new things or seeing and interpreting things in new ways. The change of mental structure yields a source of invention in experiential learning (Moeran et al., 2015).

Artefact 3. Dancing Flowers and Balls, Robot Programming for Pre-School Children, Rollercoaster Building at Cologne (2016) and Dortmund (2017)

However, maybe, experiential knowledge should be seen as a prerequisite for making inventions. Who decides what kind of experiential knowledge is relevant or not and when? How do we gather this experiential knowledge? As the author Kets de Vries describes it, ‘our earliest meaning-making activities have their origins in the early developmental trajectory formed by the interaction of mothers (or other caretakers) and infants. In this interface, through play, an intermediate area is created where primary creativity (illusion) exists and can develop,’ (de Vries, 2012, p. 2). Also, the child psychologist Jean Piaget wrote, ‘If you want to be creative, stay in part a child, with the creativity and invention that characterises children before they are deformed by adult society,’ (de Vries, 2012, p. 26). Deformed by society! The individual or the society by itself? These questions lead my thought back to the importance of the context, for the child psychologists it is the family, during later years the context may become the field, in between is the educational system, like the schools and the universities. However, the context could be constructed for an individual or a group of individuals by providing a new, external environment:

> ‘In the context of tinkering settings, novices, journeymen, and experts work side by side, assist one another, and continually shift roles depending on the task, goals, or tools at hand, throughout processes of investigation and invention. These interactions support learning and identity development in ways that resonate with theories of learning and pedagogy in the work of Vygotsky (1978), Friere (1970), and Lave and Wenger (1991),’ (Bevan, Gutwill, Petrich, & Wilkinson, 2015, p. 100).

Why external, because it may be external to the society (field) or even culture (domain). That sounds very difficult to be created. However, from a network perspective, the conditions for recombining existing ideas, artefacts, and people in new ways exist because the social world is NOT a seamless web. Instead, it is fragmented into much isolated, and isolating, domains (Swidler, 1986; DiMaggio, 1997). The concept of domains describes sets of resources that are densely connected within but loosely connected across domains (Baker & Obstfeld, 1999).

> ‘The expanding community that crystallizes around a new combination of resources creates the necessary conditions for turning initial innovations into enduring institutions, through diffusion (Rogers, 1995), learning-in-use (Rosenberg, 1982), and through the coordinated efforts, legitimacy, and social capital that such dense relationships provide new ventures (Walker, Kogut & Shan, 1997). This adoption and subsequent evolution, from a network perspective, involves developing new ties to the expanding web of ideas, artefacts, and people that form an innovation,’ (Hargadon, 2002, p. 54).

That citation of the author Andrew Hargadon could be the nucleus explanation for the Maker community. Much further the Maker community may solve the ‘difficulty derives from the contextual, domain-specific nature of knowledge and the inability of domain inhabitants to recognise when ‘irrelevant’ knowledge can become relevant,’ (Hargadon, 2002, p. 77).

In summary, this theme can be described as we become mature on our way to adulthood; we are losing much of our playful learning. The trial and error and personal experience are replaced by the use of recorded experience of others. Therefore, a know-how advantage is often defined as learning from the mistakes of others. What we as adults unfortunately forget is that mistakes and the deficiency of knowledge can also generate an invaluable advancement to invent, as fortune also did.

D. The Knowledge Society

> ‘The false dualisms of economic and cultural value (that is, the values imposed upon the field) disintegrate in complex forms in the light of closely and attentively observed cultural practices. The normative view of the cultural economy is that it is in some way a deficient or poorly disciplined version of the economy,’ (Moeran et al., 2015, p. 242).

In this paper mentioned by this citation, researchers like Andy C. Pratt, Doris Ruth Eikhof, Keith Sawyer, Robert D. Austin, Peter Johnson, Martyn Straw, Patrik Wikstrom, Jie Ren, Filip Lau and Mikkel Brok-Kristensen, started a discussion to interrogate and re-configure the question of innovation and

creativity. As a result of their analysis, they conclude on the significant role of knowledge. They assume that knowledge is a “thing” that is amenable to transaction and exchange, independent of its value or its constitution. As these arguments sound first a little philosophical, if I connect these arguments to the Systems Model of Creativity (SMoC), knowledge is part and interconnect all three systems as there are transaction and exchange. The value and constitution of knowledge may vary between these systems. Also, I would mention that the intent to memorise knowledge is different from the individual, the field and the domain.

Artefact 4. Transient Knowledge Artefacts of Societies at Dortmund (2016), Friedrichshafen (2016) and Stuttgart (2016)

Starting with the domain, and as an example of one of its institutions, the school, usually learning that takes place continually within a single domain

may be more dependent on, and hence situated within, a single context. But as 2002, Andrew Hargadon mentioned that ‘further, studies have shown that many failures in problem-solving result not from the lack of appropriate knowledge but from the inability to recognise when that knowledge is appropriate to a new situation (Lave, 1988; Reeves & Weisberg, 1994; Thompson, Gentner & Lowenstein, 2000),’ (Hargadon, 2002, p. 54).

> ‘In today’s knowledge societies, one of the key missions of the schools is to educate for creativity. The knowledge economy is, at root, driven by the creation of new knowledge—prototypically, technological innovation, but also the creation of new procedures and new organizational forms. Business theorists are essentially rediscovering Piaget’s original insight that learning and creating are fundamentally the same process (R Keith Sawyer et al., 2003). To educate the innovation economy, schools must provide students with opportunities to engage in collaborative knowledge building activities, through disciplined improvisations. Schools should not try to identify and nurture a few special geniuses; instead, they should prepare all students to participate in complex creative systems, in which they will need to work collaboratively, at multiple levels of the organization, to build knowledge together,’ (R. Keith Sawyer, 2006, p. 43).

Does this critique only reach the domain? What is if we follow this thread into the field, and as examples here I would take companies or labs, where more specialised and emerging knowledge is needed?

> ‘Three colleagues would go down in history as the inventors of the transistor: a skilled experimentalist named Walter Brattain, a quantum theorist named John Bardeen, and a solid-state physics expert named William Shockley. However, there was another player in this drama that was as important as any individual: Bell Labs, where these men worked,’ (Isaacson, 2014a, p. 114).

We could see the field in two dimensions, one as it is stated here. It is an organisational frame, a static set; a socio-cultural context where invention takes place, not by a solitary individual but by collaborative teams and

complex organisations. The other dimension would be field as a network to exchange knowledge, create new knowledge and abandon knowledge. What is learning in this context and how does learning works here? ‘Learning enables organisations to function effectively in their current tasks, and also to apply their experiences to similar problems in the future. However, not all learning is the same. Socio-cultural approaches to learning have found that the social and physical context in which learning takes place significantly shapes the process, in particular, because such learning often relies on situational cues to recall or replace particular knowledge (Bruner, 1979; Lave, 1988; Lave & Wenger, 1991),’(Hargadon, 2002, p. 58). That sounds very static to me, in practice I think, we talk about the myriads of interactions an employee runs through his or her daily business. Other would call this at the beginning of the profession as training on the job. If we would accept these interactions as embedded experience to the learning process, would not be the quality of these interactions essential?

What do I mean by quality of interactions? If this is related to the learning process in the field, constructivist and constructionist pedagogies may come into play.

> ‘It is vital to distinguish constructivism (Dewey 1938; Vygotsky 1978; Piaget 1953, 1955, 1970; Bruner 1961) from constructionism (Papert 1980; Papert et al. 1998; Knorr-Cetina 1997). While both emphasise lived, individual, socially embedded experience as key to the learning process, constructionism emphasises the importance of actively making things,’ (Ratto, 2011, p. 254).

So, also in a society that deals with knowledge exchange and continuous information flows, making may be significant to the learning process. Alternatively, because of our experience in the field is more about the exchange of non-physical things, making may become that important for a society openly to allow new perspectives to emerge. ‘For us, affect serves as a way to begin to understand the importance of personal investment in linking conceptual understandings of technology’s potential and its problems to everyday experience,’ (Ratto, 2011, p. 254).

At last to get focus on the individual within the knowledge society. In the early years, the individual is actively embedded in its family. As given in the abstract, following citation ‘A piece of wood becomes, in the child’s mind, a wand. A building block becomes a mobile phone. The child plays at being the mother in the home corner,’ (Smidt, 2009, p. 105). ‘This trial and error process, in which the maker does not know what to expect from the materials and learns what they and he or she are capable of only through doing the actual making, is the central transformative concept that I found unified throughout all these many works,’ (Barba, 2015, p. 648). For me, this means, long before we learn our profession to do things with mastery there is this process of discovery and invention. So playing is something important in our knowledge society, as making also.

‘In 2005 high-profile global science fairs such as the Intel Science and Engineering Fair (ISEF) started to gain traction worldwide, generating interest from hundreds of schools around the world in project-based science. Events like the Maker Faire and the ISEF created, even more, demand, in schools, for project-based learning, especially around STEM disciplines,’ (Blikstein & Krannich, 2013, p. 614).

Our knowledge society is progressing, and many of the schools have adopted team-oriented projects to develop capabilities. Also, school is no longer the only place to impart knowledge. In Germany in particular, associations and social institutions play an integral role in passing on knowledge and enabling diverse experiences. Also, the Media has become multifaceted, information and knowledge are more straightforward to provide, more accessible than in the past and is transported much faster today. As an adverse side effect, the actual quality of information and knowledge can often be undermined.

Also, access to field-specific information is now more accessible, and the Internet often provides direct access to detailed information that was previously reserved for industries or professionals only. As a result, people sometimes look into fields out of curiosity, coincidence or starting interest.

E. The Cultural Evolutionary Process - Systems Theory

> ‘Creativity represents the starting point of the cultural evolutionary process. Thus, to fully understand complex cultural abilities, the evolution of these abilities, and what sets human culture apart from that of other animals, we must first understand what circumstances lead to innovation, what is unique about human creativity, and what drives humans alone to create art on cave walls or design increasingly sophisticated technologies,’ (Fogarty, Creanza, & Feldman, 2015, p. 740).

Processes of creativity are vital to our understanding of culture, and following the thoughts of these authors, in the beginning, the terms ‘innovation’, ‘creativity’, and ‘invention’ seems to be often used interchangeably. In cultural evolutionary theory, important distinctions exist between these concepts in their fields. As an example, in management science, the term ‘creativity’ refers to the process of developing a new product, whereas an ‘innovation’ is the output of creativity: a finished, valuable product that can be marketed. As I already mentioned in the introduction of this thesis, an important terminological distinction exists between what economists term ‘invention’ and what they term ‘innovation’.

> ‘Research on the psychology of creativity has addressed topics relevant to cultural evolution, such as the nature of creativity and its occurrence, as well as its relation to personality and environment (Golann, 1963). Certain personality domains and behaviors might promote creativity, such as ‘openness to experience’ (McCrae, 1987), happiness and positivity (Baas, De Dreu, & Nijstad, 2008), diligence (Glăveanu, 2012), and the intelligence to generate and analyze ideas (Sternberg, 2006; Sternberg & Lubart, 1996), whereas some behaviors, such as dishonesty and unethicality, characterize highly creative individuals but are unlikely to foster creativity directly (Gino & Ariely, 2012). However, these creativity-enhancing personality traits are difficult to capture in population-level models. Indeed, some have argued that many scientific studies of creativity are inappropriate for answering questions about the archaeological record precisely

> because they focus almost exclusively on the characteristics of individuals and not on more general population-level creative forces (Mithen, 2005). However, if idiosyncratic and perhaps randomly distributed personality traits do drive individual rates of creativity, a variable per-individual probability of innovating might be the most appropriate model of population-level creativity.' (Fogarty et al., 2015, p. 741).

Social and cultural contexts are essential to understanding creativity. The model described by Teresa Amabile (Teresa M Amabile, 1996a, p. 46) outlines several steps that constitute a creative process in a specific social environment. The process starts with task identification and is initiated through a problem to solve (external stimulus) or the desire to create something (internal stimulus). Perhaps, as suggested by Teresa Amabile, problems posed to oneself are intrinsically more captivating than problems posed by others. The critical point here is the socio-cultural context and creativity, including the invention and combination of ideas, is the source for cultural evolution and accumulation, introducing new artworks, new technology, and new social norms.

'The most comprehensive theory of creativity is the Darwinian (formerly 'chance-configuration') model of Dean Keith Simonton. More than any other theory of creativity, Simonton's Darwinian view aims to understand the nature of genius, eminence, and Big-C achievements,' (Kaufman & Sternberg, 2010, p. 35).

Artefact 5. Citizenship Projects, Maker Spaces, Environmental Change and Virtual Reality Toys at Stuttgart (2016)

As these fundamental cultural evolutionary process theories noted here are essential, broader theories can be found in the systems theories. The most ambitious theories of creativity take the view that creativity is best conceptualised not as a single entity, but as emerging from a complex system with interacting subcomponents. As a cornerstone in research, Mihaly Csikszentmihalyi's systems theory of creativity is less focused on the creative person than the evolving systems approach, but it likewise involves multiple factors and takes a broad view of the phenomenon of creativity. Mihaly Csikszentmihalyi (Csikszentmihalyi, 2014) introduced his systems view by reframing the fundamental question of 'what is creativity?' to 'where is creativity?' Mihaly Csikszentmihalyi argued that creativity emerge via three interacting systems: (i) the Domain or body of knowledge that exists in a particular discipline at a particular time; (ii) the Field, comprised of other experts and members of the discipline, acting as gatekeepers, who decide which novelties produced by all of the individuals working in that discipline are worth preserving for the next generation and (iii) at least the Individual, who acquires domain knowledge and produces variations on the existing knowledge. Mihaly Csikszentmihalyi's systems view has many advantages, particularly in its conceptual richness, but also potential limitations. First, it acknowledges the immense importance of extrapersonal, socio-cultural factors in creativity. So this Systems Model of Creativity (SMoC) can be used to generate specific hypotheses about how the Domain, Field, and Individual

(and culture, society, and personal backgrounds more generally) impact creativity (Csikszentmihalyi, 1999).

> ‘In evolutionary theory, generation of new variety, in new interpretations or new ideas is ascribed to errors in replication, mistakes, random and uninformed trials as steps into the dark (‘mutations’). […] In socioeconomic evolution, there is invention and knowledge development that is informed, somehow, by experience from failures and resulting inferences about where sources of failure may lie and where to look for improvements,’ (Nooteboom, 2007, p. 36).

As Bart Nooteboom here describes there may be distinctions to be made about the process and results if we use the evolutionary theory or if especially organisations had to be led by the socioeconomic evolution. Neither the less the current discourse in organisational studies about the identification of radical innovation may show the intermingle between both. Moreover, as Bart Nooteboom expressed it, based on the work of Yuri Lotman ‘in culture studies also, it is a familiar principle that novel culture tends to arise at, and penetrate from, the periphery of existing culture (Lotman, 1990)’.

In summary, the theme can be characterised as the connection between invention, rejuvenation and the continuously evolving culture. Contrary to this, the current culture and its values influence the urge to find needed solutions to wicked problems.

Moreover, these values in culture can change over time, and regional distinctions are inevitable. While economic goals are probably still in the foreground in western nations, it is clear that the preservation of a liveable and healthy environment is becoming increasingly crucial for all individuals and society.

F. The Inventions - Unwanted Enemies

> ‘Innovation brings disorder and risk into a stable ‘running system’, and we all know ‘never change a winning team’. Innovations interfere with

> the immune system of a company or system. Just as the body in diseases immediately eliminates the disturbance or at least tries to do so, an organization has also implicitly impaired an immune system of rules and rules that aim to minimise exceptions and irregularities. The immune system attacks every exception like a disease or an enemy. It is almost indifferent. Everything abnormal is an enemy. All innovation is an enemy,' (Dueck, 2014, p. 302).

Our standard systems are not made for overcoming hurdles. Everyone has a job and a typical duty to do work day by day. This work bites with the eruptions through innovation. That is why we are all unintentionally enemies of everything new. Who is that - we all? A selection of these enemies to be named: scientists, marketing, sales of companies, management and managers, consulting systems and consultants, investors, and some more.

> 'On some level, depending on how competence is destroying an innovation, and in how many dimensions it innovates, the entrepreneur has to escape from the grip of the existing selection environment, within a job, profession, organization, industry, country or the wider economic system. The first reason for such exit or escape is to gain the opportunity of being different, a second reason is to gain the motive to change a dominant design, a third reason is to gain new 'insight' into where the limitations of existing dominant designs lie, and a fourth is to gain novel experience and insight into elements of novelty to allow for the full realization of an emerging innovation's potential,' (Nooteboom, 2007, p. 48).

In summary, this theme can be described as, although if most of the inventions and new achievements benefit us and we are aware of this, it may happen that we do not tolerate these innovations. The invention as the unwanted enemy may be accompanied by considerations of one's own, but may also be deliberately influenced by external considerations. As an example, lobbying is an instance of prevention of the potential loss of status, influence and economic interests if an invention is in sight.

Artefact 6. Unwanted Enemies from History, Today and Tomorrow at Dortmund (2016), Hannover (2016, 2017)

G. How to Handle Invention in Institutions? - Part I

‘In traditional society, it could be assumed - and was assumed - that learning came to an end with adolescence or, at the latest, with adulthood. However, also what one had learned by age twenty- one or so one would apply, unchanged, the rest of one’s life. On these assumptions, traditional apprenticeship was based, traditional crafts, traditional professions, but also the traditional systems of education and the schools. Crafts, professions, systems of education, and

> schools are still, by and large, based on these assumptions,' (Drucker, 2014, p. 324).

I call this chapter how to handle inventions in institutions, but anyhow it could also be named the chapter about the necessity of lifelong learning and the continuous adaptation and loss of knowledge or the need for continuous learning and re-learning. However, more than that, how to retain creativity from childhood to adulthood? Moreover, how to stimulate a lifelong journey from the childlike roots of creativity to the society's objective having innovators at their adulthood?

> 'Researchers occasionally address the issue of how to develop innovators. From many chapters in the International Handbook on Innovation (Shavinina, 2003a), only a few of them discuss the development of innovators in science or the development of innovative abilities via the stimulation of creativity […]. How to develop innovators is a new direction in innovation science,' (Shavinina, 2012, p. 55).

In other words, what will be the context, what will be the conditions under people's creativity will not fade? - I would step into the sociology research of Niklas Luhmann conducted with pupils in educational systems like Kindergarten.

> 'Under these conditions pupils are encouraged to: Resolve their action impulses by playing out the possibilities of attracting attention in appropriate cases, waiting, carrying interruptions and failures, patience, resignation, orientation to all stringent conditions and minimisation of the necessity for success,' (Luhmann, 2011, p. 16).

Niklas Luhmann also focuses on the difference in age, but more important to me is that the interaction and the stimuli of the interaction system they passively involved is a crucial feature of excellent educators. Also, the withdraw of the constitutive system features!

> 'Good educators are correspondingly characterised by the fact that they can withdraw the constitutive system features, which in any case

> effect, by stimulating the interaction system, also stimulate the passively involved and involve them in the happening, and by overrating the age difference by childlike behaviour,' (Luhmann, 2011, p. 16).

So what will be the conditions under which people's creativity will increase? To follow the work of Bart Nooteboom it may be the variation by communication and collaboration as a significant pattern. He indicates, 'that the absorption or assimilation is to a greater or lesser extent, accompanied by expansion and transformation of the knowledge absorbed. In that sense, communication not only yields 'replication' but also contributes to the generation of variety,' (Moeran et al., 2015).

> 'In learning by interaction, one runs into both the problem and the opportunity from a cognitive distance: greater distance not only makes mutual understanding and acceptance (absorptive capacity) more difficult but also generates novelty value. If the first decreases, say linearly, with cognitive distance, the second increases with it, and performance of learning by interaction is the mathematical product of absorption and novelty value, resulting in an inverse U-shaped relationship with an optimal cognitive distance, large enough to yield novelty value though not so large as to preclude understanding and collaboration,'(Nooteboom, 2007, p. 46).

In other words, experiences in dealing with other individuals who think differently seem to be an advantage. The ability to find others, at an optimal cognitive distance, and to understand and collaborate with them is vital. The early experience in communicating and collaborating with others who think differently is the issue.

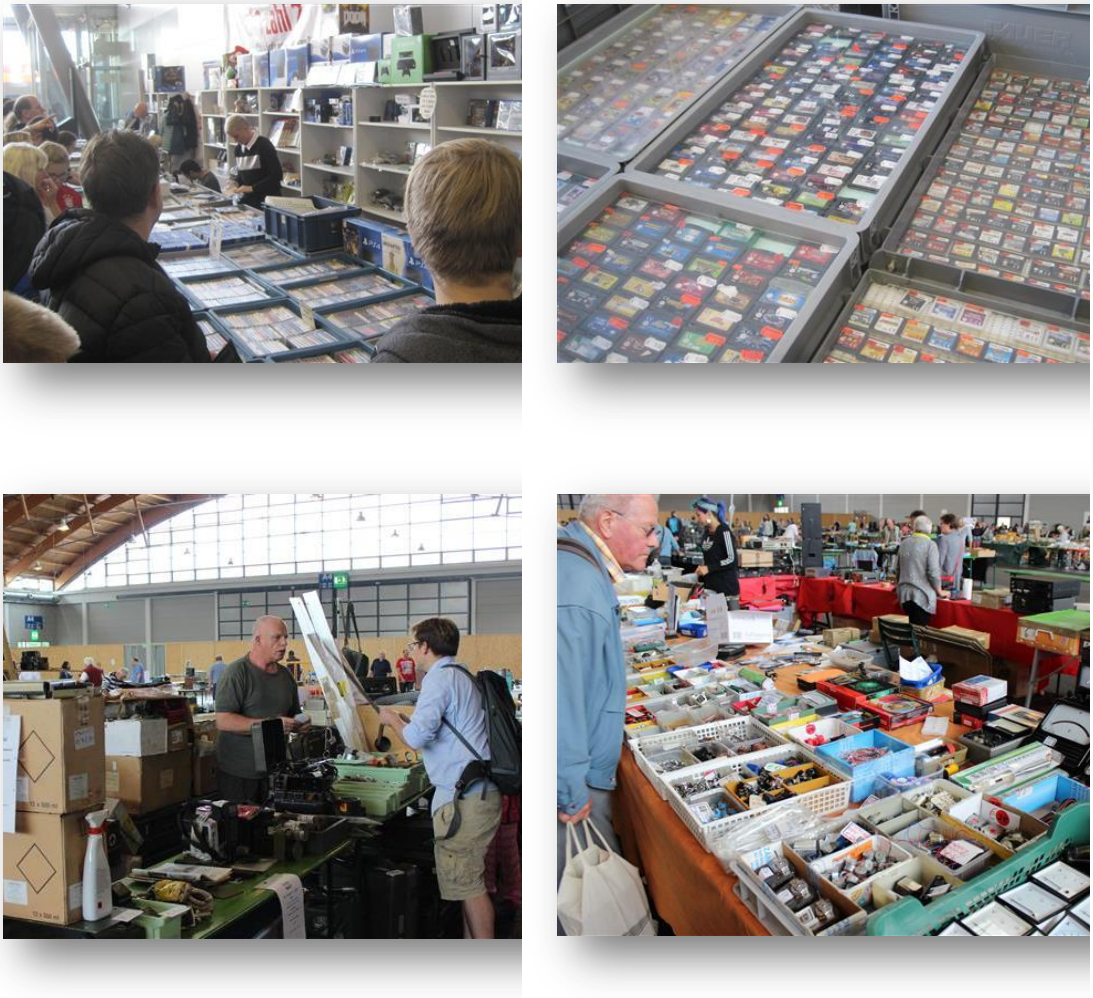
In summary, the theme can be described as the collaboration and sharing of ideas is an essential ability for creativity in a team and that these skills must be learned. Nevertheless, other influencing factors support creativity. It is also essential to take into account the problem of a decline in creativity in ageing. In general, it has to be taken into account how creativity turns into a tendency to invent.

H. How to Handle Invention in Institutions? - Part II

In the last chapter, the term institution was used for schools, universities and other educational resources to state how knowledge is transferred. Therefore it is a close interpretation of the descriptions of the Systems Model of Creativity (SMoC). As I avoid the economic dimension so far, here is, for me a critical aspect of what constitutes markets and what is our economics and financial-driven understanding today and what was a market in the medieval time? Therefore, I want to introduce the market definition from Andy Pratt's research to define markets in a so-called cultural economy.

> 'The socially and culturally embedded forms of social action that constitute 'markets' are important and constitutive: they are not residuals. Innovation and creativity are relational activities; they are based on social interaction and ideas. They have a generative relation. In fact, it would be a fair characterisation that this interaction in situ is generative of ideas; but such ideas and practices have to be recognised for what they are. There is no necessity for ideas and inventions simply to become apparent. […] In so doing we might perhaps approach an understanding of the cultural economy—not as a failed, inefficient, or ineffective economy, but as a more useful "model" of action. Perhaps, then, we will avoid the conceit that economists make markets, and artists make creativity. The application of a humble anthropological perspective might help us to take more seriously what happens, as opposed to what we would like to, or what should happen. The study of innovation and creativity is, I would argue, at the very beginning of a new journey. A good place to begin is with the cultural economy,' (Moeran et al., 2015, p. 242)

What is the product we handle in the market? - Culture! We handle beliefs, values, knowledge and experience. I do not want to stress, what the markets are in the Domain, the Field or in the Family, but to come back and redefine the market as a socially and culturally embedded form of social action. The market should be recognised as an institutional instrument for social action and the exchange of culture and not only as the platform for the interchange of money, services and goods.



Artefact 7. The Characteristics of Markets, Stuttgart (2016) and Friedrichshafen (2016)

In summary, this theme can be described as to keep attention to where similar structures to markets in the meaning described can be found in the Maker community.

I. Protection - Intellectual Property and Creative Commons

In 2006 the author Stefano Brusoni provided a discussion paper based on a survey of the inventors of 9,017 European patented inventions. Stefano Brusoni's paper provides insights 'about the characteristics of European inventors, the sources of their knowledge, the importance of formal and informal collaborations, the motivations to invent, and the actual use and economic value of the patents,' (Brusoni et al., 2006). As mentioned already in the introduction the roles of the patent system are manifold and have to be related to numerous contexts. Firstly, as a discriminator for relevant research

data about innovation, ‘patents are the most commonly used quantitative measure of national innovation because, by definition, they are related to innovation. The use of patents to measure innovative activity was pioneered in the 1960s by Scherer (1965) and Schmookler (1966) who used patent statistics to investigate the demand-side determinants of innovation,’ (M. Z. Taylor & Wilson, 2012). Secondly, the protective nature, as ‘patent law protects inventions in the form of patents, taste and usage patterns. Characteristics of an invention are (a) novelty, (b) inventiveness, and (c) industrial applicability. The invention is sufficient for patent protection if the invention is not obvious to the person skilled in the art from the prior art. The same applies to taste and use patterns. An in-depth examination grants patents and constitute a comprehensive intellectual property right. The granting of a utility model is carried out in a simplified protective procedure; an examination only takes place in the case of disputes. Flavour patterns, in turn, provide protection for a specific design,’ (Braun et al., 2009). Thirdly, we should ask if the use of patent systems in these contextual intended notions are real. Therefore the survey of Stefano Brusoni gave reliable data that we should think carefully about this system. So Stefano Brusoni concludes, that ‘we do not know much about the inventors, or the nature of the research or other processes that gave rise to the invention; we typically have no measures of the value of the patent other than the proxies that we can retrieve from the patent document; and we know very little about whether the patent is used or not, whether it is licensed, or whether it is further developed into a new product by the applicant,’ (Brusoni et al., 2006). Stefano Brusoni’s arguments behind this are more obvious as the path between invention, and the commercialisation of a new product or a new technology can be long and costly, and many patents are never exploited, and only a few of them yield economic returns. ‘More than half of the unused inventions aim at blocking competitors,’ (Brusoni et al., 2006). ‘One-third of the patents are developed by individual inventors, suggesting that most inventions are the outcome of a team activity. However, the vast majority of co-inventors belong to the same organisation,’ (Brusoni et al., 2006).

My conclusion would be that patents are not a perfect quantitative measure of innovation anyhow but also not for inventions. Even if the patent law uses the notion of invention the patent system is a qualitative discriminator by its rule for industrial applicability. Also, a quantitative discriminator, as 'raw patents counts do not take into account the quality or impact of the innovation patented. Most patents are for minor innovations, and only very few could be considered revolutionary innovations,' (M. Z. Taylor & Wilson, 2012). The conclusion is, the patent system is the gatekeeper function of the field that shields the intellectual property existing of its society members.

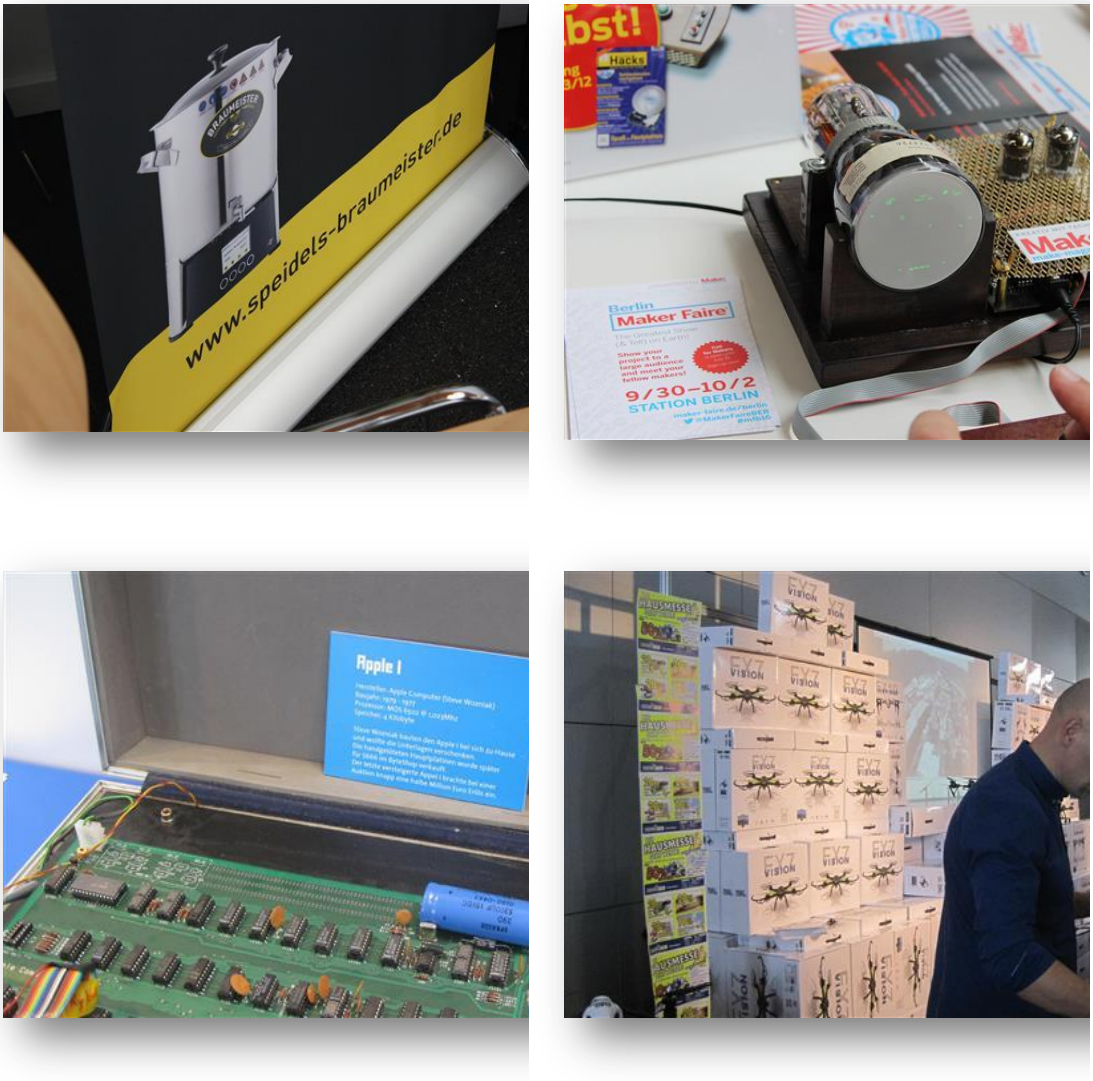
However, today, there are other types of licenses available to protect the inventor and the economic interest if required. The idea of open-source for software initially initiated these types of licences. The creative commons were usually used to protect people for their rights in cultural works such as music and writing. Today the creative commons are standardised by a non-profit group and are used more broadly for digital data and hardware designs. 'You could think of hardware as a piece of culture you want to share with other people,' (Kushner, 2011).

Another argument comes from Stefano Brusoni if he asks about the origin or the source of invention and puts the customer in the place. Also, some methods contained in the design thinking approach do this very explicitly like the user-centricity or user experience.

> 'Customers are the most important source of knowledge for invention processes, followed by the patent and the scientific literature. It is surprising that university and public research labs are the least important source of knowledge. In fact, the distance between academic inventions and commercial patented inventions is large in most industries. There can be many steps before the more academic knowledge becomes useful to firms. In this respect, users, customers, suppliers, patents, and more generally industrial sources of knowledge are more important,' (Brusoni et al., 2006).

The first question to conclude: do we protect our users, customers, suppliers? Second question if industrial sources of knowledge are more

critical for an invention; do we protect them? - For their economic merit? Alternatively, should we use a higher amount of creative commons instead to allow sharing and collaborating and to protect our capability to invent - to the better?



Artefact 8. Artefacts of Intellectual Property at Friedrichshafen (2016) and Stuttgart (2016)

J. How Reputation is given to People in a Community?

The following chapter is a copy of an interview, conducted in 2015, between Walter Isaacson and Megan Smith (Isaacson & Smith, 2015). The interview consists of two parts, firstly what is known about Bill Gates and Steve Jobs their ingenuity and their reputation in the personal-computer revolution. And the second part, where Walter Isaacson and Megan Smith speaking about a

contemporary film about Bletchley Park, Britain's codebreaking centre, and on one hand stressing the importance of socio-cultural interaction for Alan Turing's success in codebreaking the German enigma, but also on the other hand the false perception of the central role of women during the Second World War in hacking the enigma by making the available mainframe hardware flexible for faster reprogramming. Therefore mentioning that also Dilly Knox and Grace Hopper should have a reputation in the invention of programming, and not only Alan Turing who is widely considered to be the father of computer science with the invention of the Turing machine.

> MEGAN SMITH (MS): One of my favourite expressions is: ‘People do things. Things do not just magically happen.’ Innovation comes out of great human ingenuity and very personal passions.
>
> WALTER ISAACSON (WI): It is not a passion for making profits. When Bill Gates wrote BASIC for the Altair, and Steve Jobs created the Apple, they had no idea that the personal-computer revolution was about to start. They wanted to create something cool.
>
> MS: It is founding teams - these small, agile teams that come together.
>
> WI: When I asked Steve Jobs near the end of his life what product he was most proud of, he said, ‘Making a product is hard, but what I’m most proud of is putting together Apple the company, because that was a great team, and it is the team that can continue to make future products.’
>
> WI: One of the things ‘The Imitation Game’ [remark by the author: American historical drama film, published in 2014] got exactly right was that Turing was a real loner. Suddenly, at a certain point in Bletchley Park, he realises he needs to be a team player.
>
> MS: But the film also has a little bit of historical inaccuracy: I think Bletchley Park was more than half women. I once met a woman who told me she and her siblings used to live next door to Dilly Knox’s team [a group of Bletchley Park mathematicians]. Their mum always

> was saying, ‘Shhhh, the girls are working.’ I think: Wow, the girls are working, saving 11 million lives and shortening World War II by two years.
>
> MS: Right, or Grace Hopper and the beginnings of programming languages.
>
> WI: When Hopper taught students mathematics, she made them write essays. Then she would correct their writing, and they would say, ‘We are supposed to be taking a math course.’ She said, ‘Yes, but if you cannot explain it in writing, then you do not fully understand it.’
>
> MS: She is an elite-level American like Thomas Edison, and people do not know her.

I use this interview as the trials and tribulations that could happen in recognising the reputation of the right people of an invention. As there is no magic, it needs people and teams, there might be no passion for profit, but there has to be a purpose defined by someone that lets him or the whole team persevere. In some cases, others and history writers have to question if the reputation is given to the right people. The history of inventions and innovations could be rewritten as a pro and a con.

In general, why is reputation important? Reputation as a word is from Latin reputatio of reputo and means to calculate or to consider and describes the standing of a person, group or an organization in culture, society or community. The reputation is based on trust and credibility and can be understood as a resource based on the collective recognition of the economic, cultural and social assets of an individual. The reputation is part of the evolution of behaviour as its transmission allows the socially desirable behaviour to spread. As an emerging research question, the consideration of reputation and its transmission methods in the German Maker community could be of interest; it leads to the continued conservation and further development of habits and behavioural patterns in the community.

Artefact 9. Artefacts of Reputation at Dortmund (2017)

K. Designed Obsolescence and Critiques of the User

Before we come to an end of gathering the potential significant themes to define the facets of the invention and to build a second preconception, I want to introduce the insights of Eli Blevis about the interrelations between invention and disposal, renewal and reuse. As Eli Blevis writes that the 'Sustainable Interaction Design (SID) principle, linking invention and disposal, calls attention to the ways that interaction design contributes to premature obsolescence, often as part of intentional and coordinated business strategies,' (Blevis, 2007). The critiques of the users started because premature obsolescence becomes aware to the users and the public discourse has shown that this trickery had become an active part of

business strategies. ‘Through criticism of particular cases, such as Apple’s iPod, Blevis observes that obsolescence is achieved through the reinvention of product form and functionality in concert with fashion trends and marketing tactics,’ (Roedl, Bardzell, & Bardzell, 2015). A disputable strategy, to increase the revenue of companies but ignoring any present environmental issues occurring from the needless disposal, and additional resource and energy consumption for the replacement.

Artefact 10. Obsolescence and Waste Art Artefacts at Cologne (2016), Dortmund (2017) and Hannover (2017)

Preconception II including the Results of the Literature Review

Figure 10. Preconception II - Including Results of Literature Review

Finally, the purpose of the literature review is to uncover the gaps in previous research and critically evaluate the ideas of other researchers to carry on research. The result of the literature review is the springboard for the possible, meaningful continuation of research to close further gaps in knowledge. Of course, the literature review also serves to identify any weaknesses in the research carried out so far, in order to solve them, to mitigate them or to avoid them if they remain. These results and insights from the literature review must, therefore, be taken into account when developing the research design. Based on the assumptions of this literature

review, it should be considered how difficult-to-define the invention and the inquiry of the invention have been so far.

Today's concept of invention and innovation is often used synonymously, although the term innovation is strongly linked to the aim of gaining profit. On the other hand, the notion of invention often refers to the problem of determining what an invention is and why it is. Due to timing constraints, the time lags, it is not always clear who was the actual and first inventor of the invention as goods or as the first thoughts. The problem of determining invention and inventor leads to the problem that the selection of inventors as investigative subjects in research, especially in quantitative research, is inadequate. Often the definition of inventors is based on people who are identifiable within the background of patent law, i. e. who hold a patent - generally speaking. However, this leads to the fact that the population of inventors, including those who have not applied for a patent, is difficult to determine, which means that the results of research are becoming less generalizable. In addition to this difficulty, in terms of content, there is also a temporal and causal problem here. If you want to enquire existing inventors and determine their personality traits or if you want to ascertain the potential whether someone has what it takes to be an inventor. Moreover, to what extent the potential of the individual ultimately leads to an invention. The introduction of the system theory then additionally considers the possible dependencies with the environment, in particular in the considered working environment, society and more generally with the culture in which the inventor has grown up, lives today or will live in the future. It is here that we can understand what has to be invented since the needs of the cultures can be much different, and yet the multitude of inventions relate to satisfying one or more needs.

The author Larisa Shavinina then asks the final question, if you do not know what inventors are and what makes them stand out, how do you develop them? What structures are required and when are they needed to create a disposition or a tendency to invent? A first step can be to develop a qualitative concept, which describes what the potential stimulating factors, first of all on a small scale but across the identified research fields are. In

further steps, it is then possible to think about and research what are factors that have the opposite effect, and in which weighting and interdependence these factors correlate.

2.3 Overview of the International Research about the Maker Movement

The origin of the Maker Movement can undoubtedly be found in the first event in 2006; it was the first Maker Fair in San Mateo, California, USA. From the research perspective, the topic was highlighted in the context of Human-Computer Interaction (HCI) conference in 2009 when the relationship between craft, DIY, hacking and the Maker Culture was also researched.

> ‘The year 2009 was perhaps a watershed year for Maker discourse in which many papers appeared at CHI and a workshop brought together research on craft, DIY, and hacking. Hacking is a term with a long history among programmers and in popular culture, but it has not received much attention in HCI. It has appeared only recently and only about recent trends in Maker culture,’ (Roedl et al., 2015, p. 15:18).

On the one hand, the handling of materials, the DIY and craft content was focused on the HCI light. On the other hand, the concepts of ethical values behind Making, which goes slightly hand in hand with hacking, was also emphasised, exemplarily the democratisation of tools. ‘In contrast, discourse on DIY and hacking tends to focus more on broader social issues such as democracy, resistance to authority, community, values, and norms. For example, Wang and Kaye claim that resistance to authority is a key element that distinguishes hacking from the craft,’ (Roedl et al., 2015, p. 15:18).

In the last, over ten years Sylvia Lindtner conducted most extensive ethnographical studies within the Maker Movement with a strong focus on the development in China. Sylvia Lindtner participated in majorly design-related activities as open source hardware prototyping, hackathons, design workshops, and design for manufacturing.

> ‘In total, we conducted over 180 formal interviews and surveyed 70 relevant stakeholders including software developers, tech

> entrepreneurs, hobbyist makers, members and founders of hacker/maker-spaces and startups, organizers of maker-related events, and open source hardware entrepreneurs, factory workers, owners, and managers, government officials and policymakers, employees in design firms and large IT corporations, artists and urban planners, and investors,' (Avle & Lindtner, 2016, p. 2236).

The relevance of Silvia Lindtner's research for the evaluation of my research about the German Maker community is because the long timeline of her studies those also allow insight into the beginnings of the Maker Movement in foreign countries. 'Research includes participant observation in hacker and makerspaces, co-working spaces, incubators, factories, hardware facilitators and design solution houses across the cities of Shanghai, Beijing, and Shenzhen,' (Avle & Lindtner, 2016, p. 2236). Also critical here is the political alignment, which is closely connected with the development of the Chinese Maker Movement. An example in which this political relationship is expressed is the suppression of the term hacking (resistance to authorities) in China, the notation was forbidden and replaced in the broader sense by the term Making.

> 'While the earlier movement was concerned with the workings of software code and the workings of the Internet, this contemporary Maker Movement is concerned with hardware designs and the workings of the Internet of Things,' (S. Lindtner, 2014, p. 146).

From my perspective there is relevant research that was conducted by Emma O'Sullivan for her master thesis 2016 at the University College London, Department of Science & Technology Studies, is very important too, as it deals very objectively with the development of the Maker Movement in the UK which seems closely related to the development I also identified in the German Maker community. Her explored topics are very similar to my themes. Moreover, similar to my research, Emma O'Sullivan draws parallels to international research activities (see (O'Sullivan, 2016)). She also concludes, that 'identification with the term 'Maker' is not a prerequisite for participating in the maker community and utilising the opportunities it

provides for personal and social empowerment. Over the past five years the global 'Maker Movement' has attracted an enormous amount of attention in academia,' (O'Sullivan, 2016).

International Studies explored Topics	
Potential to Facilitate Informal Learning and Upskilling	
Identified Authors	(Blikstein & Krannich, 2013), (Kuznetsov & Paulos, 2010), (Troxler, 2011)
Countries	US, NL
Methods	Action Research, Qualitative Research, Mixed Method
Data	Digital Fabrication Workshops, Prototypical Episodes, Survey across DIY communities
Key Findings	DIY as a vibrant culture facilitate Learning and Upskilling, DIY has a long history, Digital Fabrication and Making is seen as the Ultimate Construction Kit
Public Engagement with Science and Technology	
Identified Authors	(Dickel, Ferdinand, & Petschow, 2014), (Nascimento, 2014)
Countries	US, NL, ID
Methods	Action Research, Narrative Analysis
Data	2 Cases, Literature
Key Findings	Benefits of Low-Cost-Prothesis built in Shared Machine Shops at Indonesia, Engage in Critical Understanding of Technologies for instance in the Areas of Sustainability, Social Justice, Ethics in Design
Technological Sustainability	
Identified Authors	(Kohtala, 2016), (Maldini, 2016), (Rosner, 2014), (Smith, Hielscher, Dickel, Soderberg, & van Oost, 2013)
Countries	FIN, NL, US

Methods	Explorative Approach, Semi-Structured Interviews, Longitudinal Ethnographic Fieldwork, Participant Observation and Non-Participant Observation
Data	Interviews, Narrative Summaries, Videos and Photographs, Authentic Materials
Key Findings	Step away from the Environmental Impacts embedded in Mass Production, Fab Lab ideology to communicate impacts of Maker Movement, Understand Local Conditions to understand Local Needs, Stimulate and Sustain Engagement with Local Users, Role of FabLab, Fixit Clinic and Repair Cafe: DIY become increasingly applicable to more people in a greater variety of circumstances, Replace mass-produced goods with more durable products (reduce waste), diminishing consumption (care for environment), Digital Fabrication transforms Grassroots Innovation Capabilities in Society
Entrepreneurship, Innovation and New Methods of Manufacturing	
Identified Authors	(Birtchnell & Urry, 2013), (Halbinger, 2014), (Gershenfeld, 2008), (Troxler, 2010)
Countries	AU, UK, DK, US, NL, IN, NO
Methods	Analysis of Socio-Technical Systems, Quantitative Approach, Survey/ Web-Based
Data	Expert Interviews, Self-Collected Dataset of Hackers and Makers/ Individuals, Survey of Fab Lab business models, Interviews in Fab Labs, Cases of Fab Lab projects about innovation
Key Findings	Personal Fabrication changes the Ecology of Machines and Technologies ('The Future World of Fabrication'), Impacts on Social Practices and Transport, Words and in particular pronouns reveal core aspects of individuals' identity, thinking

	style, networks and status as well as behavioural tendencies, Social Skills are Core in Entrepreneurship to access and leverage Opportunity-related Information and mobilise Resources, Analysis of Language appears to be a Research Trajectory in future studies, Digital Fabrication/ FabLab: Better ways to build things can help build better communities. 'How will we live, learn, work, and play when anyone can make anything, anywhere?', Fab Labs: Part of a Community that comprised elements of Commons-based Peer Production and Grass-root, User-driven Innovation
Grassroots Collaboration and Peer Production	
Identified Authors	(Kohtala & Bosqué, 2014)
Countries	NO
Methods	Ethnographic Research, Semi-structured Interviews, Qualitative Data Analysis, Observations in Fieldnotes
Data	Audio Transcriptions of Interview, 400 photographs, Fieldnotes and numerous Drawings
Key Findings	Fab Labs are not all alike, despite their surface similarity; each Lab becomes an entity shaped by its founders, funders, fabbers and followers. Labs are also likely to experience tension or need for balance between acting in their particular local. The role of stories and rhetoric in shaping culture – stories to boost learning, stories to establish a reputation, and stories and metaphors on growing and seeding as guides for envisioning new forms of organisation.
Democratisation of Technology	
Identified Authors	(Pederson, 2016), (Richardson, 2016), (Tocchetti,

	2012)
Countries	MX, GT, AU, US, UK
Methods	Action Research, Literature Review
Data generated	Fieldnotes of Workshops
Key Findings	Activate Awareness and Change both on a range of Social Justice Fronts, Challenging and Expanding the more Conventional Conceptualization of Maker Spaces, Maker Culture: Aims to reignite the joy of labour and discovery through openness and making, DIYbio becomes an evidence of the 'expanding frontiers of hacking', The information:machine:biology recursive assemblage has become open source software:open hardware:personal biology. In this respect, cyborgs are still the products of this technocultural endeavour, but similar to how computers transitioned from 'institutional' to 'personal'; the maker is now developing the language, the tools, and the spaces to think about their production as 'personal'.

Figure 11. Studies included by the Research of Emma O'Sullivan, compiled from (O'Sullivan, 2016, p. 1)

There is relevant research from David Roedl who is one of the few who used the Discourse Analysis for his research to identify what has been said about the maker culture and by whom; also by taking into account the Human-Computer Interaction (HCI) publications of the last 15 years as his primary source.

> 'We look at how the conversation has evolved and how it maintains a logical coherence through a set of common themes, rhetorical strategies, and unstated assumptions. After this initial analysis, we attempt to explain how these patterns in the discourse result from specific institutional pressures, disciplinary conventions, and legitimate practices,' (Roedl et al., 2015, p. 15:15).

Therefore it is of particular interest to see the similarity of results from his research and my themes identified so far. Especially if a potential 'evolutionary' timeline should be recognised, that there is an evolution from the localised craft, DIY and hacking groups to regional and national Maker communities and later on all is adapted to an international Maker Movement.

> 'The most prolific authors can be seen as representing several distinct groups based on collaboration and affiliation: UC Boulder/MITMedia Lab (Buechley, Blauvelt, Eisenberg, Elumeze,Mellis, Perner-Wilson, Wrensch), UC Irvine (Dourish, Lindtner, Williams), UC Berkeley (Goodman, Rosner, Ryokai), Simon Fraser University (Desjardin, Maestri, J. Tanenbaum, K. Tanenbaum, Wakkary), and Carnegie-Mellon University (Kuznetsov, Paulos, Pierce),' (Roedl et al., 2015, p. 15:15).

In addition, it is relevant that David Roedl is also working with Shaowen and Jeffrey Bardzell, by whom a great deal of research has been carried out, mainly in the USA. 'This research includes studies of online communities of expert amateurs, digital fabrication methods and their connections to technological innovations,' (J. Bardzell et al., 2014, p. 473).

There is relevant research from Jeffrey Bardzell who use the notion 'culture of making', thus avoiding the notation of the Maker Movement. He states that making is more than just the capability of the individual.

> 'Cultures of making - that is, social practices of hacking, DIY, tinkering, repair, and craft - continue to rise in prominence, and design researchers have taken note, because of their implications for sustainability, democratisation, and alternative models of innovation, design, participation, and education,' (J. Bardzell et al., 2014, p. 473).

As many of the earlier studies are limited to quantitative approaches of their research they already conclude; 'we discuss DIY as a vibrant culture with a long history of learning, creating and sharing,' (Kuznetsov & Paulos, 2010, p. 302).

There is relevant research from Evans Barba's who is also based in the USA. Ewan Barba comes to similar conclusions even if he has loosened the strong linkage to technology so far. 'In this sense, Making is a form of design rhetoric that is not necessarily tied to digital technologies. For others, the emphasis is on individual creativity or the DIY ethos,' (Barba, 2015, p. 639). On the other end, Ewan Barba emphasises the distinction between democratisation of power structures and the economic dimension of making seeing its role in innovation and making business.

> 'These Makers combine design and personal fabrication to create the artefacts they want in their environment or to gain greater control over technologies created by others, for purposes of function, aesthetics, or both. Others see Making as intertwined with 'innovation'; and for them, the practices of knowledge production and sharing are ways of creating new products and processes that change the way business is done for both the large- and small-scale producer,' (Barba, 2015, p. 639).

With this few but relevant examples from international research in the first place, I should have set the ground for the evaluation of my additional themes (AT01-AT10) identified so far from my research data and analysis in chapter 4.3 Analyse the Data for Additional Themes. These authors researching about the Maker Movement will be mentioned in the chapter 6.2 Evaluate Additional Themes (ATx), as their work is related to my potential findings specific to the German Maker community (A), similar (B) or equal (C) with international research results or (D) where international research found distinct results (see Figure 48. Use of the Principle of Multiple Interpretations to Evaluate Research).

2.4 The Systems Model of Creativity (SMoC)

Next, will be a short description of the Systems Model of Creativity (SMoC) as it contributes to the contemporary socio-cultural approaches. Even if system theory might be criticised in several ways, I found this model very compelling on how the interaction with and around an individual may influence each other. Mihaly Csikszentmihalyi describes there in the dynamics caused by identified relationships between the three subsystems - the Individual, the Field, and the Domain. Further, that creativity occurs at the interfaces of these three subsystems: Firstly, an Individual who absorbs information from the culture and its family background. Secondly, the individual changes this information in a way that will be selected by the relevant Field of gatekeepers for inclusion into the Domain. From whence the novelty will be accessible to the next generation (Csikszentmihalyi, 2014, p. 166).

'All models are wrong, but some are useful,' George Box

The new insight of Mihaly's Csikszentmihalyi Systems Model of Creativity (SMoC) was his idea to change the dimension to look at the phenomenon of creativity. Instead of insisting on the question, 'what is creativity?' Mihaly Csikszentmihalyi changed the question to 'where is creativity'? In addition to citing Mihaly Csikszentmihalyi and conclude on the three waves of creativity research,

> 'It seems that an understanding of the complex context in which people operate must eventually enrich our understanding of who the individual is and what the individual does. However, to do so, we need to abandon the Ptolemaic view of creativity, in which the person is at the centre of everything, for a more Copernican model in which the person is part of a system of mutual influences and information,' (Csikszentmihalyi, 2014).

Mihaly Csikszentmihalyi argues that creativity cannot be studied by isolating individuals and their invention from a social-cultural context; creativity is never the result of the individual acting alone. For Mihaly Csikszentmihalyi, it is the product of three main shaping forces: a set of social institutions, or

field, that selects from the variations produced by individuals those that are worth preserving; a stable cultural Domain that will preserve and transmit the selected new ideas or forms to the following generations; and finally the Individual, who brings about some change in the Domain, a change that the Field, will consider being creative (Csikszentmihalyi, 2014). So the question 'where is creativity?' cannot be answered solely with the only reference to the individual and the invention. Creativity is a phenomenon that results from the interaction between these three systems; Domain, Field and Individual that are embedded in culture, society and family.

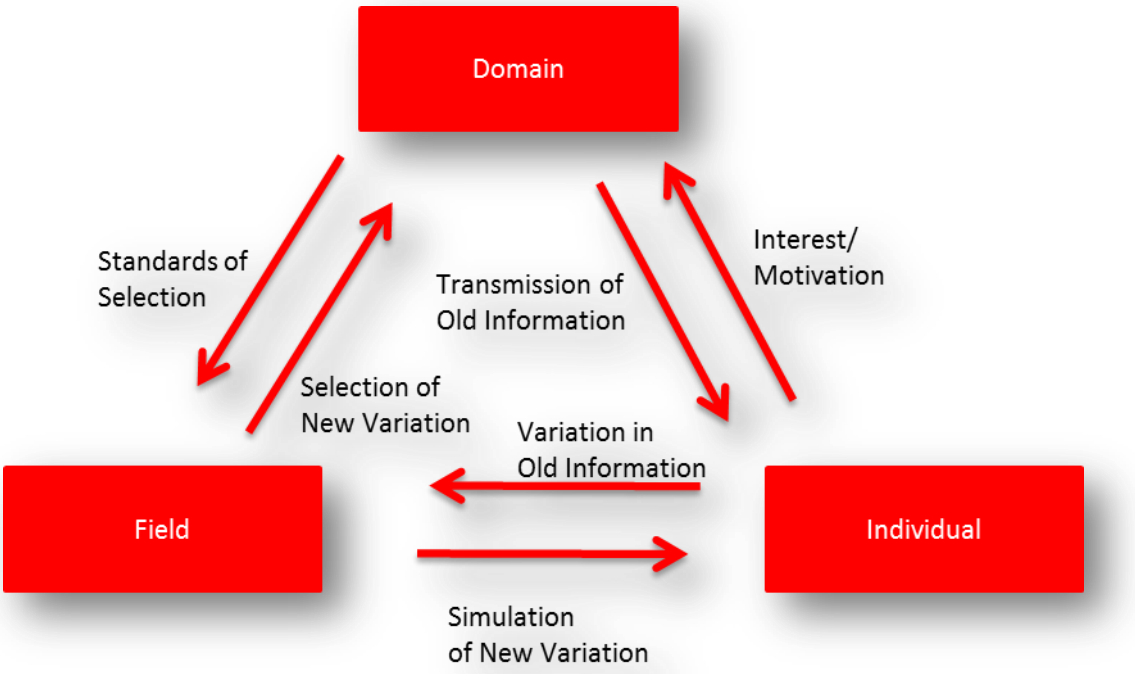


Figure 12. The Systems Model of Creativity (SMoC)

Preconception III including the Systems Model of Creativity (SMoC)

There are two main parts I take from Mihaly's Csikszentmihalyi Systems Model of Creativity (SMoC), firstly, it is the structure of systems that I will map structures I will search for in the Maker community. Secondly, a part of the research design he used to come up with the Systems Model of Creativity (SMoC), which is the project 'Creativity in Later Life' where Mihaly Csikszentmihalyi interviewed persons over 60 years of age, such as Nobel Laureates and Pulitzer prize winners who have made significant

contributions to a domain. From this project, I used his questionnaire as a template for creating the questionnaire for my semi-structured interviews. It consists of four parts, with the focus on (A) career and life priorities, (B) relationships, (C) working habits and insights, (D) attentional structures and dynamics. My full questionnaire is contained in this thesis in the Appendix VIII Questionnaire for Semi-Structured Interviews. The four parts cover the systems of Domain, Field and Individual.

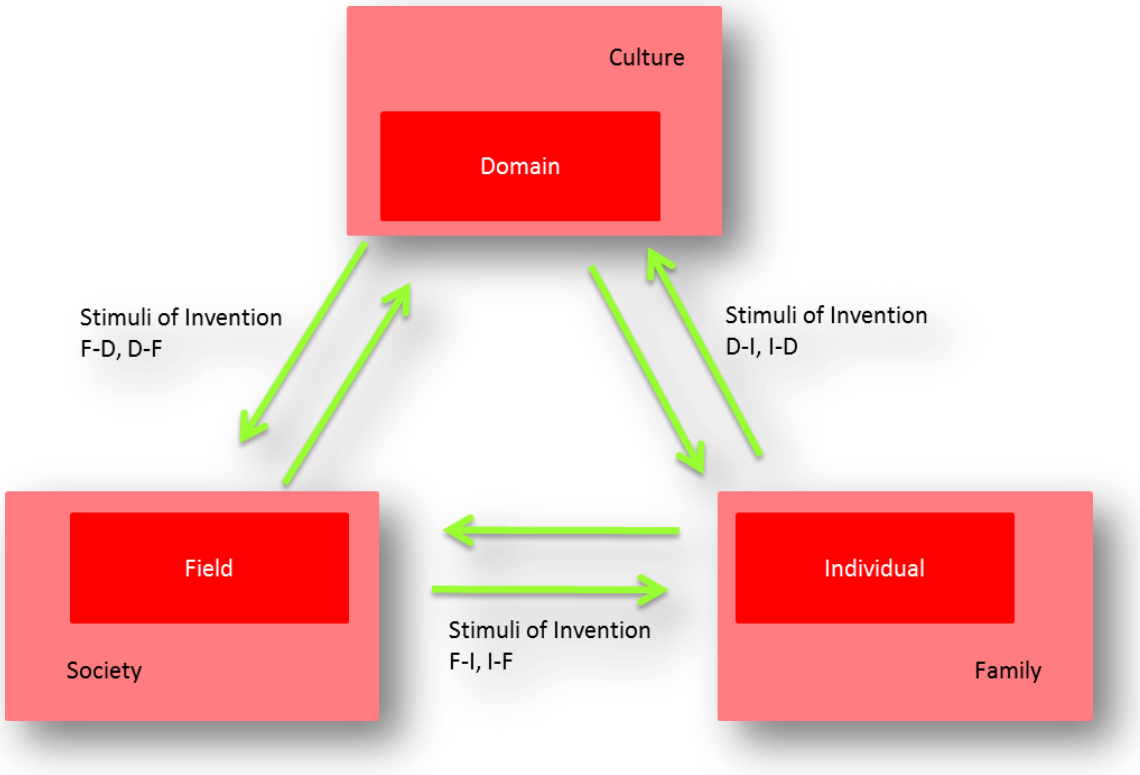


Figure 13. Preconception III - Insights from the Systems Model of Creativity

The difference between preconception II and preconception III is that I see Mihaly Csikszentmihalyi interaction between the systems mainly focused on the transmission, variation and selection of information or knowledge. Therefore, I substituted his interactions into the Stimuli of Invention (SI) which are also directed between the systems Domain, Field and Individual. When you look at the next Preconceptions of Stimuli of Invention (PSI), you may recognise that not all combinations of interactions are present from the very beginning (note: in later Preconceptions of Stimuli of Invention (PSI)

missing interactions are presented as dotted lines). As the gaps were suspicious, I started actively to search for extended Stimuli of Invention (SI).

Other Systems Model of Creativity

The work of Tabor Greene is impressive; he creates a new four-cycle model of creativity because he argues that creativity research needs some creativity. However, putting this glimpse of irony away, he identified, analysed and structured forty-two models of creativity, see Figure 14. Tabor Greene's 42 Models of Creativity. He also introduced Mihaly Csikszentmihalyi's several works on creativity and in particular the Systems Model of Creativity (SMoC). Tabor Greene first started with seven types; he introduced the Systems Model of Creativity (SMoC) into four of these types, the recommendations model (catalogue type), the Darwinian system (catalogue type), Systems Model (social type), Influence (purity type) and Interest (self-type). Tabor Greene analysed the attractive possible future combinations among these forty-two models, and he concluded that the result was a matrix of natural selection's four operators with three of the four entities of the Csikszentmihalyi systems model (variation, combination, selection, reproduction as rows with person, field, and domain). The creative work was omitted.

Tabor Greene sees this - in the context of a model of 42 models of creativity - as a starting point to search for other fruitful combinations for research or creative practice improvement (Greene, 2001), I came to the conclusion that choosing the Systems Model of Creativity (SMoC) for being a structural part of my research design is not the worst doing.

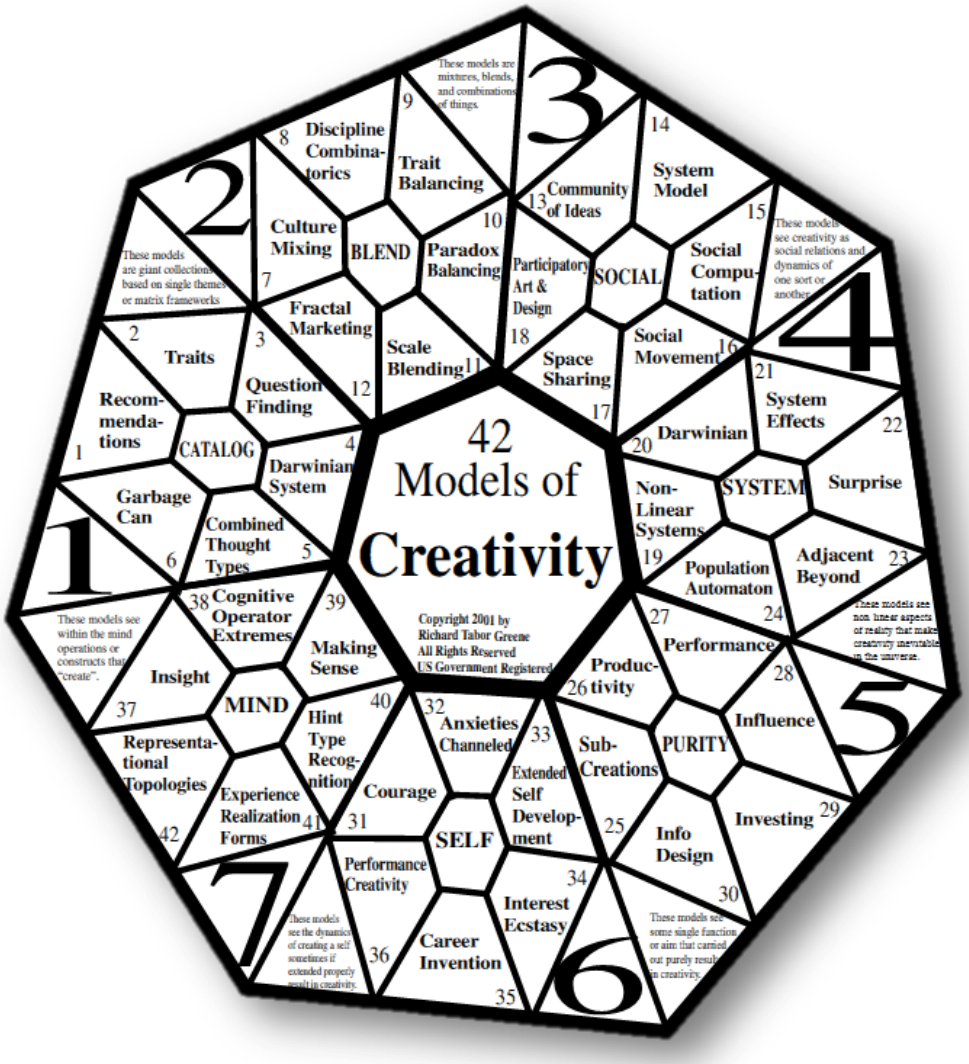


Figure 14. Tabor Greene's 42 Models of Creativity (Greene, 2001)

2.5 The Preconceptions of Stimuli of Invention (PSI)

The following figure shows the preconception IV made during the pilot phase and is mainly based on the findings from the literature review and the introduction of the theoretical concept of the Systems Model of Creativity (SMoC). After the pilot phase, the codebook was initially prepared. The codebook can be found in Appendix V, starting with the raw concept codes. This hand drawing is the foundation for further insight documented in the concept codes from appendix VI-4 Pattern Codes. The concept codes from V-4 were used for further analysis of data gathered from and about the Maker community, as well they were associated with interviews with creativity researchers, see Appendix IX-5 Contemporary Research about Creativity, Analysis of Interview with Janet (anonymized and IX-6 Contemporary Research about Creativity, Analysis of Interview with Karen (anonymized). As these associations led to further insight, they will be introduced hereafter in chapter 3.4 Preconception V - The Theoretical.

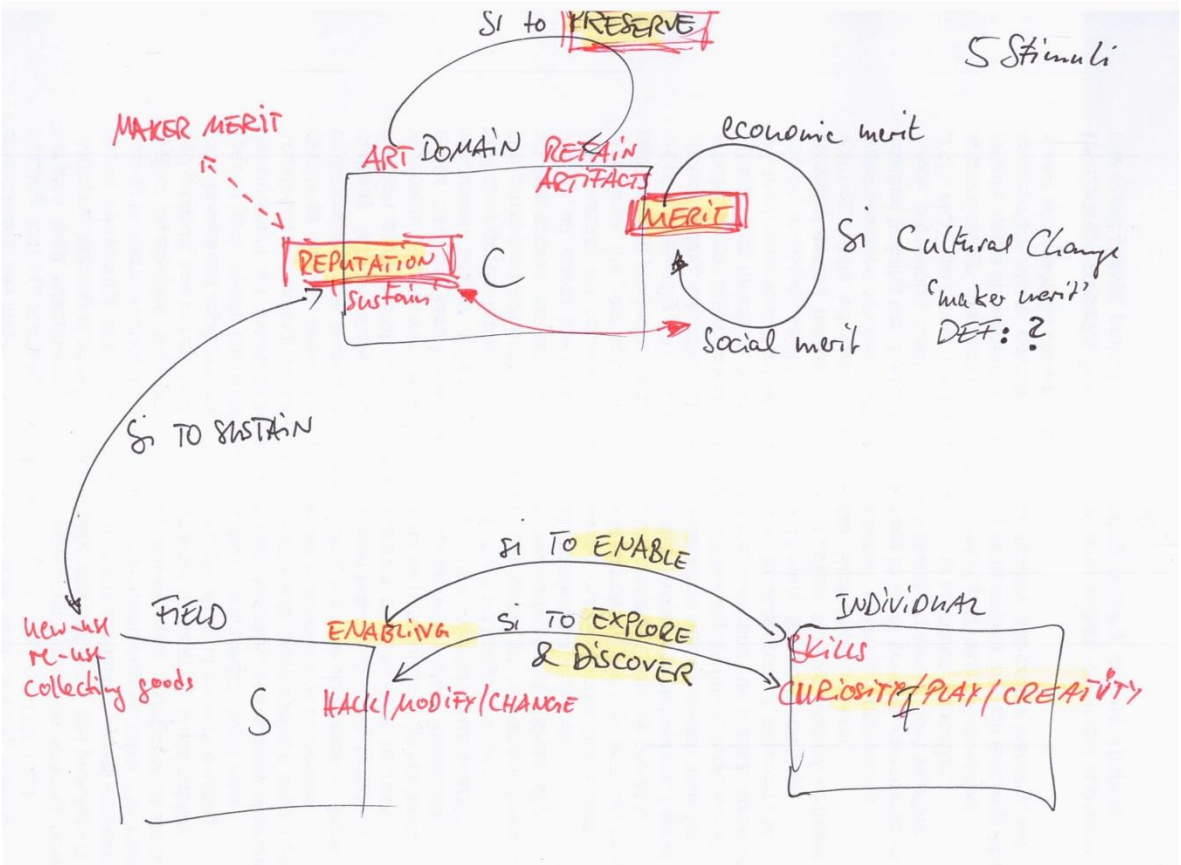


Figure 15. Preconception IV - Stimuli of Invention (PSI)

3. Research Methodology

3.1 Research Philosophy

‘Language is unique to human beings.’ (Burr, 2003)

Finding the right research philosophy is like going to a bad tailor. Every time you think that the made-to-measure suit fits neatly you experience situations the trousers are too tight, the sleeves are too short, and the tie strangles you more than to be accepted. First, you start changing shirts, then you change the tailors, and at least you must learn to make your suits. I think it is the confidence in using a research philosophy and being aware of the research philosophy you are using; it is the knowledge about the potential problems and concerns that the research philosophy can cause to your research and your outcomes. Neither the less, it should not lead to constantly changing your stance as the clothes and the fashions that evolve. Stance is to find the right wardrobe for the situations you may be faced with during your research. Moreover, these situations, from the other researchers perspective are not embarrassing, they are known.

Language is essential, as people use language in their everyday social interaction to come to agreements with each other. Words do not mean only to reference things in the real world, but they are also used to exchange understanding between people and make meaning for them. So the words are not only used for explanation reasons, as in the natural sciences; words are used for a socially constructed, contemporary understanding between people, as in the human sciences (Lock & Strong, 2010). The philosopher Wittgenstein has influenced the social constructionist’s view of language as he posed a radical challenge to the idea that words are an unproblematical reference, arguing that the meaning of words is intimately bound up with social practice (Burr, 2003). So the overall context was the time of articulating, and the cultural circumstances or Zeitgeist is essential. Moreover, as social constructionism is concerned with meaning and understanding being the central feature of human activities, the discourse, with its continuity of a conversation that goes back and forth, until what is being said becomes more explicit, is key (Lock & Strong, 2010). The ways of

meaning-making, being inherently embedded in socio-cultural processes, are specific to particular times, places and socio-cultural traditions (Lock & Strong, 2010). 'In the untenable position of saying there is no difference between true and false accounts, or in effect, any description of the world is as true as any other,' (Gergen, 2015). However, there should be a researcher's concern about the discovery of false preconceptions. The discovery of true and false preconceptions is the reason why I decided to use the seven principles described in detail in the next chapter and are based on a conceptual paper of the authors' Heinz Klein and Michael Meyers (Klein & Myers, 1999) to define conventions for conducting and evaluating interpretative field studies in information systems. I use these principles to guide my judgement and to evaluate the findings from my research.

3.2 Hermeneutic Circle

If we construct society, following the concept of society as constituted by individuals, it has to function by continuous discourse, - relationships. Moreover, to shift the balance from critique to creativity, not seeing the others as the opposite. What this world means to us is different, and in this sense, we approach this world in different ways. People are speaking from a particular standpoint or tradition of understanding, the tradition of sense-making. To cite Ludwig Wittgenstein, the form of life is built from the entire array of relationships - words, actions, objects. Otherwise, it is a cultural tradition. The care for relationships is prime. 'It is out of relationships that we foster our vocabularies, assumptions, and theories about the nature of the world, and the way we go about studying or carrying out research' (Gergen, 2015).

As mentioned in the last chapter, the quality of my thesis can be secured by the use of a set of principles for conduct and evaluation. These set of principles are derived from the philosophical perspective of hermeneutics and are based on the conceptual paper of the authors' Heinz Klein and Michael Meyers. The authors describe the general purpose of this set of principles is to reduce the risk that the interpretative work may judge inappropriate. Therefore, this set of principles support researchers, reviewers conducting, evaluating, or justifying their research (Klein & Myers, 1999).

As these set of principles create a whole to ensure the quality, they will be defined individually, in the beginning, may be revised and used later for evaluation of the research findings.

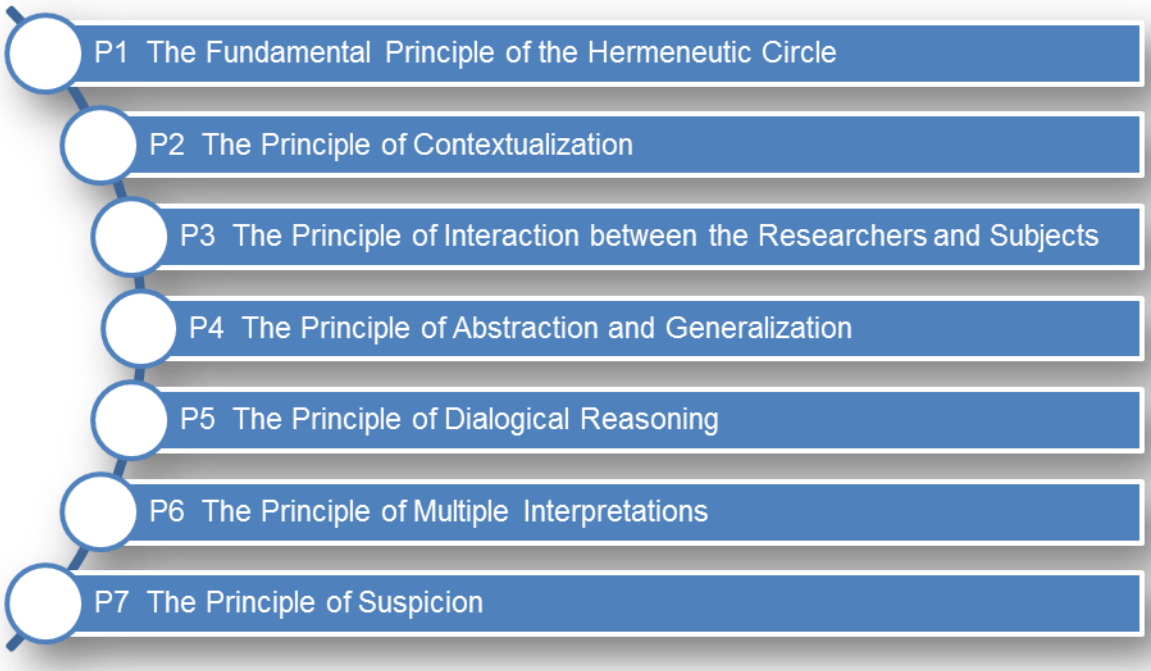


Figure 16. Set of Principles used for Research Conduct

P1 The Fundamental Principle of the Hermeneutic Circle

> 'This principle suggests that all human understanding is achieved by iterating between considering the interdependent meaning of parts and the whole that they form. This principle of human understanding is fundamental to all the other principles,' (Klein & Myers, 1999).

For me, the critical part of this citation is 'considering the interdependent meaning'. The idea of the hermeneutic circle is to use iterative preconceptions about the meanings, which explicitly means the plurality of meaning, of its parts and interrelationships (Gadamer, 1976b). The chapter building themes are the result of this process. From different perspectives, also the historical perspective, we come to different meanings of the part called an invention. In this process of the hermeneutic circle, my understanding moved from a precursory understanding of the parts in the literature review about 'invention' to the whole. Moreover, from a global

understanding of the whole context ‘invention’ back to an improved understanding of each part. ‘Part’ I use here metaphorical as I would interpret the categories like Domain, Field, Individual as parts of my understanding, as well the research fields, like psychology, sociology, technology are parts of my understanding. As a reader, you may have the impression that this is an abroad, and liberal interpretation of part and whole, but these parts lead to preliminary understandings in the study. Also, the later whole consists of the shared meanings that emerge from the bidirectional interactions between the parts, forming a complex web of interpretations for potential findings, discussion, implication and conclusion.

> ‘Thus the movement of understanding is constantly from the whole to the part and back to the whole (concentric circles the unity of understood meaning). The harmony of all the details with the whole is the criterion of correct understanding,’ (Gadamer, 1976a).

My objective is, to give to you as a reader (as well as to myself) a transparent picture of the research process that hopefully concludes in these shared meanings to discuss the findings, the implication, and come to an understanding and a common, possibly critical, conclusion. Neither the less, to reach Gadamer’s harmony of all details is the vision.

P2 The Principle of Contextualization

The principle of contextualisation requires that the researcher reflects on the social and historical background of his research. As various contexts could be explored, it is essential, also, to place the subject matter in a social and historical context. ‘A result should be that you the intended audience can see how the current situation under investigation emerged,’ (Klein & Myers, 1999).

The introduction opened up the social and historical background of human creativity and invention, in the literature review preconceptions were developed from research with the objective to place the definition of invention in a historical and socio-cultural context and to conclude with the Preconceptions of Stimuli of Invention (PSI). The research design is a reflection of the research opportunities and constraints of data gathering and

data analysis on the one hand, and the roles of the researcher and the subject on the other. As this is still a kind of preparation for the research, it provides extra context to the research, like the intended concept of the case study, the methods to be used for data gathering and analysis (chapter 3.6 Methods for Data Collection and Analysis). Moreover, on the researcher's role to ensure the quality of research (chapter 3.7 Quality of Research Design), the compliance with ethical considerations (chapter 3.9 Ethical Consideration), and to maintain the actions and the schedule (chapter 3.10 Research Schedule).

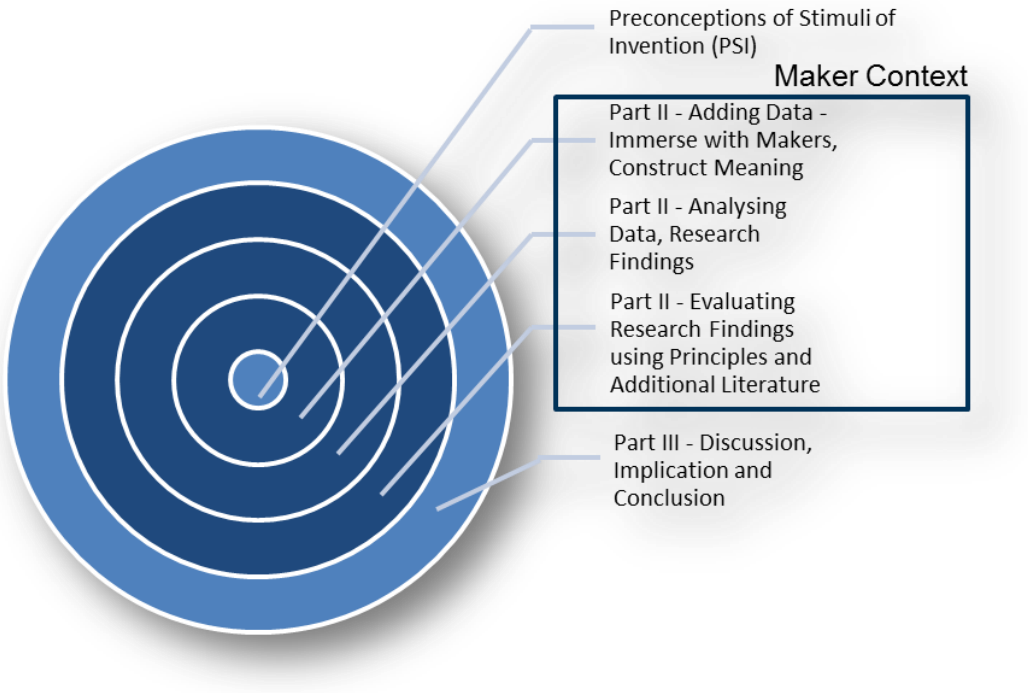


Figure 17. Adding Context and Data for Analysis and Report

In part II, when entering the stage of the Maker Movement, further and the most important context is created. It is the immersion with makers, the interviews and discourses, the making of meaning from data and artefacts gathered in the community of Makers, see Appendix III Extract of Images in Fieldnotes and Appendix IX Transcripts. Also, to evaluate the research findings, I introduce additional literature and therefore extend the context using contemporary research conducted in Maker communities in other countries than Germany. Frankly, I gathered that additional literature in parallel to the data gathering and analysis in the German Maker community.

Moreover, it took time to decide where to put that - additionally in the literature review or becoming explicitly a role in part II for the evaluation of research findings.

Just to repeat the intention of the principle of contextualisation, the ‘result should be that you the intended audience can see how the current situation under investigation emerged,’ (Klein & Myers, 1999).

In summary, the principle of contextualization is fundamentally about embedding the underlying ideas behind the research aims and objectives in a historical and a social context and paving the way in a certain manner; my intention and reasoning on this path need to be understood by the reader. To do this, I certainly need to build a path through this context from where the reader is here to the end of red-threaded conclusions.

P3 The Principle of Interaction between Researchers and Subjects

> ‘The interpretation of culture(s) is, in fact, part of a process of construction, and the researchers themselves are similarly part of a broader sociohistorical process,’ (Kahn, 1989).

Moreover, to make it even worse, it is a continuous flow of interactions between people in the community and interactions with people outside of the community. Meaning is continuously constructed, changed and discarded, it is a moving target, and moreover, it is localised, people within the community may have another understanding than people looking from the outside (e.g. DIT versus DIY). Further, it is to recognise that people in and outside the community, just as me, the researcher, can step into or step out of a community, or alter changed horizons alter horizons and future actions. That is different from culture(s) within we are all embedded. The principle of interaction between researchers and subjects starts to question their own assumptions. It is about the self-consciousness and the how to embrace the context, in this case, the community and culture of the Maker Movement (chapter 3.8 Researcher’s Role). It is the consciousness about emotional and intellectual reactions to own experiences and observations, as well as emotional and intellectual reactions that are based on others’ experiences and observations. Others in this context explicitly mean, Makers in the

German Maker community and researchers that conducted similar socio-cultural research in other countries. The principle of interaction between researchers and subjects ‘requires critical reflection on how the research materials (or ‘data’) were socially constructed through the interaction between the researchers and participants,’ (Klein & Myers, 1999). Results of this reflection about the interactions were the decision to immerse with the Maker community, the discourses about findings so far with Makers, and at least the additional use of research from other researchers to evaluate my findings. The detail level of my observations was created by the situation that I immersed in the Maker community over three years until now; my preconceptions, my culture, my experience and observations in the Maker community still affect the construction, documentation, and organisation of this material (chapter 3.6 Methods for Data Collection and Analysis).

P4 The Principle of Abstraction and Generalization

> The Principle of Abstraction and Generalization ‘requires relating the ideographic details revealed by the data interpretation through the application of principles one and two to theoretical, general concepts that describe the nature of human understanding and social action,’ (Klein & Myers, 1999).

With the research perspective, we have seen in the literature review that there are concepts and models available that describe potential habits, techniques and skills to be or become more creative (Individual level) and Creative (Field level). Even more, we could build a preconception (abstraction) about stimuli that may influence Domain, Field and Individuals under a Systems Model view. This abstraction should be used as the sensitising device to view the world in a certain way and should be evaluated within the selected context. Alternatively, the contextual data gathered within the community of German Makers (ideographic details) is analysed under the research question: ‘What behaviour, techniques and skills that stimulate invention could be identified?’ Also, to answer the research question: ‘What other behaviour and habits might German Makers have that improve their skill set to invent?’ Moreover, this last question could be extended to ‘could these other behaviours and habits be seen elsewhere’. For the theoretical

abstractions and generalisation, it is important to carefully relate the field study details as they were experienced and collected by me, being the researcher. The documentation of cases should value the unique circumstances but allow relating these unique instances to ideas and concepts that apply to multiple situations. ‘The base is on plausibility and cogency of the logical reasoning used in the describing the results from cases, and in concluding them,’ (Klein & Myers, 1999). As it sounds easy, the drawing of conclusions is described in the next principle, the principle of dialogical reasoning. In addition, we will see that before we come to the abstraction and the generalisation, it needs much juggling of the principles of hermeneutics, the contextualisation and the interaction between the researcher(s) and subjects; and the principle of dialogical reasoning.

P5 The Principle of Dialogical Reasoning

> ‘The principle of dialogical reasoning requires the researcher to confront his preconceptions that guided the original research design with the data that emerge through the research process. It requires sensitivity to possible contradictions between the theoretical preconceptions guiding the research design and actual findings (‘the story which the data tell’) with subsequent cycles of revision,’ (Klein & Myers, 1999).

Research findings may not support preconceptions. It has to be accepted that preconceptions have to be modified or abandoned during research. Prejudice, prejudgement, or prior knowledge plays an integral part in our understanding, and hermeneutic recognises that prejudice is the necessary starting point for our understanding. Therefore, it is a standard task that preconceptions have to be modified or abandoned during research, and the criticality is to distinguish between true prejudices, by which we understand, from the false ones by which we misunderstand. The rule can be applied several times in sequence. Therefore I, the researcher, must become aware of my historicity so that my improved understanding of one iteration becomes the prejudice for the next iteration. In practice, several revisions of preconceptions are confronted with the accessible, conventional empirical and observational records.

In this study, you already saw that five preconceptions were continuously built and modified. This process of modifying and abandoning of the preconception is still in place. During the data collection in the context of the German Maker community and the data analysis, there will be further insights and increasing understanding. The data analysis then will get closer to answer the second research question of what behaviour, techniques and skills stimulate invention. In other words, the current preconception V will be confronted with my empirical and observational records and the preconception will be undergoing further revisions. This is also true for the evaluation which is another iteration of the findings using contemporary findings of other researchers that already conducted and still conduct research in the Maker Movement internationally. The evaluation will answer the third research question of what other behaviour and habits might German Makers have that improve their skill set to invent. In other words, the preconception will be confronted with additional empirical and observational data to allow multiple interpretations and the preconception will be revisited.

P6 The Principle of Multiple Interpretations

> ‘Requires sensitivity to possible differences in interpretations among the participants as are typically expressed in multiple narratives or stories of the same sequence of events under study. Similar to multiple witness accounts even if all tell it as they saw it,’ (Klein & Myers, 1999).

During my research in the German Maker community, I concluded that the findings from prior research and research that had been conducted in other countries might differ. Of course, there are similarities, but there are dimensions where there is a significant variance; dimensions based on the history of the countries, the educational and political systems established and for how long. As it was a specific constraint for me to conduct research in other countries than Germany, partially I tried in the UK during my onsite stays at the University of Gloucestershire, but I had to find another way to involve the ‘other’ social context. Consequently, I defined the findings of other researchers as sources from multiple agents. Moreover, this gave me the opportunity to confront myself to the contradictions potentially inherent in

the several viewpoints, and to revise my understanding primarily according to these distinctions. Also, it fostered me in the exploration of influences that the social context has upon the actions of Makers by seeking out and documenting several viewpoints along with the reasons for them. During this process of the analysis of reasons, I had to extend my knowledge about the understanding of conflicts related to power, economics, and values; - the socio-cultural context which now is supported by the Systems Model of Creativity (SMoC) and other sources from the research field of sociology.

The principle of multiple interpretations may go beyond the point I described it up to now. In addition, the principle of multiple interpretations also may seek for the confrontation of conflicting interpretations of the participants in the field. Therefore, 'the principle of multiple interpretations is of heuristic value because it leads to probe beneath the surface. Such probing is strengthened further with the principle of suspicion discussed next,' (Klein & Myers, 1999).

In either case, revisions of the researcher's preconception may be the outcome. In my case, I use this principle twice; once by evaluating my findings that are first hand based on data I gathered within the German Maker community, by adding research data and results from other known researchers that are researching the Maker Movement internationally. Secondly, I used the principle by presenting my findings repeatedly during doctoral colloquiums to get feedback from other researchers, explicitly researching in the field of open innovation. The outcome was an improved understanding derived from the practice of the principle of multiple interpretations.

P7 The Principle of Suspicion

> 'Requires sensitivity to possible 'biases' and systematic 'distortions' in the narratives collected from the participants,' (Klein & Myers, 1999).

Especially these days with lots of information from social media, we have to learn to deal with the manipulation of information through people and communities. Our beliefs, consents, trust, and attention are continuously shaped by social and political interactions. Karl Marx and Siegmund Freud

identified these effects as socially created distortions and psychopathological delusions, so this is not unknown, but the discovery of false consciousness seems a crucial issue today. So even if the meaning of my findings is discovered beneath the surface, this meaning has to be revealed further. It is the situation were the people involved in the research, and that is also me, may make false claims.

> ‘Either explicit or implicit in critical work is a goal to demonstrate and critique forms of domination, asymmetry, and distorted communication through showing how social constructions of reality can favour certain interests and alternative constructions can be obscured or misrecognized,’ (Mokros & Deetz, 1996).

The principle of suspicion or doubt may eventually lead to a wrong or, at first sight, unbelievable result. However, how many times have we experienced that the first idea following this first doubt or that first abstruse idea was the right one in the end? The initial suspicion and following this doubt is thus a strong method of exposing flaws in the perception of oneself and others. In this study, I used this principle of suspicion in the relation of the use of the notion of invention and innovation; and to question the role of economics in the definition of these two. Another example would be my distinct use, and this was a process, of the notion of Maker Movement and the German Maker community.

Summary of the Seven Principles and Determination in Structure

Now the seven principles were shortly described and set into the context of this thesis it may become evident that this was only the first step. I had to adapt these principles in a certain way to my research and research design; I needed to work out by myself how and which of the principles apply in any particular situation like the tailormade clothes. The principal objective is the understanding of human thought and action in social and organisational context, and it is infeasible and distracting to describe every aspect of the context, so I choose what to say depending on the audience and the story that I wanted to tell. Moreover, also stated in the follow-on of this research design further assumptions and limitations I had to accept for this work. For a

better understanding of the structure and application of the seven principles find below where the principles are applied to my research.

Principle Title	
Brief Description	**Determination and Use of Principle**
P1 The Fundamental Principle of the Hermeneutic Circle	
Hermeneutic principle as the foundation for the following principles 2-7.	3.2 Hermeneutic Circle Figure 5. Preconception I - Invention Figure 10. Preconception II - Including Results of Literature Review Figure 13. Preconception III - Insights from the Systems Model of Creativity Figure 21. Identified Stimuli of Invention (Table Representation) Figure 23. Preconception V - Extended Stimuli of Invention 4.3 Analyse the Data for Additional Themes
P2 The Principle of Contextualization	
By researchers decision the relevant context(s) that should be explored	1.1 Research Background - The Science of Human Creativity and Invention 2.5 The Preconceptions of Stimuli of Invention 4.2.1 Contextualise the Data to IFD Relations (Preconception V 4.2.2 Contextualise the Data to Themes
P3 The Principle of Interaction between Researchers and Subjects	
Data creation in interaction with the maker	3.3 Research Design and Units of Analysis 4. Data Collection and Data Figure 26. Detailed View of Units of Analysis

	Figure 25. Chronological View on Data Collection Figure 27. Research Schedule (Schematic Representation) Several Appendixes
P4 The Principle of Abstraction and Generalization	
The theory or concept used for abstracting and generalising	Figure 33. Multiple-Case Dimensions of 'Contribution' Figure 44. Venn Diagram - Prioritised Themes Figure 45. Overview Pattern Coding and SMoC IFD Relation 5. Research Findings 5.1 Stimuli of Invention (SIx) - Behaviour, Techniques and Skills that Stimulate Invention 5.2 Additional Themes (ATx) generated from the Research Data
P5 The Principle of Dialogical Reasoning	
Reflect on the own intellectual history	3.8 Researcher's Role
P6 The Principle of Multiple Interpretations	
Different version of the story the research unearths	6. Evaluation of Research Findings 6.1 Evaluate Additional Themes (ATx) to Contemporary Research 6.2 Evaluate Additional Themes (ATx) Figure 48. Use of the Principle of Multiple Interpretations to Evaluate Research
P7 The Principle of Suspicion	

Aspects of the reality presented that need questioned critically	6. Evaluation of Research Findings 6.3 Contribution to International Research about the Maker Movement Figure 59. The contribution of Additional Themes (ATx) to my and International Research about the Maker Movement Part III - Discussion and Conclusion

Figure 18. Determination of the Principles of Interpretive Field Research

As a concluding statement about the research methodology and to link back to the DBA context I would express my expectations of this work now as a starting point for coming closer to successful socio-cultural and organizational changes that are needed for invention. On this macro level, the insights made about the Stimuli of Invention (SI) may influence the development of new and essential elements for the structuring of future societies and organisations that invent to the better.

> ‘Micro and macro forms of social constructionism both run into problems because they have not adequately theorised the relationship between the individual and society. The person is reconfigured as constructed in the social realm, but the implications of this for personal and social change are not clear. Does the individual have the power to reconstruct themselves, to build new identities and change their life story? Do they have the capacity to change the society they live? Alternatively, are these possibilities illusions? Are our lives determined by social?,’ (Burr, 2003).

In summary, the idea of Stimuli of Invention (SI) can serve as a foundation for breaking away from the concept of innovation and hence the embrace of economics in the research field of Human Creativity and Invention. Moreover, that research into Human Creativity and Invention, perhaps as a fourth wave, places the goal of invention for the better in the first place. The Maker community may be a role model in this respect, as society and companies can and will work together differently in the future.

3.3 Research Design and Units of Analysis

Overall for this thesis, the concept of case study research is followed as described by Robert Yin (Yin, 2013). Several options are available, and decisions have to be made, in general, there is a four basic types of design for case studies, made up by the dimensions of the number of cases, and if there is a single unit of analysis, called holistic, or if there are multiple units of analysis, called embedded. Especially in single case types, we would search for criteria that seek out for the critical, unusual case or cases. As these are somehow critical or distinct, there is a reason to focus on these, as to gain a particular understanding or special meaning from them. The search of critical or unusual cases is not the circumstance for this research I am seeking for the data to validate the preconceptions that came up during the literature review and I have a potentially huge community to include into the discourse about the preconceptions. So the number of embedded units of analysis is greater than one. Next, is there only one context of the Maker community? As mentioned earlier, following the work of Emma O'Sullivan (O'Sullivan, 2016), there might be not such a thing as the identifiable Maker and Maker community. Therefore, I decided to include the data gathered already in the pilot phase, to create some specific topics on context, these were (1) sustainability, (2) invention, (3) tools, (4) art and (5) organisation (see Figure 19. Advanced Embedded, Multiple-Case Design). During the timeframe of nearly three years of participating in Maker Faires and doing a research study in the field (see 3.10 Research Schedule), I was able to identify fifteen Units of Analysis (UA) belonging to nine cases which belong to the five pre-defined contexts. These cases are artwork with waste materials, the organisation of Repair Cafes, then the invention of devices for disabilities and health concepts. Next cases were the workshops to build CNC machines for woodworking, the artwork of making rings from silver coins, and the making and use of 3D-printers. The later cases were the artwork in Cosplay and the organisational frame made up by the Maker Faire and the Maker Conference, as well as the Make Magazine.

Later, but also from data of the pilot phase, I decided to add the types of onsite and offsite contribution to the Maker community and the types of

social and economic merit to this initial context, cases, Units of Analysis (UA) schema to ensure there is evidence from the fifteen Units of Analysis (UA) identified so far. The results are shown in Figure 19. Advanced Embedded, Multiple-Case Design.

Context	Sustain		Invention		Tools			Art	Organisation
Cases	**Waste- Art**	**Repair Cafe**	**Devices for Disabilities**	**Health Concept**	**CNC**	**Rings**	**3D Printing**	**Cosplay**	**Maker Conference**
Localisation and Time									
2016									
Dortmund						UA 02	UA 01		
Hannover							UA 03		
Friedrichshafen								UA 04	
Cologne	UA 07	UA 06			UA 05				
Stuttgart									
2017									
Heidelberg									UA 08
Dortmund	UA 09								
Hannover			UA 10	UA 11		UA 12		UA 13	UA 14
Sindelfingen		UA 15							

Figure 19. Advanced Embedded, Multiple-Case Design

3.4 Preconception V - The Theoretical Framework

My first ideas about the research to be conducted: The research aims to establish a conceptual framework of Stimuli of Invention (SI) based upon the contemporary research in Human Creativity and Invention. It is about the opportunities to influence creativity and to explore the presence or absence of these Stimuli of Invention (SI) amongst the community of the German Makers.

As a result of earlier activities, I was able to draw the preconception IV shown in chapter 2.5 The Preconceptions of Stimuli of Invention as Figure 15. Preconception IV - Stimuli of Invention (PSI). This figure was transferred into Figure 20. Identified Stimuli of Invention (SI, Schematic Representation) where missing interactions or stimuli are presented as dotted lines. Also, this information was equally added to the schema of Figure 21. Identified Stimuli of Invention (Table Representation), in which the row relation shows the title and kind of stimuli, the system I and the system II are the interconnected systems which could be the Domain, the Field and the Individual.

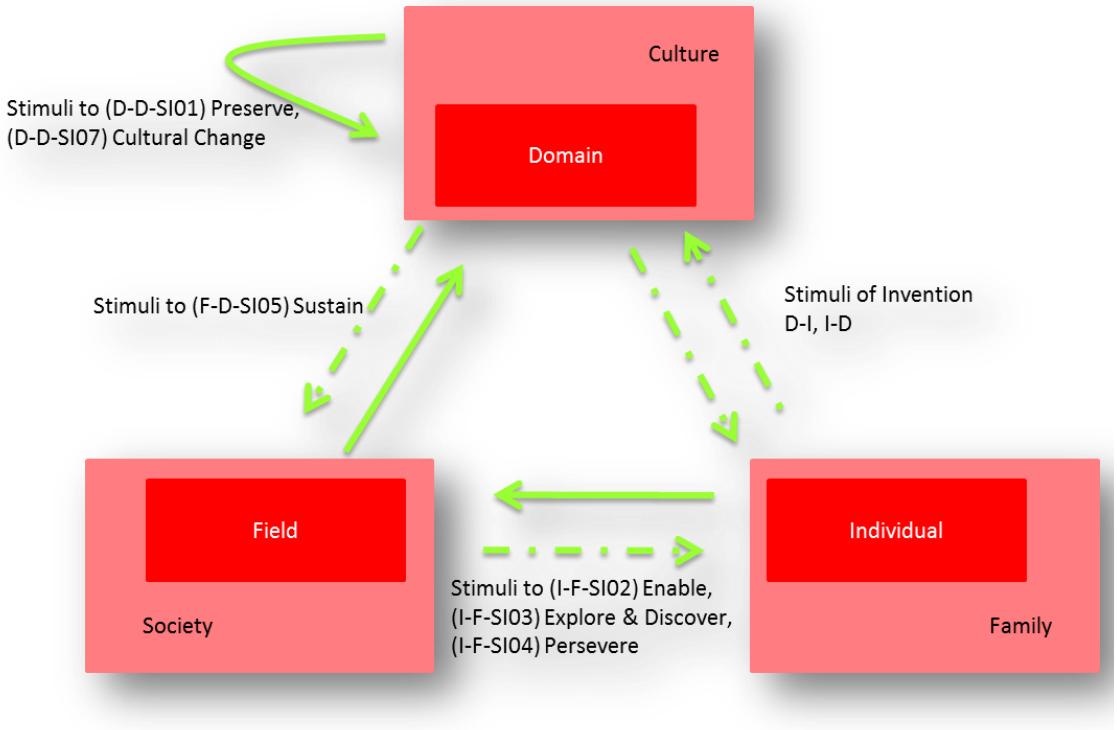


Figure 20. Identified Stimuli of Invention (SI, Schematic Representation)

	Interrelation	From System I	To System II
SI01	Stimuli to Preserve	Domain	Domain
SI02	Stimuli to Enable	Individual	Field
SI03	Stimuli to Explore & Discover	Individual	Field
SI04	Stimuli to Persevere	Individual	Field
SI05	Stimuli to Sustain	Field	Domain
SI06	Stimuli of Cultural Change	Domain	Domain

Figure 21. Identified Stimuli of Invention (Table Representation)

After I gathered this insight expressed in the identified Stimuli of Invention (preconception IV), I supplementary used the compiled codebook to analyse contemporary research data that could be found in the field of Human Creativity and Invention. The additional research data I gathered at the Innovation & Creativity Summit, a webinar arranged by Nick Skillicorn, who conducted interviews with creativity researchers about their contemporary

research topics and insights. This recent data is not available in any books or journals so far, but it was advantageous to complete my preconception about the Stimuli of Invention. The reason is that I was able to identify further stimuli that were mentioned by this creativity researchers explicitly using insight from the socio-cultural approaches, or third wave of creativity research. The interviews, my transcript and the concept coding, can be found in the appendix, chapters IX-5 Contemporary Research about Creativity and IX-6 Contemporary Research about Creativity. As most of the information given in the interviews could be coded with the existing codebook, some were not, which was hint enough to rethink the stimuli and to extend the identified stimuli.

The following four Stimuli of Invention (SI) I added to the previously identified Stimuli of Invention (SI): the Stimuli to Change the Environment, the Stimuli to Make Decisions, the Stimuli to Take Risks and the Stimuli to Tolerate. Interestingly the interviews also revealed ‘unclear’ and ‘negative’ stimuli. So it is not clear if competition helps or undermines the creativity of people and teams. Negative stimuli that were mentioned in these interviews were the redirection by bosses and when the organisational environment has no risk tolerance at all.

The Stimuli to Change Environment could be described as the habits or personal routines that should be changed over time. The network of people you work with should be changed, and you should focus on people you usually would not encounter. My interpretation would be to meet people with different behaviour and different values, as their perspective and experience may differ drastically from yourselves. The systems included in this definition of Stimuli to Change Environment are Individual to Field or Domain. However, from this interview there is another critical point, the nurture part, this could be interpreted as context and culture and the time where the individual as a child makes most of its new experiences with people and new environments. On the other hand, it is the most protected environment. My interpretation is different, and this is the reason why I didn’t try to add a different stimulus than to change the environment, first I would interpret that the time you start to change (your) environment is of importance and second

by using the Systems Model of Creativity (SMoC) I have already a focus on the individual and the family.

Concerning chapter 3.9 Ethical Consideration, I anonymized the names of the interviewed researchers to Janet and Karen.

SI07 Stimuli to Change Environment/ Additional Research Focus	
'Continuously introduce change to your routine,' TD-Janet.	'Include making an effort to meet people you normally would not encounter,' TD-Janet.
'I am going to discuss other things and talking to other people,' TD-Karen.	'It could be that creative individuals need to take walks, take their time, study new fields, and talk to people elsewhere in another culture or another business,' TD-Karen.
'People should make decisions in trying new things, being around new people, and search for other new experiences,' TD-Karen.	-
'The way someone is nurtured seems to have more than an effect on the creative potential that you have and the up using it,' TD-Karen.	'So, the nurture part which is the effort, resources, and the support, the education, the culture are all things lead into and determine the likelihood that someone invests in creativity, and that behave creatively,' TD-Karen.

Artefact 11. Transcript Details about Stimuli to Change Environment

The Stimuli to Make Decisions could be described as a stimulus that is introduced by the neuroscience and describes the vital role of the prefrontal cortex when the brain 'makes sense' of the alternatives created by the network of brain areas involved in the creation or ideation process to solve a problem. So to make decisions is not a stimulus in itself, but the skills and

techniques for problem-solving someone have onboard may influence behaviour towards a more inventive way. My interpretation is that this stimulus may also be combined with the next one if someone and also the environment is willing to take risks or not, so we may introduce a discussion about being risk-averse or risk-oriented and if the environments allow taking risks, avoiding risks or taking risks is penalised. With this broader understanding of the Stimuli to Make Decisions the systems included in this definition are not the only individual to individual but also Individual to Field and Domain.

SI08 Stimuli to Make Decisions/ Additional Research Focus	
'As insight creativity is supported by a network of distributed systems and that the prefrontal cortex is always included in judicial decision making,' TD-Karen.	'People should make decisions in trying new things, being around new people, and search for other new experiences,' TD-Karen.
'You considered alternatives those are decisions as I do not go making decisions,' TD-Karen.	Karen questioned about caffeine levels, sleep levels, 120 working hours a week, alcohol, drugs, she answered 'that these people perceive a benefit, but not an authentic benefit. It inhibits their judgement, and they are not realistically evaluating things,' TD-Karen.
Karen added that 'there are also special tactics and strategies that are useful for problem-solving; like everything from questioning your assumption, shift perspectives, and dozens of these tactics. They are trying to work backwards,' TD-Karen.	-

Artefact 12. Transcript Details about Stimuli to Make Decisions

The Stimuli to Take Risk could be described as twofold, one arranged in the beliefs of the individual and one in the environment's perspective in taking risks and its effects on the individual. In the interviews, it sounds that the effect of NON-taking-risk environments leads immediately to NON-creative behaviour. So this stimulus seems to be categorised as something DO NOT ATTEMPT to avoid risks, and there might be a degree or rank of Stimuli of Invention. As my first attempt is to develop the preconception of the Stimuli of Invention, I think it might be worth to keep these expanding thoughts for further research, but currently, I would not take these into account and see it as a constraint of my research design. The systems included in this definition of Stimuli to Take Risk are Individual to Field or Domain.

SI09 Stimuli to Take Risks/ Additional Research Focus	
'If employees do not think they can take risks. If they think they will be overlooked for bonuses and raises, or if they have been redirected by the boss; there are less likely to think divergently and to invest time in the original problem-solving,' TD-Karen.	'Risk tolerance is a very big topic in this context. In businesses in fact there almost two things to hear, firstly the recognition that is it ok to take risks, secondly tolerance for different perspectives and different work styles,' TD-Karen.

Artefact 13. Transcript Details about Stimuli to Take Risks

The Stimuli to Tolerate could be described with different dimensions in mind, as it could be interpreted in the context of risk and risk tolerance, or as in the transcript detail in a cultural context as diversity or an organisational environment as different behaviour and working habits. Therefore the systems included in this definition of Stimuli to Tolerate are Individual to Domain and Field. In my interpretation, I would add the dimension of 'to persevere' as the moment of failure tolerance; your habit how to deal with your failure, an experiment, an action or a product you tried to implement which does not what it was intended.

SI10 Stimuli to Tolerate/ Additional Research Focus	
'Tolerance is enormously important,' TD-Karen.	'Managers and Educator and even more broadly, it is about tolerance and diversity,' TD-Karen.
'Tolerance for different perspectives and different work styles,' TD-Karen.	-

Artefact 14. Transcript Details about Stimuli to Tolerate

The Stimuli of Competition could be described as twofold as well, as there is not enough evidence about how it influences creativity, it seems to block some people, and it seems to foster some others. Comparing it to the stimulus to take risks it sounds from the interview data that this stimulus should also be categorised as something DO NOT ATTEMPT to influence creativity by competition. For future research it could be reasonable to look into so-called hackathons were solutions are developed competitively, the teaming aspect stands in focus. Another source of data could come from the robot war competition were the fight not between people, but the solutions, explicitly robot designs and their mechanical robustness, take place in the arena. The systems included in this definition of Stimuli of Competition would be Field or Domain to the Individual. Interestingly the direction of the systems relation had changed from Individual-Domain (I-D) to Domain-Individual (D-I).

Stimuli of Competition/ Excluded from Research Focus	
'Some people are because of being in a competitor situation think, well I have to go in this direction, there is a set goal, I will be judged, and they are not creative at all,' TD-Karen.	'There are less likely to think divergently and to invest time in the original problem-solving,' TD-Karen.

Artefact 15. Transcript Details about Stimuli of Competition

The Stimuli of Redirection could also be described as DO NOT ATTEMPT to redirect by hierarchical structures. My interpretation would be in the context of organisational issues there is more information available what is not to do and what hinders creativity instead of supporting it. Also reading the transcript detail, it seems to be related to extrinsic motivational drivers, like bonuses and other financial benefits. As the Stimuli of Competition and the

Stimuli of Redirection need specific settings to be explored, I exclude these from the preconception that I will use for further proceeding in the Maker community. The systems included in this definition of Stimuli of Redirection would be field or Domain to the Individual. Also here, the direction of the systems relation had changed from Individual-Domain (I-D) to Domain-Individual (D-I).

Stimuli of Redirection/ Excluded from Research Focus	
Karen asked for about evaluation and judgement, she answered; 'these are known to hinder certain parts of the creative process. If employees do not think they can take risks. If they think they will be overlooked for bonuses and raises, or if they have been redirected by the boss,' TD-Karen.	-

Artefact 16. Transcript Details about Stimuli of Redirection

The preconception V now offers a systems view on the potential stimuli that eventually lead to invention. As I focus on the interrelation of systems, namely Domain, Field and Individual the further research on the existence or non-existence of these interrelations seems plausible. My next step is to use this prebuild theoretical framework to identify if there are behaviours, techniques and skills within the community of German Makers that stimulate invention (see Figure 24. The Concept Stimuli of Invention (SI) as Theoretical Framework).

As mentioned earlier in the principle of dialogical reasoning, it may happen that the research findings in the community of German Makers might not support these preconceptions. I have to accept that these preconceptions have to be modified or abandoned during the field research.

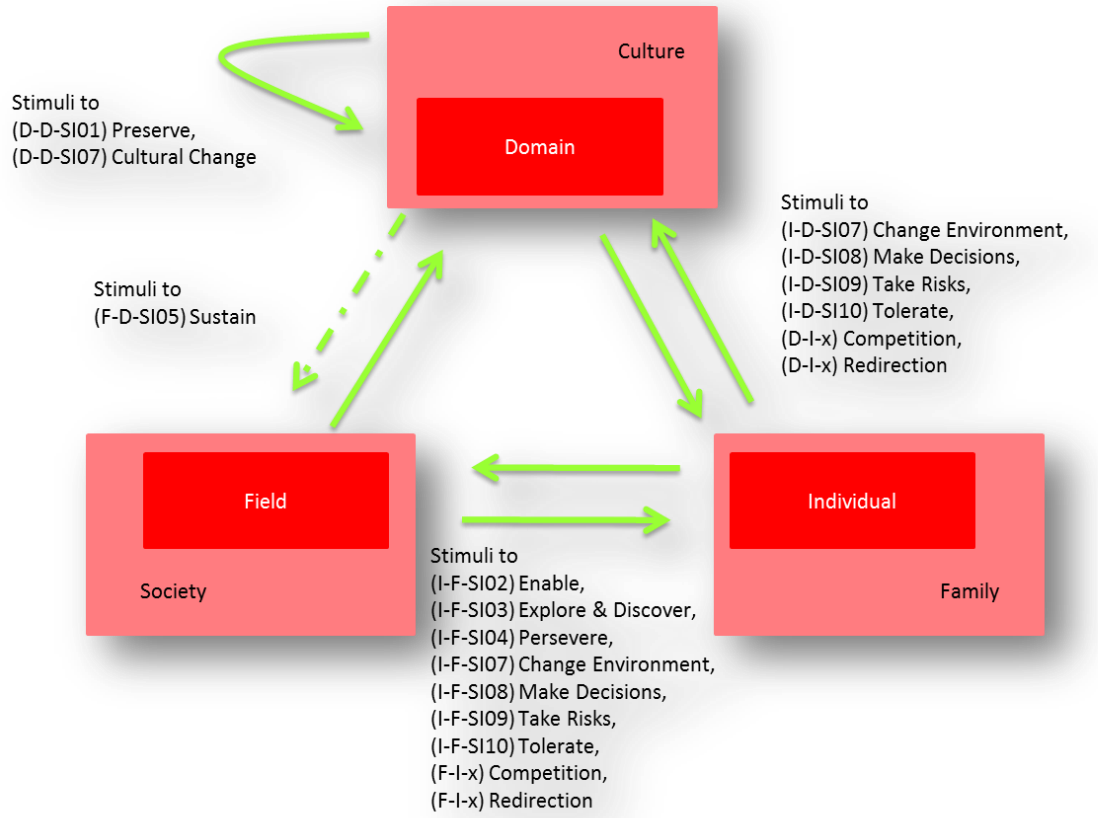


Figure 22. Preconception V - Extended Stimuli of Invention (SI-Schematic)

	Interrelation	**From System I**	**To System II**
SI01	Stimuli to Preserve	Domain	Domain
SI02	Stimuli to Enable	Individual	Field
SI03	Stimuli to Explore & Discover	Individual	Field
SI04	Stimuli to Persevere	Individual	Field
SI05	Stimuli to Sustain	Field	Domain
SI06	Stimuli of Cultural Change	Domain	Domain
SI07	Stimuli to Change Environment	Individual	Field, Domain
SI08	Stimuli to Make Decisions	Individual	Field, Domain
SI09	Stimuli to Take Risks	Individual	Field, Domain
SI10	Stimuli to Tolerate	Individual	Field, Domain
-	Stimuli of Competition	Field, Domain	Individual
-	Stimuli of Redirection	Field, Domain	Individual

Figure 23. Preconception V - Extended Stimuli of Invention (SI)

Some additional words on the systems view involved in this fifth preconception, during his study 'Creativity in Later Life', Mihaly Csikszentmihalyi generated a questionnaire with four parts to interview his participants in the study and to probe for insights from these people why they may be more creative than others or why they might be more successful on what they have achieved than others (see Appendix VIII Questionnaire for Semi-Structured Interviews). I used the questionnaire's structure for my data collection. So Mihaly's work does not only provide the structure into the three systems but also this initial questionnaire for my data collection (see chapter 3.6 Methods for Data Collection and Analysis).

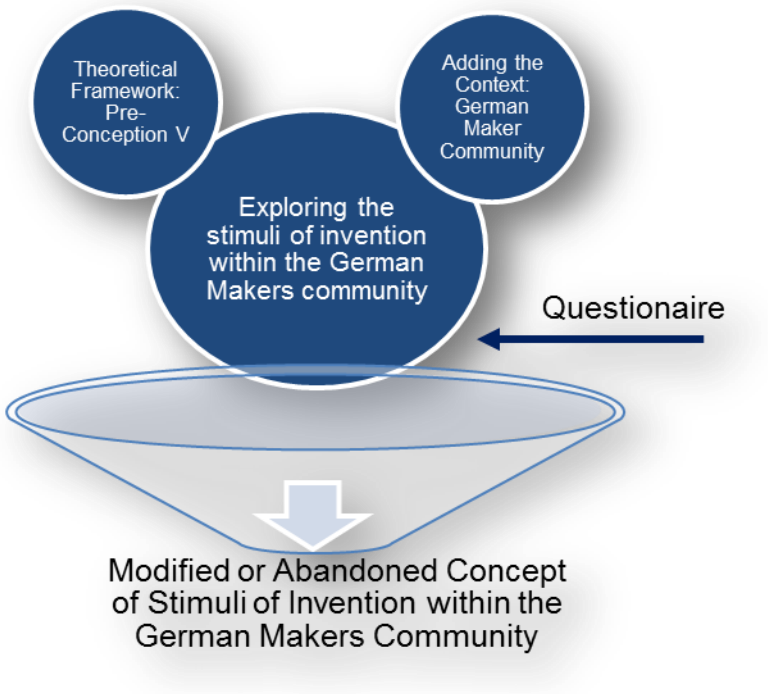


Figure 24. The Concept Stimuli of Invention (SI) as Theoretical Framework

3.5 Process of Literature Review

The methodology used for the literature review is partially oriented to the approach described by Denyer and Tranfield (Denyer & Tranfield, 2009), which consists of the stages of planning, conducting and reporting. The literature review is very costly regarding time, so the identification of research papers, the selection of qualitative studies, the process of data extraction and the monitoring of the progress are critical. Moreover, it is not a sequential process as it first seems, it is an iterative process.

For the planning of the literature review, I used keywords like innovation, creativity and organisation, which was mainly to conduct a pre-search in different databases. As a result, I used this pre-search to filter iteratively on different authors, terms; publishing dates and so on (Appendix I Literature Review Summary). The primary databases that I used for this pre-search were ABI/INFORM Global, EBSCO eBook Collection, SAGE Open and Google Scholar. As the literature developed over time, the number of keywords increased, but in combination with another, the number of relevant articles from journals and books could be reduced. In the end, about 200 articles were qualified by myself; I used the endnote functionality to set a specific number of stars to prioritise my readings and to rate the quality of the article or source. I have done the reading and annotation in the paper versions of these sources. Also, the first attempts at clustering the information were made in baskets with post-its. During the continuous reading and the clustering was also the time when the themes developed; the twelve themes presented in the literature review were the result of this data synthesis of ordering and reordering. The next step was copying the significant textual information from authors and their articles in books or journals into a document with the themes. In practice, these were two documents as I split into one more creativity, invention, innovation, and research-oriented literature sources and the second into harder facts about observations made about Makers and the Maker Movement, also from research. The first one you have found in part I, chapter 2.2 The Definitions of Invention by Research - Building Themes, and the second is used for the

evaluation of my research findings in part II, chapter 6. Evaluation of Research Findings.

As summary, the methodological and definitional issues found in the articles reviewed revealed that a lot of creativity research was based on the individual (first wave approaches of Human Creativity and Invention) and cognitive approaches (second wave of Human Creativity and Invention), getting less on the third wave of Human Creativity and Invention, socio-cultural approaches and explicitly dealing with the Systems Model of Creativity (SMoC). So I added literature explicitly from Mihaly Csikszentmihalyi and additional information I got from the Innovation & Creativity Summit, a webinar arranged by Nick Skillicorn, conducting interviews with creativity researchers about their contemporary research topics and insights to support the third wave of Human Creativity and Invention. Another methodological and definitional issue I found from the literature review was that most of the research literature about Makers is founded on quantitative studies. Only a few very recent authors, to name Silvia Lindtner, Assistant Professor at the University of Michigan in the School of Information, US, and Anne Bergner, Professor at University Coburg, Germany, used multi-sited ethnographic research (qualitative studies) to research within the Maker community.

3.6 Methods for Data Collection and Analysis

In 2015 the data collection process of primary data started with the first day-visit to a Maker Faire. The research design presented in the RD1 document (research degree) followed this prior work in using an early Case Study design (Silverman, 2015). During the research process, these prior work results were used to detail the semi-structured questionnaire for the case study and to structure and identify potential Units of Analysis (UA). During the interviews or merely first talks with German Makers at the Maker Faires, I came aware that about fifteen to twenty minutes the Makers were concentrated in answering my questions than they were more interested in getting information about my ongoing projects and my experience. The questionnaire from Mihaly Csikszentmihalyi was designed to be conducted in approximately two hours. Participants were contacted in advance, for the

interviews appointments were scheduled, video and audio settings were arranged for recordings and later analysis. My interviews were ad-hoc, in some cases, I already knew the Makers from prior visits of Maker Faires at different locations or the previous year. In the beginning, I used a voice recorder, but the interviewees were irritated even if I explained my research objectives and intention, there were even more irritated when I used the prepared paper about my overt research and the included signature page. I also tried to contact them with an email after we have met on the Maker Faires (Appendix VII Contact Letter for Initial Contact), all these activities had relatively weak success. So I changed my data collection strategy to first talking about my projects and my experiences and then shifting the interview to one or more parts of the semi-structured questionnaire, not using it physically and not by its pre-order in the specific part. Therefore I got into a more fluent interview and more detailed insights from the Makers about themselves and the Maker community. For recording reasons I used small cardboards during and after the interviews to scribble sentences, notes, remarks and reminders. That also led to situations where the Makers punctuated their answers as very important to note. The data collection process became more flexible, and I got insights about the focus of Makers on career and their life priorities, their relationships, mostly their working habits and also their reflection about attentional structures and dynamics. This all, together with additional photos, created my fieldnotes and transcript details for further analysis. The Figure 26. Detailed View of Units of Analysis shows not as a planning script but as the documentation of the data that is used - on my decision - for further analysis and the findings in part II in this thesis. The numbering schema was tidied up for this documentation.

In addition to the cases described here, a significant number of supplementary information was collected and evaluated. These included, on the one hand, further talks with makers at the Maker Faires and Makerspaces in southern and northern Germany, as well as Repair Cafes in North Rhine-Westphalia, Germany and Cheltenham, UK. At the first Maker Conference in Heidelberg, in 2017, I also had the opportunity to interview the founder of the American Maker movement personally. At the first and second

Maker Conferences in 2017 and 2018, there were also further discussions with makers who had successfully launched products in their campaigns on platforms like Kickstarter. The Maker Conference also made it possible to talk to Makerspace owners and their concepts for the creation and management of Makerspaces, including the owner of what is supposed to be Germany's largest in square footage Makerspace at the Technical University of Munich in cooperation with a German premium car manufacturer also located in Munich. The visits to the Maker Faires and the Repair Cafes were also recorded photographically and in field notes (see attachment). Besides the visits of the Maker Faires, I was also a member of the staff for the organisation of the Maker Faires in Hannover. For supplementary data gathered in fieldnotes, see Appendix III Extract of Images in Fieldnotes.

Date	Event (Location)
03 Oct 2015	Maker Faire (Berlin, Germany)
12 Mar 2016	Maker Faire (Dortmund, Germany)
27 May 2016	Maker Faire (Hannover, Germany)
26 Jun 2016	Maker Faire (Friedrichshafen, Germany)
05 Nov 2016	Maker Faire (Cologne, Germany)
20 Nov 2016	Maker Faire (Stuttgart, Germany)
16 Feb 2017	1st German Maker Conference 2017 (Heidelberg, Germany)
23 Mar 2017	9. Heilbronner Startup Meetup: Crowdfunding (Heilbronn, Germany)
25 Mar 2017	Maker Faire (Dortmund, Germany)
11 Jun 2017	Science Festival - Makershack (Cheltenham, UK)
15 Jul 2017	Cheltenham Hackspace (Cheltenham, UK)
25 Aug 2017	Maker Faire (Hannover, Germany), supporting the Maker Faire organisation as a Maker Faire crew member (look behind the scenes)
26 Aug 2017	Maker Faire (Hannover, Germany), supporting the Maker Faire organisation as a Maker Faire crew member (look behind the scenes)
26 Aug 2017	Maker Faire (Hannover, Germany)
11 Nov 2017	Mini Maker Faire (Sindelfingen, Germany)

Figure 25. Chronological View on Data Collection

The following figure gives an overview of the number of Units of Analysis (UA) their clustering in cases, the activity of the Unit of Analysis (UA) at the Maker Faire. The next row shows the data gathered in conjunction with the questionnaire parts from A to D, part A: focus on career and life priorities, part B: relationships, part C: working habits and insights and part D: attentional structures and dynamics. Also, the approximate interview time is documented, but to recognise there was a significant difference in interview time during the Maker Conference and during supporting the Maker Faire crew during the 3-days Hannover Maker Faire.

Unit of Analysis	Case	Activities	Interview Part A	B	C	D	Approx. Duration [Minutes]	Location
UA01	3D Printing	Making of Minecraft Creeper	X	X	X		30	Dortmund
UA02	Rings	Making of Ring			X		20	Dortmund
UA03	3D Printing	Talk about building an own 3D-printer	X		X		10	Hannover
UA04	Cosplay	Talk about cosplay costumes			X		10	Friedrichshafen
UA05	CNC	Talk about workshops for building CNC machines	X		X	X	20	Cologne
UA06	Repair Café	Experience			X	X	10	Cologne
UA07	Waste-Art	Know-How to build book art			X		10	Cologne
UA08	Maker Conference	Talk with Initiator of Making, Keynote	X	X	X	X	30+1d	Heidelberg
UA09	Waste Art	Working Habit/ Techniques	X		X		20	Dortmund
UA10	Devices for Disabilities	Life Story about	X	X	X	X	60	Hannover

		helping a disabled friend						
UA11	Health Concept	1st Info, Participating in Workshop	X	X	X	X	60+1d	Hannover, Stuttgart
UA12	Rings	Talk to participants			X		10	Hannover
UA13	Cosplay	Life Story	X	X		X	30	Hannover
UA14	Maker Conference	Crew support, Film Making, Interviews	X	X	X	X	Three days	Hannover
UA15	Repair Cafe	Talk	X	X			20	Sindelfingen

Figure 26. Detailed View of Units of Analysis (UA)

The approaches to data analysis follow the cycle approach for coding (Saldaña, 2015). The methods employed frequently are concept coding for the first cycle and pattern coding for the second cycle. The concept coding assigns macro levels of meaning to data and is appropriate for studies focused on theory and theory development and to more abstract or generalizable context (Saldaña, 2015). Subsequently, the evolving concepts mapped to the systems and relationships provided by the preconception and the Systems Model of Creativity (SMoC). Alternatively, some evolving categories may contradict with the Systems Model of Creativity (SMoC) which opens up the discussion of rival theories (D. Cropley & Cropley, 2012; Kaufman, 2015). As a support tool, NVivo was used to transcribe, to codify, to extract concepts, and to support further conceptual analysis, like the code mapping and landscaping functionality (see VI-2 Word Cloud on Raw Concept Codes using Nvivo Tool).

The preconception as mentioned earlier is driven by the Systems Model of Creativity (SMoC) that consists of three subsystems Domain, Field, and

Individual. In closer detail, there are concepts like institutions, universities, and schools that constitute the Domain and the causal relationship of transmission of ‘old’ information from one to the next generation of individuals. The field conceptualises by concepts like mentoring, sponsoring, inclusion or very specific as for its gatekeeper function in the selection process for a new variation. For the Individual, the perspective is defined by the focus on innovation, invention and creativity issues.

The method of concept coding defines the concept as a short phrase or word. A concept suggests an idea rather than an object or observable behaviour. It is distinct between a conceptual attribution described by a noun; the conceptual process described with the gerunds (‘-ing’ words), and concept phrases that consist of both (see appendix VI-3 Clustering of Concept Codes). Concept coding works best when the codes become prompts or triggers for critical thought and writing (Saldaña, 2015, p. 119). The second cycle of the concept codes was assembled or clustered to determine their pattern codes. A pattern code description for their intended content for further coding is documented in the Codebook. The pattern codes were simplified for further and more comfortable use with a schema of three general groups: Society (SOx), Family (FAx), and Culture (CUx). The similarity but not the equality of the Systems Model of Creativity (SMoC) is intended: Field <-> Society, Domain <-> Culture, Individual <-> Culture. The complete codebook is in appendix VI-4 Pattern Codes and Content Description.

Examples of the further use of the pattern code are in the Appendix IX Transcripts.

3.7 Quality of Research Design

The quality of the research design reflects the methods used to ensure that the conclusions made can be followed by others. Therefore a clear picture of the research process is essential. Also noteworthy is that social and political interactions continuously shape our beliefs, consents, trust, and attention; this is addressed to me as a researcher and to you as the reader. We, you as reader and me as a researcher, are similarly part of a broader sociohistorical process. You, as my intended audience, should perceive how the current situation under investigation emerged. A shared meaning gets quality. For this shared meaning and common understanding, it is essential to place the subject matter in a social, intellectual and historical context; the understanding of conflicts related to power, economics, and values completes the picture.

The quality of the research design also keeps in mind the social and historical background of the researcher, the importance of being able to distinguish between true prejudices, by which to understand, from the false ones by which to misunderstand. In practice, several revisions of preconceptions are confronted with the accessible, conventional empirical and observational records, and maybe conflicting interpretations with participants in the field. So definitely it is a constraint for me not to conduct research in other countries than Germany. Therefore I had to find another way to involve the ‘other’ social context and to start questioning my assumptions and getting conscious about my emotional and intellectual reactions influenced by my experiences and observations.

The quality of the research design also depends on how differentiated the field study details as they were experienced and collected are carefully related to any abstraction or generalisation. The preconceptions made should be used as the sensitising device, and the necessary starting point for understanding to view the world in a certain way and these preconceptions should be evaluated within the selected context.

In general, the quality of this research design is led by the use of the seven principles described in chapter 3.2 Hermeneutic Circle . The linkage between

research results and these principles are referred in Figure 16. Determination of the Principles of Interpretive Field Research. Specifically, the quality of this research is ensured by the introduction of the content in chapter 6. Evaluation of Research Findings; reflecting about additional research that was conducted about Makers in other places and applying the principle of multiple interpretations and the principle of suspicion.

Finally, the quality of research is depended on constraints and limitations given by circumstances; circumstances as already described depended on the researcher's role, the subject of research and the socio-historical context. Other restrictions can be financial or time resources, some of which can be budgeted and scheduled, others are influenced by unplanned events and unpredictable consumption. Therefore, it must be taken into account at an early stage in research design that a contingency is planned for the known constraints and the unforeseen circumstances if possible.

3.8 Researcher's Role

Traditionally my background and the experiential knowledge I bring to this research could be seen as bias and should be eliminated from the research design. In opposition to this traditional view, I would cite C. Wright Mills and Joseph Maxwell about the benefits that could be used if the researcher becomes the instrument of the research. Separating my research from other aspects of my life cuts me off from a significant source of insight, hypothesis and validity checks (Maxwell, 2012). As I stated earlier the immersion with the Maker community is key of this research design, it is objective is to get a greater understanding of the meaning of habits, techniques that are used by Maker to collaborate, and share their knowledge and skills. Also, to understand the values and believes that foster the motivation of Maker to be part and to contribute to this community. The author Peter Reason used the term critical subjectivity to refer to the quality of awareness in which we do not suppress our primary experience (Reason & Bradbury, 2000). In general, I would argue that the seven principles for interpretive field research described earlier help to create that critical subjectivity. Moreover, also, specifically to mention the principle of interaction between the researchers and the subjects; the critical reflection on how the research materials were

socially constructed (Klein & Myers, 1999). To allow the reader an insight and to increase my self-consciousness about my own identity and experience in this research I introduced the following significant episodes of this research of my life from childhood to profession.

Episodes of my Life - From Childhood to Professional

I still remember my father travelling a lot bringing new things with him from production sites all over Europe. I remember blocks built from a metal plate, plastic housing and a magnet inside. They were similar to Lego building blocks in size and colouring, but they stuck together by the magnetic force of the magnet inside the block. What I figured out later in my life about the Lego block was, in the beginning, it was only to staple and did not stick together. So these magnetic ones might be the invention amongst Lego, but Lego gets a more straightforward solution. However, everyone played with tolerances of parts knows how severe this sticking of Lego blocks is, and my father always told that Lego had the best and most expensive plastic moulding tools to make this happen.

Wrapping this up, inventions might be interesting, might solve a problem, but there might be other solutions that make the economic race.

During my childhood, there was always space for doing experiments. Once I burned my desk with magnesia, I got from school, as the fire was attractive all the time. There was always a drawer where we had things from machines and workshops. It was always filled with exciting somethings my father brought from his work and travelling. There were electromagnetic relays and other mostly electromechanical components in these times. There was also a broken pocket calculator I remember. Alternatively, better - was broken-down after I figured out what was inside. Moreover, inside these were the first microchips, cryptic names like ALU were printed on this tiny black bricks, ALU meant arithmetic logic unit and this was it. I figured out the electric lines going from the keypad to the printed circuit board. Back then printed circuit boards (PCBs) were only one layer, and you literally could see the flow of electrics as well as sometimes you could smell it depending on my experiments. When I got more advanced, I also soldered these things.

There has to be enough time for anyone doing experiments! Moreover, to fail sometimes without recourse!

Then computers came into place. A friend of mine whose father worked in the finance sector were in a situation where they got an Apple II computer in their household. So in our time after school, we spend time with this new little thing learning about VisiCalc, playing Frogger, tested what was possible with that thing at the command line level. Then one Christmas I also got a VC20 computer by myself, the Commodore C64 computer was more famous but more expensive to afford. Maybe my parents suspected that I would not only do this programming stuff but disassemble it. They mentioned they were worried about that most pupils were playing computer games with their Commodore C64. Moreover, this was right there were multiple games for the Commodore C64 and in my feeling not even one for VC20 computer. However, I started programming what was not there for the VC20 computer till then. From today's perspective and further insight, it was this earlier evolved homebrew computers from the Spectrum ZX80, the Schneider computers, and so on, I was playing with. Then the generation of Atari ST260 computers stepped in using already the Motorola 68000 central processing unit and had enough power for a graphical user interface (GUI). Memory was expensive, so I soldered the second memory bank by myself onto the first one, and it worked. I travelled from our hometown Meinerzhagen to Düsseldorf as a large German city to buy the first dual-side floppy disk drive for my Atari. Not to forget other parts that you needed to tune the electronics to be capable of working with this new floppy disk drive. These computers were never perfect; to keep up with the development, you had to be creative about any trouble if it might be hardware or software issues.

Computers at school. Yes, great! We got them. Six or eight M20 Olivetti machines already called personal computers, locked in a particular room within the school. I think our secondary school came into this unusual situation for schools these days because a teacher studied at the former Society of mathematics and data processing (Gesellschaft fuer Mathematik und Datenverarbeitung, GMD) nearby Bonn which is today the Fraunhofer

Institute Centre Schloss Birlinghoven and one of the largest research centres for informatics and applied mathematics in Germany. Moreover, yes, he also was fascinated by these machines. It took some time, but then I got the responsibility for this room and got my key. I must have been fifteen years old. With others, like Lucian and Oliver, I spend much time there but never felt this way. As the documentation of the operating system was quite good me, and Lucian stepped into this black rabbit hole of computer technical insights. I took me quite a while until I had uncovered the algorithms responsible for encrypting passwords in the system. Key was the random generator, and as it was programmed, it was deterministic in its way. It was never published, but since then I was invited to conferences of the GMD every year. My computer grade was fifteen points (A-level) and never questioned.
You know this feeling when you are doing more excellent than your tutors and mentors? - Today I know it is part of the game of being a tutor and mentor, fostering the growth of mindsets instead of fixing ones.

I studied computer science. Yes, I did. However, reflecting on this today what comes to my mind is that it had been more the practical projects that have driven me. As I was studying, I was financed by BOSCH as a large company, and there were many opportunities given to take part in several business projects dealing with computer science. So as a student I participated in the ramp-up of the first production lines for antilock brake systems (ABS). The primary purpose was to develop the software for a computer system that was able to cover all the data in real-time. By law, there was the need to document every single produced unit if it was within its accepted limits. The research and advanced engineering department covered this project for industrial data processing where two years later in 1994 I started my career at BOSCH. We did software development with a software system based on the Manufacturing Message Specification (MMS). It was a development of what is used today and supported by the OPC Foundation and its standards. Moreover, what is an essential part of the enabling ideas of Industry 4.0 for the future? However, we are talking about the early nineties within the corporate research of a large company.

The wicked problems are known and often driven by practice. However, it takes time to grow, has to be fostered and then maybe blossom into new markets. It is a question of care!

During my professional life, I invented several things. Today I would call these inventions, but within the working, it was as finding solutions to problems that could be solved by using digital technology. As there were many but I only put one into a patent as my department leader, and the head of research encouraged me to do this. It was also the first time of creating fancy incubators, so I wrote a business case as well. It was stopped after the pitch. Other companies stepped into the same idea, made business decisions, bought CAD companies they needed for it, made failures maybe lost some money but in the end, they succeeded with a product in a growing market of Industry 4.0. The simulation of production lines and detailed machine processes is no longer a myth. I still remember my early debates to call it a digital special-purpose machine (DSM) instead of a virtual one. We now live in the digital age, not the virtual one. Sometimes I still think it was my fault that the business case that I had written was not convincing enough or me as a leader. However, it guided me to get deeper into studying economics.

Following on my professional life, I moved to a department for organizational development, mostly to initiate organizational change for the domain of software development within the software for electronic control units (ECU) or embedded systems as we would call them today. I became a certified Lead Assessor and had done a high number of assessments worldwide always focusing on process improvement issues, managerial, technological, behavioural ones. It was a structured approach so that I could get into these world of policies, planned processes, efforts, responsibilities and authorities, training of skills, control of this all at independent levels like management and quality assurance. I do not want to be too picky about these words as they describe the traditional approaches of a mechanistic organization.

This personal background has driven my first ideas about the thesis and potential aims and objectives. At the beginning of the literature review (see

chapter 2. The Literature Review) I described the three early threads I followed; (i) process management and process improvement in research and development (R&D) organisations, (ii) the history, present and potential future of the Digital Age and (iii) the three waves of Human Creativity and Invention, but I had to realise on this DBA journey that the jump was too far for the thesis. For the sake of curiosity I learned a lot about research in these three streams that I followed during the literature review, but for writing a thesis, I had to focus myself, to recognise and to outline limitations to succeed in the end.

3.9 Ethical Consideration

For me, it was important to place high regard to ethical considerations throughout the entire research process. The ethical guideline provided by the University of Gloucestershire (UoG, 2008), Research Ethics: A Handbook of Principles and Procedures, was followed through the whole process. Following the ethical guideline includes providing all participants with information about the project, their voluntary participation, and ethical treatment. As the participants are not linked to me as a researcher or personally, there is no formal power relationship between the research participants and me. Neither the less there are general ethical issues to be considered during research (Saunders et al., 2007) like privacy, the voluntary nature, and the right to withdraw, to get consent, the confidentiality of data, anonymity, reactions of participants to the way data are collected including stress, discomfort, my behaviour and objectivity as researcher. This ensures overt observation and also reveals my identity as a researcher to the community of the Maker community and allows me to be overt in my research as recommended by the research ethics of the University of Gloucestershire (UoG, 2008).

For the interviews, the persons were randomly contacted during the fairs. As I got into talk with the potential interviewees, I informed them about the purpose of my study. General permission was asked to visit hackspaces or labs by providing written information (email) about the research background and scope in advance. The interviewees had the right to refuse and withdraw at any time without giving any reasons. Sometimes I was accompanied by

my children, my father or other supporters (Maker Faire crew, namely Laura, Nicole and Fatima), who assisted in organizational matters (e.g., video recording, or setting the initial topics) during the interview. In the beginning, I asked for permission to tape-record the narrative; later I made notes because the interviewees were more open in their answers. The interviews I transcribed verbatim and anonymously annotated with observational notes using mainly NVivo as supporting tool. The data was stored on my personal computer, which is password protected and only accessible to me, the author. The procedures of data handling and storage could be described as I stored the raw data gathered from the interviews and observations in the safe of my office and a protected area of my laptop, including the additional photos and video clips. The real notes (memo cards) made during the interviews and the observations, the information about the observation tasks, and also reflective notes made after the observations consisted only of anonymous data using the Unit of Analysis (UA) numbering schema. All the transcripts were categorised but anonymised. Consequently, the data analysis procedure consisted of categorised but anonymised data. All data is used only for this research and will be treated as confidential and anonymous, and destroyed after completion of the thesis.

3.10 Research Schedule

The first research schedule was made during the preparation of the research degree one (RD1). As most project plans and attached schedules, not everything will work as planned, and not all will happen as scheduled. As part of a risk strategy, some risks could be tracked and moderated to a certain degree. Plan B scenarios also helped in researching to fulfil the objectives. Next is not to be too afraid of re-planning, in my case this happened during the beginning when I started to introduce myself into the design thinking approach (before RD1), and the feedback was that this is leaving the research field already and become operative as the deployment through the Design Management Institute already started. This continuous re-planning could also be part of our understanding of the principle of dialogical reasoning with its cycles of revision as a dynamic and iterative process. Something that is impossible to take into account is that my

supervisor, my mental pillar and the supporter of my open-minded research passed away. This precarious situation was unforeseen, emotionally hard to handle and the effect on any planning is not predictable. In the following figure, I only present the 'tidied up' version of the schedule to support the formation of the thesis.

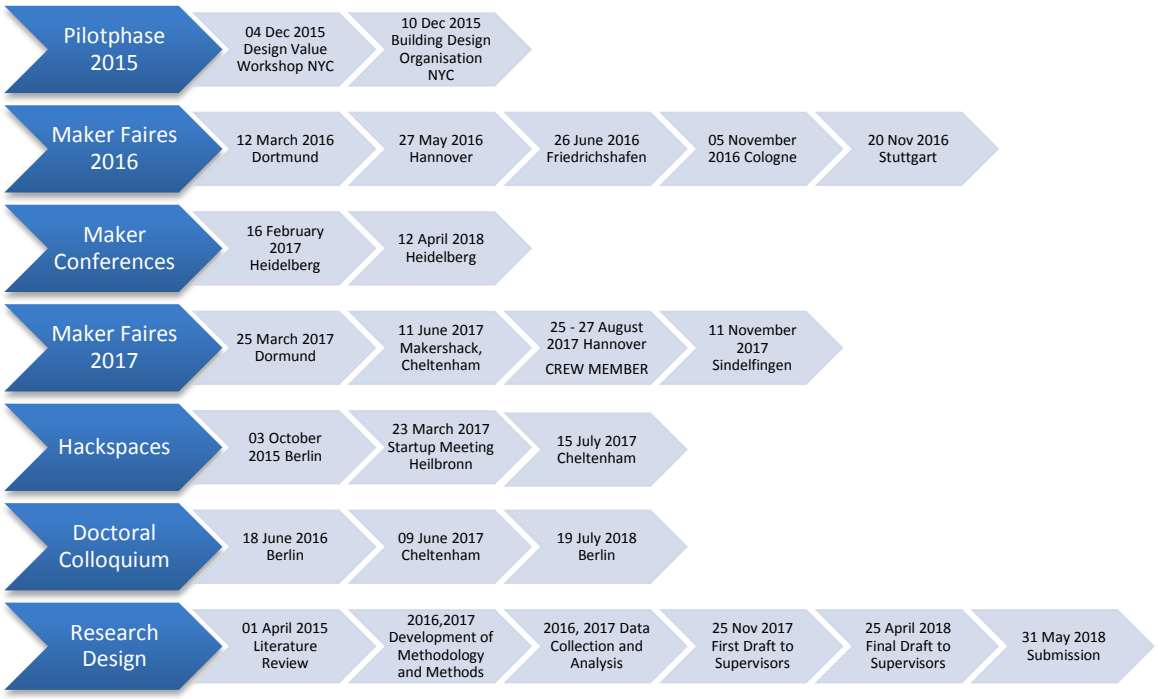


Figure 27. Research Schedule (Schematic Representation)

Looking Back, Looking Ahead from Part I

To summarise Literature Review and Research Design from your readers perspective, you should be informed about the themes I derived mainly from the research literature about potential definitions, meanings, and understandings of the invention and their context. Also, setting the scene from a historical definition and context to see the dynamics over time in the relationship with economics, psychology and sociology; and the latent dissimilarity in the understanding to the contemporary more common used notion of innovation. This understanding of the invention is then used to state the preconception of this thesis about the possibilities to influence Individuals, Field and Domain to facilitate or prevent invention. Six of these potential Stimuli of Invention (SI) were identified during the pilot, attached to the three systems derived from the Systems Model of Creativity (SMoC), and then modelled into a four-part questionnaire mainly derived from earlier research done by Mihaly Csikszentmihalyi with Nobel Laureates. This semi-structured questionnaire was then used as part of an advanced embedded, multiple-case design containing 15 Units of Analysis (UA), participants of my research, clustered into cases of 3D Printing, Rings, Cosplay, CNC, Repair Café, Waste-Art, Maker Conference, Devices for Disabilities, Health Concept. The data was then gathered nearly three years at several Maker Faires on and off the stage, the first maker conference in Germany, different hack- and makerspaces, and repair cafes all located in different parts of Germany.

Looking ahead from Part I, the research design, it is essential to recognise the seven principles I used to plan, to conduct and to ensure the quality of the research and its findings. These principles become most relevant in Part II for the evaluation of research findings.

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PART II - Data Collection and Analysis, Research Findings and the Evaluation of Research Findings

4. Data Collection and Data Contextualisation

4.1 Data Collection

This data chapter introduces in detail the fifteen Units of Analysis (UA) and additionally contextualising information about these units. The data of the Units of Analysis (UA) were collected from different individuals participating or organising Maker Faires and Maker Conferences in different areas of Germany.

The order of the following chapters is by contexts which are (i) Sustain, (ii) Invention, (iii) Tools, (iv) Art, and (v) Organisation. The order of the data of the Units of Analysis (UA) is by cluster or case, and not by time, location, age, kind of contribution or interview parts answered.

The synonyms and names are independently selected by me and are not known by the participants, nor any other person knows the relationship between participant and synonym. Therefore the data is anonymised for participants' themselves and any outstanding parties. However, the synonyms helped me to sort the data during the research period, and as mentioned earlier the Unit of Analysis (UA) numbering schema was introduced lately.

The transcript details are only an excerpt of notes taken during the interviews; additional supplementary notes can be found in the Appendix sections. These transcript details are mainly selected by the existence or non-existence of a relationship to the pattern codes documented and described in the codebook (see Appendix VI-4 Pattern Codes and Content Description). Also, a potential relationship with any themes developed in the literature review has led to the selection.

The understanding of the notion 'conclusion' here in this context should be like a short descriptive reflection on the Unit of Analysis (UA) into the direction of the different Stimuli of Invention (SI) that are listed in the preconception V. The next column 'Stimuli of Invention (SI)' itself uses an abbreviated notion of the stimuli description from Figure 23. Preconception V - Extended Stimuli of Invention, the reading is as follow, the dedicated

system I, involved systems II and the numbering of the relation (e.g. I-F-SI04 read as from system Individual to system Field with the stimuli 04 which is the Stimuli to Persevere). '(!)' as a notion is used if the relation, especially the involved or the order from the connected systems from the preconception V does not sound fit to the recent understanding of the case. If possible, another arrangement of the dedicated systems is expressed after the '//'. Of course, these are hints to changes of thinking that should be recognised in the data discussion, further preconceptions and the findings.

The column 'themes from literature review' shows potential links to the themes developed in the literature review, the character ('A' – 'J') shows the theme connected. If a bracket is used, then it seems a weak link to the theme as described in the sources which may give hints to probable distinctions to contemporary research.

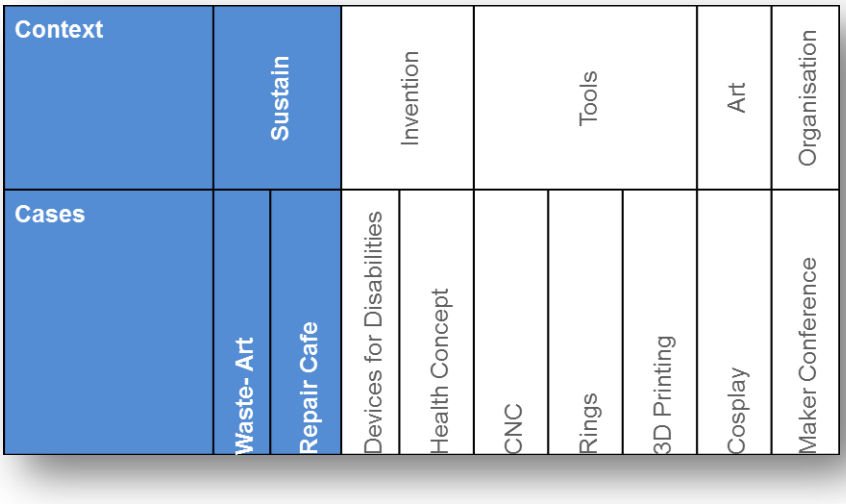


Figure 28. Overview - Context Sustain

Context Sustain - Cases Waste Art

Waste Art could be found at several Maker Faires. The characteristics may vary as one example the artist himself producing artwork from needless materials or as another example the artist develops an art performance inviting others to build their artwork with the provided 'waste' materials. This kind of art performance is also observable in other than the sustain context

using other ‘valuable’ materials, exemplarily old silver coins for making of rings or multi-coloured paper and cardboard for paperwork.

Artefact 17. Exemplification of Waste Art

The significance of Book Art is that something for someone needless the book will be recreated as an art object that leads to an ambiguity value, and if the folding technique is used the book is still intact for its original feature of reading a fascinating story.

Unit of Analysis	UA07	**Location**	Cologne
Case	Waste-Art	**Interview Parts**	C
Gender	Female	**Age (approx.)**	45
Activities	Know-How to build book art	**Synonym**	Artist, Jenny
Description	Jenny described how to build book arts. She started about four years ago after she saw it for the first time in the UK. Jenny buys her material/ books at different stores, the internet and flea markets or friend donate them. In the beginning, it was not essential for her to choose the title of the books or the stories, now she is sometime inspired by the title or if she already knows the content. Many friends ask for making individual books with names to give it as a personal present. There are different techniques for cutting or folding the pages; effort is about 6 to 8 hours depending on the		

	technique and the preparation that has to be made in advance. Jenny describes the preparation as the creative and intuitive part, the cutting or folding is to persevere, sometimes to stop and restart again. Failure is possible but a question of concentration and the difficulty of the silhouette to create. Yes, in the beginning, she failed more often. Jenny came here to Cologne because she is living close to the library and as this is the library it interrelates to her hobby, both are about books. Jenny makes but asked if she is a Maker, she negated. Jenny has fun to talk with the people here at the fair and get new ideas. Yes, she also visited other fairs; here are the people much younger and very interested.
Onsite Contribution	Presentation of Art, results of the 'making', giving insight to people
Offsite Contribution	-
Transcript Details	'This is book fold. You could do nearly every silhouette. In the beginning, there are templates available,' TD07. 'Some only fold and some cut. Folding is more original but also more effort,' TD07. 'You need only an old book to start,' TD07. 'There are charts available with all the measures. Alternatively, black and white prints as a template to use,' TD07. 'It is not difficult, but folding 400 to 800 pages takes your time. However, you could stop and take it with you,' TD07. 'It is a little like knitting,' TD07.
Conclusion	Jenny does book art for her amusement; it is a hobby for spending time. There is no financial interest

	noticeable. She likes to present her work and get recognition for this work.
Stimuli of Invention (SI)	I-F-SI04, D-D-SI01, I-F-SI03, I-F-SI07
Themes from Literature Review	(J),(K)

Artefact 18. Unit of Analysis (UA07) - Artist

In the original Waste-Art, the intention is the value of the material, to prolong the lifetime of the use of the material, even if the original feature is destroyed. Exemplarily is making waist belts from punctured bicycle tires; even if the tires have lost their original functionality to hold the air pressure, they are still strong enough to be used as a belt. So the value is in the material, and also to the changing usefulness/ features.

Unit of Analysis	UA09	**Location**	Dortmund
Case	Waste-Art	**Interview Parts**	AC
Gender	Male	**Age (approx.)**	25
Activities	Working Habit/ Techniques	**Synonym**	Bohemian, Karl
Description	Karl is a student (mechanical engineering), very relaxed and making artwork from old bicycle tyres, floppy disks, crown caps, broken leather belts, shoelaces. He also brought his material which was already washed and well sorted. Karl mentioned that he is inspired by the material, describing his idea for the floppy disk as a storage media and now it is the cover of a diary. Sometimes he tries to interrelate the material or the old function with the new thing made of waste. For him it is new material, not waste, Karl cleans it and sorts it. Friends bring it to him; he never buys material. Tools like the hot-melt glue and grippers are essential. Karl mentions that it is a hobby, but Karl also mentioned that it has a financial part in		

	his living with this activity.
Onsite Contribution	Presentation of work, making things during this time and discuss the technique with interested people coming by. Sells things, everything has a price tag.
Offsite Contribution	Studio with a small shop to sell his work/ art.
Transcript Details	'First I wash the pieces in the washing machine,' TD09. 'People bring me stuff, like these old bicycle tubes. I make waist belts of it,' TD09. 'I do not need many tools, sometimes only a glue pistol. Sometimes a drill, some wire and a gripper, often superglue,' TD09. 'I play with the material. Test some things, show others, speak with others,' TD09. 'I have my studio,' TD09. 'It is still more hobby,' TD09.
Conclusion	Karl is passionate in making things, he loves the material/ matter, creating something new with material that is broken in the intended use, and earning some money seems more to maintain his tools and some additional materials like glue.
Stimuli of Invention (SI)	F-D-SI05, D-D-SI06(!!)// I-F-D-SI06, I-F-SI03, D-D-SI01
Themes from Literature Review	A, B, (K)

Artefact 19. Unit of Analysis (UA09) – Bohemian

Context Sustain – Cases Repair Café

The focus of repair cafes is to repair things that are out of order, and the owner wants to know if it is possible to repair it instead of instantly throwing it away. Therefore the owner cares for the good for several reasons, the long sentimental relationship like the 30 year old radio clock waking someone up since years in the morning, the financial reasons as the potential cost for the

replacement, or the care for the environment in saying it may only be a small part to be replaced and to make it work for another ten years. As the individuals running the repair café, mostly once a month, as a community service, there is no financial risk for the owner of the good if it gets wracked or it is figured out that a spare part is costly or is maybe not available anymore, especially for old tape recorders. The repair cafes are often supported by giving meeting places from Christian and Catholic churches or municipal facilities. Tools and spare parts are often donated by the individuals running the repair café or could be bought by the donations given by the visitors which are often independent of a successful repair.

Some not so obvious point to visit the repair cafes is the social aspect as a communication platform for older adults within the community, from my observations all visited repair cafes offer some coffee, cake or snacks at reasonable low prices, especially if compared to a street café.

Today the local repair cafes are supported to get acknowledged more broadly to the public by the website repaircafe.org and a standard logo design coordinated and located in Amsterdam.

Artefact 20. Exemplification of Repair Café

The relation between Maker Faires and repair cafes seems on the one hand in their technical background, the curiosity to gain know-how about the functionality of products in the first place; a black and white hacking ethos.

On the other hand, there are social or socio-cultural aspects in both, as helping others and offering support by their skill and experience, on what they 'do good'. At first glance, it seems that repair cafes present at Maker Faires to show up in public and maybe to get a reputation for their work. However, after several observations I made, the principal point seems the interest in the broad and divergent skill sets presented at Maker Faire that are needed to repair old and especially new things today. It is to have personal interrelations and networks that could be contacted if a particular skill is needed, the use of the internet for getting the vast information for fixing things or buying replacements is very welcomed but somehow dull for these people. Moreover, also it may be the knowledge of someone that is proven by his experience if he is part of a community or society/ field. These people are open, but very critical until skills had been proven.

Unit of Analysis	UA06	**Location**	Cologne
Case	Repair Café	**Interview Parts**	CD
Gender	Male	**Age (approx.)**	65
Activities	Experience	**Synonym**	Senior, George
Description	George describes the services of the repair café and a little the frustration of things that could not be repaired because of their design. He also argued that there are favourite designs like the Senseo coffee machine where all the capacitors break because they used the cheapest one available and also that the housing is design to throw it away because there is no opportunity to open it without breaking it. George retired two years ago and is now regularly participating in the repair café activities. He likes to help people and is interested in what is coming next. George is also very proud in telling young people where they should look at when buying new things, as an example I would pick the story of a mother and son with a scooter made of plastics which was not fixable. My observation was that he mostly spoke to the young		

	boy to address the issues of using screws instead of latches, the availability of replacement parts, and so on. The mother was impressed about how thoughtful her son took the information. In the interview, George also reflected about the characteristics of people helping in the repair café, like the age structure, the participation of women, the participation of younger people, the role of social work, the support given by the city in offering community facilities. He especially figured out the community role of the repair café in talking and helping each other, also in small little things like the repair of trousers. About the skills needed George told about his former job as a mechanical engineer and about the tools and websites he is using in getting additional information needed to fix more complicated things like smartphones.
Onsite Contribution	Presentation of Service
Offsite Contribution	Community service, once a month
Transcript Details	‘We like to share, that there are products that could be repaired and such designs that could not be repaired,’ TD06. ‘Sometimes only one part fails, often capacitors, a part worth 1 EURO,’ TD06. ‘Once a month. People know that date, and they are prepared. For us, it is always new,’ TD06. ‘Now we also work on textiles. Here she made up my trousers again,’ TD06. ‘All people, young and old come. Here is a boy with a scooter, plastic is broken so we cannot fix it. However, there are others we could fix,’ TD06.

	‘I worked in a company,’ TD06. ‘I am retired,’ TD06. ‘I have the tools I bring with me, but now we have a coffee machine,’ TD06. ‘We use community facilities,’ TD06. ‘We look at the internet for help, but mostly it is our experience. When someone comes with an old record player nearly always the rubber rings are dissolved,’ TD06. ‘Often capacitors. Things after nearly two years of use,’ TD06. ‘The group we come together. It is a sit-in, sometimes there is a lot to do, sometimes not. Then we talk,’ TD06. ‘Only a few young people are joining us. However, some,’ TD06. ‘Smartphones are complex. We change screens,’ TD06.
Conclusion	George likes to help and to share his knowledge and experience with others, especially the young generation. George hopes that he provides insight into the society that somehow the throwaway society will change its behaviour and economic goals will be not only the increase in revenue. Technology, in general, is not dangerous; as he adores the benefits of medicine, but there have to be additional thoughts about its convenience, efficacy and potential destruction.
Stimuli of Invention (SI)	D-D-SI06, F-D-SI05
Themes from Literature Review	K, A

Artefact 21. Unit of Analysis (UA06) – Senior Citizen

In the beginning, the next Unit of Analysis (UA) was very irritating as it would not fit into the repair café case and certainly not in the context of sustainability. However, the interview takes place with these formal

characteristics and seems like the black swan. The observations become vital if they are seen in the contemporary situation of the German car industry and the German employees that feel they are entirely accused of this incorrect behaviour of the industry. Sindelfingen as a city is intensely linked to the German car industry because of development and manufacturing facilities of one of the large car manufacturers internationally.

Unit of Analysis	UA15	**Location**	Sindelfingen
Case	Repair Café	**Interview Parts**	AB
Gender	Male	**Age (approx.)**	50
Activities	Talk Clock	**Synonym**	Do-Gooder, Dean
Description	Dean is very extroverted and tries to address people very directly at the mini maker fair; only a few makers are there (about 7-10), mostly it is a presentation of the school facilities where the fair is located. Dean shows different examples of design that could not be repaired because of their design. Other examples are to show mechanistic approaches of precision engineering like old clocks. Dean points out that the importance of repair cafes is to communicate the importance to buy products that are environmentally friendly if people come with a product that could not be repaired it is already too late to intervene. However, Dean expressed his hope of setting the mindset for the next products these people will buy. Dean also told that the repair café is entirely new in this city and they still look for more volunteers in participation. Dean is still working for a car manufacturer in this area, but he seems to be annoyed about public discussions about air pollution caused by cars. Moreover, also, the public criticism that people who are working for them do not care for the environment. Dean is working in car design.		

Onsite Contribution	Presentation of Service
Offsite Contribution	Community service, once a month
Transcript Details	'We come together once a month,' TD15. 'It is to show people how some things work,' TD15. 'It is not only to repair. It is to talk about things that could be repaired,' TD15. 'Maybe next time they buy something different because it could be repaired,' TD15. 'We always look for volunteers,' TD15. 'The sustainability of products is important,' TD15.
Conclusion	Dean is not a Maker; he is an alike salesman. He points out the technical achievements made in history, and he is annoyed at the accusations made against car manufacturers.
Stimuli of Invention (SI)	I-F-SI07, D-D-SI06(!!)/ I-F-D-SI06, F-D-SI05, D-D-SI01(!!)// I-F-D- SI01
Themes from Literature Review	K, A

Artefact 22. Unit of Analysis (UA15) – Do-Gooder

In summary, sustainability can be summed up as follows: the motivations are different; one is to give things a new function or a new sense of meaning. Secondly, it is a matter of preserving things in their function and increasing their life-span through some minor and simple repairs. In general, there is a kind of criticism of our throwaway society. Moreover, the knowledge that today's products are designed with a built-in expiration date, to design for obsolescence, makes it even worst in the perspective of these people.

Context Invention – Cases Health Concepts and Devices

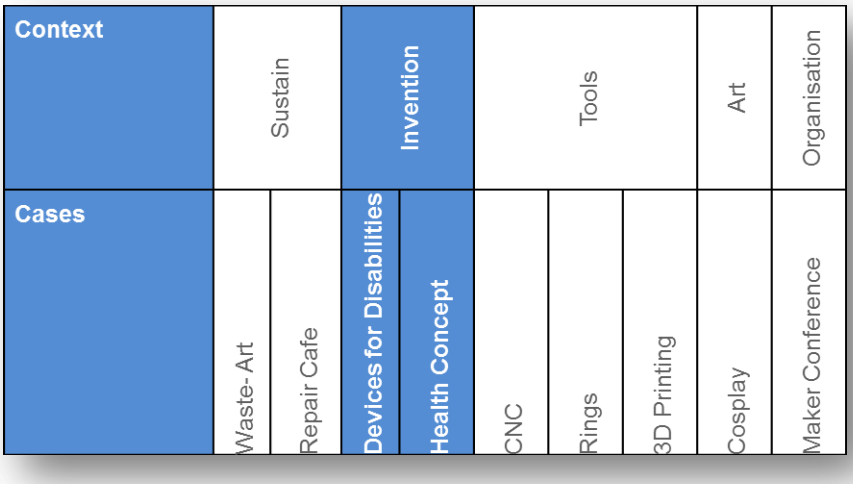
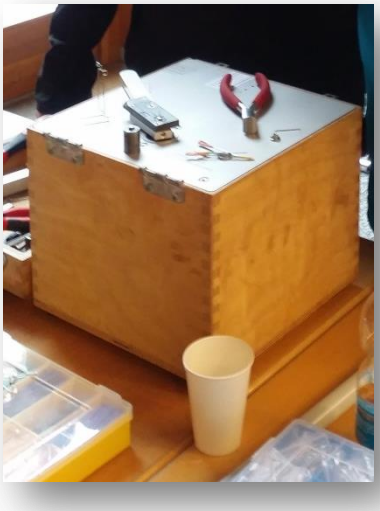


Figure 29. Overview - Context Invention

In the literature several cases of health concept and devices for disabled persons developed in the Maker Movement are described, here are two of few Units of Analysis (UA) that I identified at German Maker Faires and the Maker Conference. In general, this might be caused by the law-like regulations in the field of medicine, for being specialist, for treatments, for pharmaceutical devices and so on. The cost of development is high due to development time, trial and test phases, approval by the federal ministry, and other unforeseen risks. On the opposite, the markets may be small to the number of addressed individuals or the efforts to customise the product for the patient may be relatively high. Because of these reasons most of the inventions and innovations in the medical field are protected by patents and products are sold at high prices. In Germany, it is to be mentioned that we also have the demographic change, but the primary health care is still excellent, especially if compared to other Western Nations. Under this circumstance, the two Units of Analysis (UA) are few but not ordinary.



Artefact 23. Exemplification of Health Concept and Devices

Unit of Analysis	UA11	**Location**	Hannover, Stuttgart
Case	Health Concept	**Interview Parts**	ABCD
Gender	Male	**Age (approx.)**	35
Activities	1st Info, Participating in Workshop	**Synonym**	Vision, Chris and Hans
Description	Chris has a leading position within this project, he organised seminars, the interviews with a potential volunteer in this project and was also supporting in the developmental regions. The project acts internationally, but currently, the health concept focuses on regions in South Africa and India. Chris is not the initiator of the project but very enthusiastic about the success story and the beneficial outcomes in the regions. In a nutshell, this project brings skills and simplified tools to fabricate and maintain spectacles into developmental regions. The vision is		

	that they could build spectacles lower one Dollar which is the case, but there are other costs like travel, visa, transport of material that are funded by donations. Chris told me that the goal is to sell the spectacle for an equal of three-day loans and that he was surprised that there was no word in the African language so far. Chris also mentions they need a lawyer and financial experts as volunteers because in the developmental countries also governments and other care organisations try to regulate the access for political and financial reasons. During this one day workshop, we build spectacles on our own with the support of people that will advise people in the developmental regions later. Hans is well experienced and was multiple times in South Africa, Malawi and Burkina Faso, he was optician some years ago, sold his two stores and started to support this project. It figures out that also others are opticians and are very skilled, not only to make and customise the spectacles but also to distinguish between ametropia and eye diseases. The health concept objective is to aid the approximately 150 million people with ametropia with simple resources and the access to spectacles; as seeing is an essential source for gathering knowledge during childhood and assuring an income during a lifetime. Chris told me that it is since this year (2017) that they started actively informing the public about their project, and they were amazed how many people were impressed about the project but never heard of it. This was the same response I got from the participants at Hannover two month earlier. Same for me. Impressing also the professionalism they conduct this one-day workshops with project information, structured

	assessment interviews, building your own one Dollar spectacle, free lunch and beverages. Later on, Chris gave me the annual report containing strategic and financial information about the project to review. This project has a turnover of 2.7 Million Euro and revenue of 680.000 Euro.
Onsite Contribution	Presentation of materials and tools to make spectacles, Advertising for Donations
Offsite Contribution	Heath Concept for Developmental Countries, One Day Workshops
Transcript Details	‘Simple resources, large effects,’ TD11. ‘150 million people are ametropic. It would take 500 years with the current number of opticians,’ TD11. ‘Idea is the primary health care. To see again. The ability to learn and work. To get the ability,’ TD11. ‘I am a precision engineer. I work on the bending machine,’ TD11. ‘I am an optician. Last year I sold my two shops,’ TD11. ‘In Africans is no word for spectacles/ glasses,’ TD11. ‘It creates workplaces and income for 25 people. As they have learned to make glasses from the beginning, they maintain the glasses as well,’ TD11. ‘Martin got the Empowering People Award from the Siemens Foundation in 2013,’ TD11. ‘We look for volunteers, that after a while support our projects offsite,’ TD11. ‘We look for different skills, also clerks, and finance people. It is like social business, social entrepreneurship; we are doing,’ TD11. ‘We conduct interviews with all participants of the workshops,’ TD11. ‘This summer we did marketing for the first time. There

	was a one-page article in the newspaper about us,' TD11. 'People are amazed, but they recognised our project for the first time,' TD11.
Conclusion	Quite impressive under the aspect of passionate people in the interim phase retiring, second perseverate needed to scale from an initial idea upon a healthcare organisation of this size.
Stimuli of Invention (SI)	I-F-SI03, I-F-SI02, I-F-SI09, I-F-SI08, I-F-D-SI06(!), I-F-SI04
Themes from Literature Review	H, F, B

Artefact 24. Unit of Analysis (UA11) – Vision

Unit of Analysis	UA10	**Location**	Hannover
Case	Devices for Disabilities	**Interview Parts**	ABCD
Gender	Male	**Age (approx.)**	40
Activities	Life Story about helping a disabled friend	**Synonym**	Hero, Dan and Bob
Description	Dan has built a scooter for his friend Bob that had been fallen from a gantry six years ago with complicated ruptures in his backbone and the lower extremities. After several surgeries, Dan recognised the agony of his friend and how little the time of the physiotherapy support was compared to the whole day and week. Bob spent most of the time at home in his wheelchair. Dan got this idea of the scooter which has impressive features. First someone could drive onto with the complete wheelchair, second, it has an		

	additional lifter mechanism that you could stand, hanging in a unique belt, reducing the weight at hips, knee and feet. With this belt, you could also walk when supported by the scooter and if you get tired you just sit in the belt and drive. Dan also has a patent for the scooter he showed me with some proud. Then he told me the story that he already visited some companies in the medicinal branch to show them his health and care device. They all refused with the argument that too many of the products they already sell would come obsolete. Dan told me shaking his head that the unique belt for Bob was a donation of one of these companies, worth 2000 EURO.
Onsite Contribution	Presenting of Scooter, Test drives for children and others
Offsite Contribution	Presenting of Scooter in hospital, nursing and healthcare facilities
Transcript Details	'I have built this scooter for my friend after he has fallen from a gantry,' TD10. 'I have a patent for this, see,' TD10. 'I have spoken to a manufacturer of medical devices. They said my invention would substitute too much of their products at once. So they are not interested,' TD10. 'One company donated this belt for my friend. It costs 2000 EURO. This belt!' TD10. 'Look here at the wheels. I could switch them that the scooter gets into the bus. However, for higher speed, it is better if they are outside,' TD10. 'This mechanism took me a while. Now it is easy; it works to relieve and control the pressure to his legs,' TD10. 'It gave me new vitality,' TD10.

Conclusion	Unwanted enemy. However, Dan is proud that Bob enjoys his life again, only by starting to electro-weld some tubes.
Stimuli of Invention (SI)	I-F-SI04, I-F-SI02, I-F-SI08, I-F-SI09, I-F-SI03
Themes from Literature Review	F

Artefact 25. Unit of Analysis (UA10) – Hero

In summary, this cases could also be called health, but I have chosen to call it an invention because it is the source of fantastic product ideas, prototypes or early products. It should be stressed, of course, that demographic change in all nations has led to a continuous increase in the need for medical care. For this reason, health is also a high-growth market for companies. Engaging, in this case, is that the described instances primarily follow the concept "help" rather than the concept "heal". The first case shows the accelerated deployment of assistive devices, here "glasses". He thus directly supports people in their everyday life to be able to see again. Indirectly, it opens up the market for traditional glasses manufacturers or could make them obsolete. The second case shows how the medical industry defends its products and does not include enemy products in its product range. These two units of the analysis show the distinct in the objectives and plans behind the ‘concept to help people’. These concepts may be based on low resources with a substantial effect, using voluntary services and donation, targeting the audience which lies in the developmental regions. Alternatively, if the help relies on a friendship relationship, with a high personal effort, mainly own resources and the will to improve the quality of life of one beloved person. Neither the less, in both cases the improvement in the quality of life is the objective. – Invent for the better!

Context Tools – Case CNC Machines

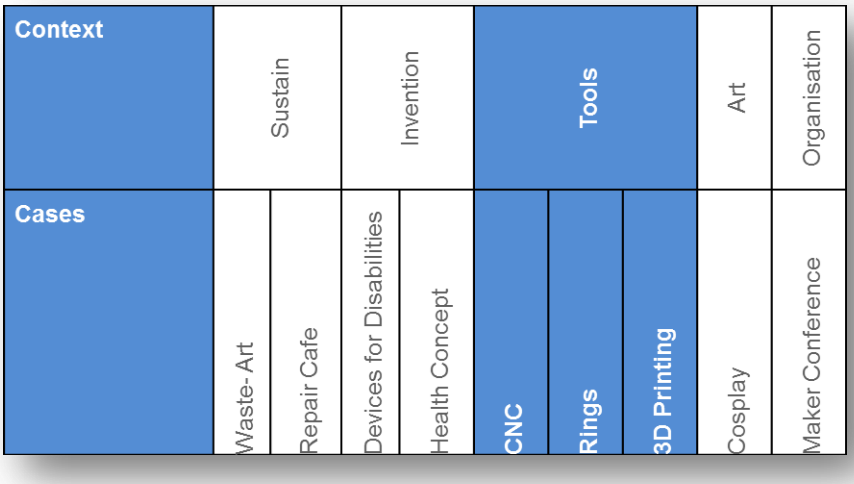
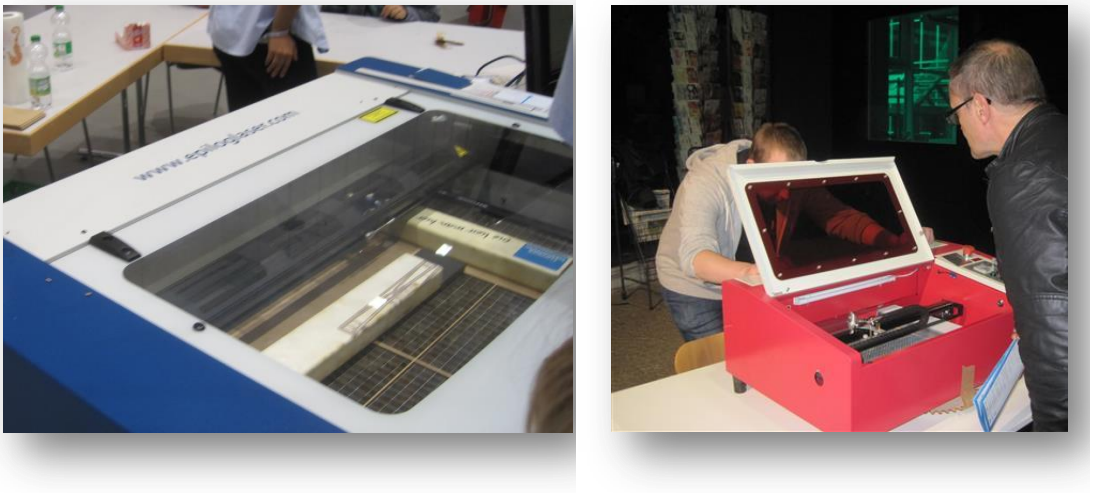


Figure 30. Overview - Context Tools

As we have seen a lot of the products made in the Maker community are based on craft work, so the tools are simple and could customarily found in DIY markets or even in markets for household appliances. The typical form of workshops to gain the needed skill level are welding or soldering courses, apart from other courses like paper cutting and folding, sawing woodworks, calligraphy, sewing or knitting. Materials are collected from different sources, mainly for low prices or donation. However, in the context of tools, the Makers build their machines using skillsets based on mechanical and electrical engineering, software development and potentially product design. These computerised numeric control (CNC) machines typically are based on the movement in X-Y-Z dimensions plus a specific tool header which could be fitted with a laser for laser cutting, a milling cutter for milling machines or an extruder and hot end for the popular 3D-printers. Newer projects combine knowledge from a different area like the sophisticated sinter material 3D-printers with laser exposure or the pick and place units for printed circuit board (PCB) assembly. These machines are built from scratch in certain limits or from pre-configured construction sets. As one typical example of the information and level of documentation given, the Rep-Rap 3D-printer design (http://reprap.org/wiki/About) is mentioned. In this context also the idea of a self-replicating machine seems essential or the even more liberal notion of

the democratisation of machines and tools. The Rep-Rap 3D-printer was developed under an open source license (the GNU General Public License) which is very common, but as a negative example, MakerBot could be named which first developed under open source and then closed its sources for new features like double extruders for multicolour prints. MakerBot, a company, founded and led by Chris Anderson, was the first one that commercialised the making of 3D-printers others followed but there are still many lower-priced construction kits available (see Appendix III Extract of Images in Fieldnotes, artefacts #0060, #0114). As today 3D-printers are sold under the label commodity product, there are still skills needed from mechanical and electrical engineering, software development.



Artefact 26. Exemplification of CNC Machines

The Artefact 22 shows an ‘in development’ project for a PCB assembly, pick and place the unit, on the left. Moreover, on the right an improved laser cutter design for cutting and engraving of paper, wood and plastic parts. Especially the wood parts are often used for the housing of other machine designs which is a familiar pattern of how the machines look.

Unit of Analysis	UA05	**Location**	Cologne
Case	CNC	**Interview Parts**	ACD
Gender	Female	**Age (approx.)**	38
Activities	Talk about workshops for building CNC machines	**Synonym**	Man of Merit, Clara
Description	Clara had built a unique CNC machine design for wood milling. The speciality is that the size is large enough to mill parts for making guitars. Usually, these milling machines allow parts of a size of forty to forty centimetre, Clara's design allow more than a meter on the plot and about 40 centimetres in high. Clara does not build these machines for herself anymore, but she organises workshops with people interested in building this machine and then later use it for their purpose. It has to be recognised that this machine is made mostly of wooden parts but of cause additional skills are needed to choose the right steppers and electronics (CNC) for the control. Clara is connected to the hackspace since years and also very involved in the community; I also met her at the Maker Faire at Dortmund. Clara is writing articles for journals, and as the community knows her well, she was already interviewed for several DIY books.		
Onsite Contribution	Presenting a smaller version of her CNC milling machine. Promoting her workshops.		
Offsite Contribution	Executing workshops four to five times a year with up to 10 people per workshop, the outcome of three to five large CNC milling machines.		
Transcript Details	'This is only a small CNC I bring to the fairs. Normally I do workshops for larger CNC machines. This large that people can build bodies for their guitars,' TD05.		

	‘I make four to five workshops a year with up to 10 participants. I support in doing this; the participants bring their materials, it is their project,’ TD05. ‘It is my skill to share with them,’ TD05. ‘Currently, I am participating in a book [Die Welt reparieren/ Repair the world – Open source and DIY as post-capitalistic practice],’ TD05. ‘The workshop is 360 EURO, and the material depends, about 600 EURO it starts,’ TD05. ‘I started at a hackspace. I wrote an article for ct’hacks. People are building this CNC machine on their own now,’ TD05.
Conclusion	Clara started as a hobbyist and is now a passionate professional; she also earns additional money from the workshops and books to support her life.
Stimuli of Invention (SI)	I-F-SI03, I-F-SI02, I-F-SI07
Themes from Literature Review	A, B

Artefact 27. Unit of Analysis (UA05) – Man of Merit

Context Tools – Case Rings

Ring making is an old art and craftsmanship. There are several techniques used over time like to cast in bronze or forging. As there are examples of moulding in the Maker community, especially for making a part for Cosplay costumes and weapons or parts for robots known mainly from the Star Wars series, I have chosen ring making where forging or hammering is used. It is less dangerous even if hazardous liquids like hydrochloric acid are used in the process, and the ring had to be heated up and cooled down several times using a gas burner and ice spray. Neither the less, under the skilled support of a professional craftsman also children can make their ring.

Artefact 28. Exemplification of Making Rings

Unit of Analysis	UA02	**Location**	Dortmund
Case	Rings	**Interview Parts**	C
Gender	Male	**Age (approx.)**	45
Activities	Making of Ring	**Synonym**	Keymaker, John
Description	John is from the Netherlands, and he is travelling with his wife to several markets and offering workshops to people making their ring. John has an art studio and is also selling old jewellery. John likes the atmosphere at the Maker Faire here in Dortmund. John is here for the second time. For ring making the number of tools seems very limited but the tools are specific, and the skill set in making rings from an old silver coin is tricky. The fascinating feature of this ring is that the letters from the outside of the coin remain on the outside of the ring. It takes about twenty to thirty minutes to produce one ring, and he only took one person at a time, but all other interested people could look at the ring making process.		

	John likes to show and to transfer his skills in ring making. John told me, that it is important to him to transfer a tradition of craftsmanship and how people value the rings they made by themselves.
Onsite Contribution	Presentation and Workshop
Offsite Contribution	Workshops, Studio for Sale of Jewellery
Transcript Details	'I gathered coins than I started in making rings out of these. It is not that easy to find silver coins, but if you know where to search for, it is ok,' TD02. 'I like to work with others. However, everyone has the piece he is working on. I help, I show, and if a special skill is needed, I do. See here this drilling in the coin is the difficult part,' TD02. 'It is not for earning money. The 20 EURO is more or less the material and some money for tools. I like to share the craftsmanship with next generations,' TD02. 'Normally we are at medieval festivals, but Dortmund was close to home. Moreover, it is nice here, the working atmosphere. The blast furnace. Alternatively, that guy on his high-wheel bike!' TD02.
Conclusion	John values craftsmanship and likes to preserve craftsmanship.
Stimuli of Invention (SI)	I-F-SI04, I-F-SI05, I-F-SI02, I-F-SI07
Themes from Literature Review	D, B

Artefact 29. Unit of Analysis (UA02) – Keymaker

As from this Unit of Analysis (UA), it became clear that skill and the product stay in focus and the transfer of knowledge or perseverance is essential. In Hannover, I made an observation that seemed quite like the opposite as the material flow and the hammering seems to be in focus.

Unit of Analysis	UA12	**Location**	Hannover
Case	Rings	**Interview Parts**	C
Gender	Female	**Age (approx.)**	55
Activities	Talk to participants	**Synonym**	Old Lady, Lisa
Description	Lisa is a hobbyist in making rings. Under a tree, Lisa sits together with three other ladies on wooden logs, and three ambos on another log in the middle and hammering rings. Lisa works for hours on one ring, forging it, getting it broader, and thinner, larger and smaller, a continuous flow of the form. Lisa's focus is the material flow, not the outcome; she tells that she likes to sit outside under a shady tree and enjoys the sound of hammering and the silence if she and the others stop for a while.		
Onsite Contribution	Presentation		
Offsite Contribution	-		
Transcript Details	'I like to work outside. Here under the trees,' TD12. 'After a while, you get used to,' TD12. 'I like to see something from my work. Made by my hands and easy tools,' TD12.		
Conclusion	For Lisa making rings is a ruminant relaxation.		
Stimuli of Invention (SI)	I-F-SI07		
Themes from Literature Review	-		

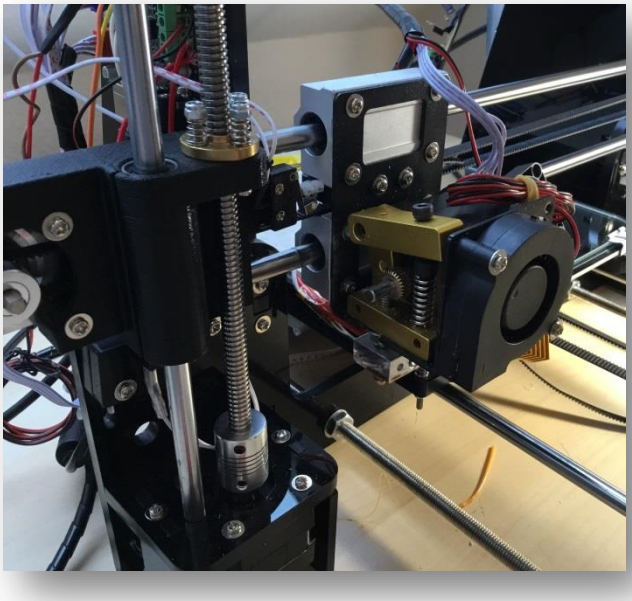
Artefact 30. Unit of Analysis (UA12) – Old Lady

This Unit of Analysis (UA) may show how difficult the demarcation of Makers is, so Lisa would not call herself a Maker but that she and her friends were sitting there, hammering and showing this as their hobby is impressive. It shows the sort of entrance barrier to the Maker community if there is one.

Context Tools – Case 3D printing

In the context of tools and the Maker community, it may be a flaw if information about 3D-printers is missing. Nowadays 3D-printers may be the most commercialised product that was initially developed in the Maker community. Additive manufacturing was not an invention as the technology was known and available to manufacture already. The cost was high and printed parts were limited in number and by high prices. In professional approaches, 3D-printer use tungsten powder sintered by laser light to create highly reliable and lightweight products like gearboxes for Formel one race cars, alternatively parts for the aerospace industry. So the initial idea for the 3D-printer had to be watched under the notion of democratisation of machines and tools again. The electronic hardware used is simple as these are stepper motors for the movement from the old matrix and inkjet printers, an Arduino/AT Mega microcontroller with additional motor drivers for the higher current, and the extruder with the hot end which is mainly another stepper motor, a heating element and a temperature sensor. In the beginning, the idea was that the printers could replicate themselves, the RepRap idea was born where someone builds a printer initially and then prints the parts for another printer. Also, parts in the construction sets available today contain some of these original parts. Compared to today most of the discussion is no longer about the 3D-printer it is the flexibility of what you could make with it. The website like www.thingiverse.com show a broad variety of things that could be printed, not to mention that Thingiverse is interconnected with MakerBot, but there are other platforms available to get the same broad spectrum of ideas and geometry files to print. If someone is interested in designing own geometries most often 3D computer-aided design (CAD) software is needed, like Autodesk’s Fusion 360 or others. In most cases, the use of this professional CAD software packages is licensed but for free to students and teachers. Many people learn the features of this CAD software packages autodidactic by using available online help and tutorials on YouTube, or blogs. Not everyone is interested in all aspects of 3D printing therefore commercial services developed over the last years that are announced and sometimes also provided at Maker Faires. These services include the printing but also the design of new products

(prototyping) or the reconstruction of spare parts. As the printing process is still very time consuming the available lot sizes for parts is often very limited.



Artefact 31. Exemplification of 3D Printing

This Unit of Analysis (UA) is such a service that is provided by two students. They are involved in the development and building of 3D-printer about six years now. The second Unit of Analysis (UA) shows someone that still builds one of these RepRap 3D-printers from scratch.

Unit of Analysis	UA01	**Location**	Dortmund
Case	3D Printing	**Interview Parts**	ABC
Gender	Male	**Age (approx.)**	28
Activities	Making of Minecraft Creeper	**Synonym**	Rocker, Ben and Steve
Description	Two engineering students at University at Dortmund, Ben running the 3D printing service, extrovert, Steve more technical oriented, introvert. The two already participated in the Dortmund Maker Faire the year before. Steve is open to inventions and spending money on Kickstarter projects. He makes decisive		

	feedback about Kickstarter but has no own projects until now. Ben and Steve are waiting for input from others, interest how children use a new 3D pen. Ben shows some economic interest in providing the service but for Steve is more like a hobby. Ad-hoc Ben build a creeper for Linus, my son.
Onsite Contribution	Running 3D-printer (original MakerBot), a banner with an offsite contribution in 3D printing parts/ marketing, expert talk, new Kickstarter product for children to test (3D pen), help others with printing parts immediately (sustain, repair)
Offsite Contribution	3D print service
Transcript Details	‘We are the second time here at Dortmund; my friend is the driving force. He is responsible for the technique of the printers. He also bought these 3D pens from a Kickstarter to test them together with others at the table,’ TD01. ‘If we could make a creeper? First, we have to look for the stl. File, then it is not a problem. About 15 minutes,’ TD01. ‘My friend is extremely important to me because he tries the new things,’ TD01. ‘We are students. Mechanical Engineering,’ TD01. ‘Look here. How the kids work with these 3D pens, nobody told them, he or she just start making,’ TD01. ‘That is a tower,’ TD01. ‘That is a face,’ TD01. ‘People are asking, what or if we could do something with these printers. Like this men asked for a broken part of his Märklin railway,’ TD01. ‘Here is a creeper!’ TD01.

Conclusion	Playful entrepreneurs that see the benefits of 3D-printers. The business model seems developing as the scope of application of 3D-printers gets clearer.
Stimuli of Invention (SI)	I-F-SI02, I-F-SI03
Themes from Literature Review	C, D

Artefact 32. Unit of Analysis (UA01) – Rocker

Unit of Analysis	UA03	**Location**	Hannover
Case	3D Printing	**Interview Parts**	AC
Gender	Male	**Age (approx.)**	25
Activities	Talk about building an own 3D-printer	**Synonym**	Christian
Description	Christian is a member in the hackspace since one year and is the first time at the Hannover Maker Faire; he is proud about his 3D-printer and telling about the development and the mistakes on its way. His background is engineering, needed help in the software and electronic stuff from others in the hackspace; others are open and friendly		
Onsite Contribution	Presenting his self-build 3D-printer (RepRap model), presenting the hackspace/ club		
Offsite Contribution	Participation in hackspace, help in building 3D-printers/ expertise		
Transcript Details	'Yes. You are printing all the parts by yourself. Moreover, some metal sticks from the Baumarkt. Moreover, the Arduino with the controllers and the motors,' TD03. 'We have our makerspace. We are about eight people, the same as here on the fair,' TD03.		

	‘I am here for the first time,’ TD03. ‘I got help from the others to build this 3D-printer, a rep rap design,’ TD03. ‘Next, I build a larger one. However, this was a start,’ TD03. ‘I always tinkered. I am an engineer,’ TD03.
Conclusion	Christian tells the typical ‘how to become a Maker’-story. The sharing of knowledge and the collaboration and support by a hackspace/ fablab environment.
Stimuli of Invention (SI)	I-F-SI03, I-F-SI02, I-F-SI09
Themes from Literature Review	B, C

Artefact 33. Unit of Analysis (UA03) – Christian

The context of tools is very multi-layered, on the one hand, tools are developed which do not exist so yet in their application case, or which are not price-wise affordable for private use, or whose use without safety features may also be prohibited. The motivation to develop, try-out and use tools by yourself indeed corresponds to the classic idea of the Maker. Here, the Maker is exploring new fields of application, initially, niches that potentially will later be developed into markets. We are thus following the traditional approach from invention to innovation, in this case often driven by technological progress, such as the availability of low-cost electronics from Asia and the cost-free availability of high-performance software development tools for private-use.

Concluding on the context tools were Maker make their tools and machines there is a trend to commercialising these machines. Small machines, especially for Makers, become available on the Maker Faires; no longer build from Makers but offered from machine vendors that close the gap between low hobbyist performance and low precision machining in the living room to the professional and expensive machining for shop floor and industry 4.0.

Context Art – Case Cosplay

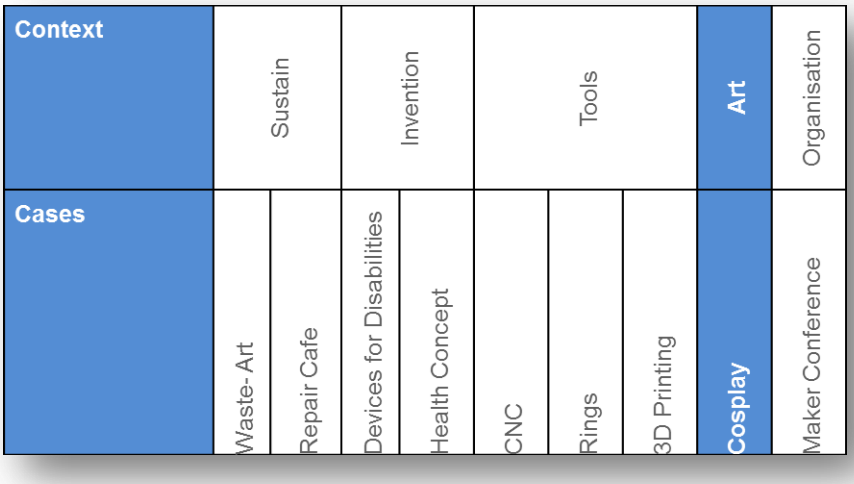


Figure 31. Overview - Context Art

In general, Cosplay is a trend started in Japan; mostly anime characters are the sources of costumes made by Cosplayers. Cosplayers are part of the German Maker community, but the source of inspiration seems broader than the original definition of the notion Cosplayer. In Germany, there is influence from the medieval times for the costumes, and the trend of individuals in fictitious outfits started earlier as the Cosplay trend in Japan. In Germany, there also seems a loose relationship to professional fashion design as one of the actors at Hannover already presented his design at a Channel fashion show years ago. Also, in the Germany Maker community, most of these presentations are included in small shows or timed events. An economic dimension in selling these unique costumes or any merchandise products of anime is not present in the Maker community but may be part of other game or comic conventions that are already established at Stuttgart and Cologne.

Artefact 34. Exemplification of Cosplay

Unit of Analysis	UA13	**Location**	Hannover
Case	Cosplay	**Interview Parts**	ABD
Gender	Male	**Age (approx.)**	62
Activities	Life Story	**Synonym**	Phoenix, Peter
Description	Peter is a member of a makerspace in the southern region of Germany that come every year to Hannover since the Maker Faires started. Peter makes his costumes for over 20 years now. He is well known in the Maker community, in the professional life he is a teacher of mathematics at a grammar school. Peter will retire next year. He also saw the first day of the Maker Faire that is open for schools, teachers and pupils very critical. As Peter had observed that many pupils are not interested in the day and are glad if they could leave at one o clock as the school was regularly over. Peter told me that they had a discussion at Berlin as well and already skipped then ‘open for school day’. Peter is used to walking around the Makers and visitors; some visitors ask to take pictures with him.		

	Some are amazed at his outfit with this about five-meter great wings stuffed with pure white feathers he could move in and out.
Onsite Contribution	Presenting his costume.
Offsite Contribution	-
Transcript Details	'I am doing this for 20 years. I think it was not even called cosplay,' TD13. 'I am a teacher for mathematics,' TD13. 'I also presented my costumes in shows for Channel,' TD13. 'Over the years this fair becomes more commercialised,' TD13. 'Most of the people want to take pictures with me. Some steal my feathers,' TD13. 'I travel from south of Germany to Hannover,' TD13. 'There is always a discussion about the first day, the school day. In Berlin, it was skipped. Some pupils are interested some not. If there are not interested, they make nonsense. The teachers should give them free for the day,' TD13. 'The last project was this box. I can move my wings now,' TD13.
Conclusion	Peter started in making music and other art performances, later he stepped into fashion and making costumes.
Stimuli of Invention (SI)	I-F-SI03, I-F-SI07, I-F-D-SI10, D-D-SI06
Themes from Literature Review	B

Artefact 35. Unit of Analysis (UA13) – Phoenix

Unit of Analysis	UA04	**Location**	Friedrichshafen
Case	Cosplay	**Interview Parts**	C
Gender	Female	**Age (approx.)**	25
Activities	Talk about cosplay costumes	**Synonym**	Cinderella, Mia
Description	Mia has a booth at the Friedrichshafen Maker Faire, in front are the costumes she already made, but she is sitting at her table and stitches a cape. Mia seems to be introverted and like to show her costumes. Mia mentioned that not many people in this southern region of Germany know Cosplay and for her, it is essential to plan for her characters not only to copy from the range of animes. Mia is part of a group of people being fascinated in making costumes. For me, it seems that there are two distinct groups of people, one group making the costumes and the other group that is excited about wearing them.		
Onsite Contribution	Presenting costumes, show how to make.		
Offsite Contribution	Cosplay group (of about five people)		
Transcript Details	‘I start with comics. I look at the characters, and then we discuss it and how we could make this helmet, this cape, this weapon, and so on,’ TD04. ‘I make my drawings first. Sometimes I play with the material, especially for capes,’ TD04. ‘We use paper mâché. Others make moulds,’ TD04. ‘It depends, some of these costumes are over 300 EURO. However, much more time. About a year until it is finished,’ TD04. ‘I like to make them,’ TD04. ‘I make my costumes. Here in this area are not that		

	many making cosplay,' TD04.
Conclusion	Mia reminds me being Cinderella.
Stimuli of Invention (SI)	I-F-SI03
Themes from Literature Review	B

Artefact 36. Unit of Analysis (UA04) – Cinderella

The Cosplayers seem to be another subcultural community within the Maker community. As steampunks are another subcultural community in the context of art as well, but the immersion with steampunks was much natural as there was still a relationship built on technology and engineering. For Cosplay the immersion seems incomplete as the focus is more on the artistic, somehow surreal and somehow becoming real aspects. The interrelation between virtuality, gameplay and these individuals might be very interesting for successive researchers. The personal traits of Cosplayer from my observations appear unequal in the context of the remaining Maker community. Therefore it is necessary to evaluate any findings evolving from these two cases carefully.

Context Organisation – Case Maker Conference and Fairs

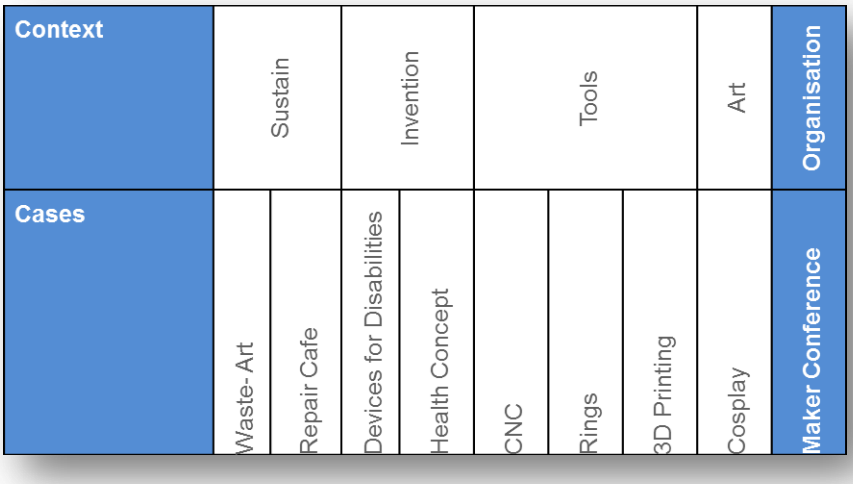


Figure 32. Overview - Context Organisation

Individuals or a group of individuals primarily initiate Hackspaces, Makerspaces and Labs; these days that could be a project on GitHub as well, where people collaborate. Sometimes it starts with the own blog in WordPress what gets other people interested and may contribute to this project. One extraordinary project started this way and gets excellent support in German cities and it started to be recognised internationally. It is the Feinstaub project (see http://luftdaten.info/) which started in Reutlingen and citizens all over Germany installed already about 8.000 fine dust sensors and already punctual in some international, air quality critical locations like Shanghai. The website http://deutschland.maps.luftdaten.info visualises the current overview of installed sensors and the current air pollution with the amount of fine dust in the air produced by traffic and fireplaces. This projects I would count to the German Maker Community as well, as some would argue that these are independent citizenship projects. However, I would argue they are recognised because of existing journals like the Make magazine that open up for participation in the Maker community. The publisher of the German Make magazine the Heise Gruppe GmbH & Co. KG and the Maker Media GmbH are also the official organisers of Maker Faires and Maker Conferences in Germany. Mini Maker Faire are locally organised but under license and with restrictions on marketing, size, content and pricing

to protect the Maker Faire brand. As a participant in the Maker Faire, there are also different contracts depending if you plan to make a profit on the fair or not. Usually, a booth of different sizes is free if you just present and sell nothing. So it favours Makers, schools, universities, and other non-profit organisations on the first hand. On the other hand, it is supported by sponsors like the Conrad electronic shop that is a significant German provider of electronics and gadgets like Arduino, Raspberry Pi's, PCBs, construction sets, drones, radio controlled cars, helicopters and planes, music and studio equipment and so on. Also, the share of professional vendors of 3D-printers and other tooling machines increased over the last two years; I made this observation in Hannover, as these just present their machines and sell later. Sometimes they offer competitions to win a 3D-printer or construction sets but mainly to get the contact data from the visitors for later advertisements. Even if there is a discussion about the pros and cons of this format, it is some form of platform for the German Maker community, and it is recognised by the public, especially families and technique oriented individuals, as the official fair for Making. If we look a little closer to the hacking background of some members of the Maker community, we may find additional relationships to the Germany Chaos Computer Club. This association founded in 1981 at Hamburg is mentioned as Europe's largest association of hackers. They have a yearly congress, called '33C3' this year, standing for the thirty-third Communication Congress of the Chaos Computer Club e.V in 2017. The distinct roles of hacking and making and how they are societally recognised will be part of this thesis in chapter 6. Evaluation of Research Findings.

Artefact 37. Exemplification of Maker Conference and Fairs

Unit of Analysis	UA08	**Location**	Heidelberg
Case	Maker Conference	**Interview Parts**	ABCD
Gender	Male	**Age (approx.)**	60
Activities	Talk with Initiator of Making, Keynote	**Synonym**	Shipmaker, Martin
Description	Martin is organiser behind the Maker Faires and Maker Conferences. Martin works for a German publisher that is specialised to technical journals in electronics and software for professionals and semi-professionals.		
Onsite Contribution	Fair and Conference Organisation, Keynote		
Offsite Contribution	Journal articles, Fair and Conference Organisation, Platform for Maker Community		
Transcript	German/ Translation to the English Language		
In 2004 haben wir den ersten „Mach flott den Schrott" Wettbewerb angekündigt// Ich habe mich dann	In 2004, we announced the first 'work with scrap' competition // I then wondered about this title, and I		

gewundert über diesen Titel, und habe erst etwas später verstanden, was die Mission dahinter ist, was das bedeutet, denn „Mach flott den Schrott“ ist so für jemanden, der so ein bisschen von außen kommt, doch ein wenig ungewöhnlich, doch die Recycling Idee, und dieser open Gedanke war schon da vertreten. Interessanterweise in 2005 als der erste Wettbewerb dann auch die ersten Gewinne ausgelobt hat, wurde das make Magazin in den USA gestartet. Wir hatten direkt gar nichts miteinander zu tun. In 2006 hatte Dale die erste Maker Faire gestartet in den USA. Und wir waren etwas später dran und wir haben in 2011 den „Mach flott den Schrott“ Wettbewerb wiederholt. Der Mario Lukas hat ja gestern noch einmal über seinen Preis, den Toilettenpapier Drucker berichtet, der in 2001 gebaut wurde und der damals auch einen Preis bekommen hat. Das war sozusagen die 2 Variante. Und das war für uns der Startzeitpunkt, mit ct‘hacks zu starten, also einem Sonderheft aus der ct, wo wir gesagt haben, lass uns dieses Thema DIY doch mal beleuchten und daraus ein Magazin machen. Und wir haben da erst so	only understood a little later, what the mission behind it is, which means, because ‘work with scrap’ is for someone who comes from the outside, but a little unusual, but the recycling idea, and this open thought was already represented there. Interestingly, in 2005 when the first competition was the first to win, the magazine was launched in the US. We had nothing to do with each other directly. In 2006, Dale had launched the first maker fair in the US. Moreover, we were a bit later, and we repeated in 2011 the “Mach flott the scrap” competition. The Mario Lukas yesterday reported once again about his price, the toilet paper printer, which was built in 2001 and which was then also received a prize. This was the second variant. Moreover, that was the starting point for us to start with ct’hacks, so a special booklet from the ct, where we said let’s look at this theme DIY and make a magazine from it. Moreover, we have only then seen what happens in the USA. I was 2012 at the first Maker Faire in America, was wholly enthusiastic, and I said that you could have gotten to it before, these worlds

gesehen was in den USA stattfindet. Ich persönlich war 2012 dann auf der ersten Maker Faire in Amerika, war total begeistert, und habe gesagt, Mensch hättest du ja früher mal drauf kommen können, diese Welten haben irgendetwas miteinander zu tun, und das war auch der Zeitpunkt, wo wir ins Gespräch gekommen sind und über eine intensive Zusammenarbeit geredet haben.	have something to do with each other, and that was also the time when we talked And have talked about intensive cooperation.
Was mich an Dale immer wieder begeistert hat, ist einerseits, es ist ein demokratischer Gedanke, der dahinter steht, Wissen für alle, das Thema open source ist ein ganz wichtiger Gedanke und was er hat! Er ist wirklich ein Missionar, er hat Passion, er redet mit jedem Maker, in bin immer wieder erstaunt auf der Maker Faire, egal ob das in Stadt X ist oder ob das in San Francisco ist. Er spricht mit jedem dieser Maker und möchte die Geschichte hören, die dahinter steht. Und man merkt einfach das ist derjenige, der als Evangelist diese Bewegung auch voran treibt. Er ist der Gründer der Make und er hat diese ganze Bewegung auch vorangetrieben. Das ging sogar so weit, mittlerweile gibt es heute maker faires in	What has always fascinated me about Dale is, on the one hand, it is a liberal thought, which stands behind it, knowledge for all, the theme open source is a critical thought and what it has! He is a missionary; he has a passion, he talks to every maker, I am always amazed at the Maker Faire, whether that is in City X or whether it is in San Francisco. He talks to each of these makers and wants to hear the story behind it. Moreover, you just can see that he is the one who evangelises this movement. He is the founder of Make, and he has also pushed this whole movement forward. Up to that point that meanwhile there is a Maker Faire in craving in China there is Maker Fair even in Egypt for which

shenzen in china es gibt maker faires sogar Ägypten was auch interessant ist ein Amerikaner startet in Kairo mit Hilfe der lokalen maker eine maker faire und er hat es auch geschafft ins weisse haus zu kommen. Obama hat seinerzeit die Maker Faire eröffnet, weil die Amerikaner dann auch gemerkt haben, welchen Impact diese Bewegung, die von unten heraus kommt, die so „open“ ist, vielleicht auch für die ganze Gesellschaft haben kann.	is also interesting that it is an American who started in Cairo with the help of the local maker a Maker Faire, and he has also managed to come to the white house, So if you are interested you can look at it on YouTube. Obama has at that time opened the Maker Faire, because the Americans have also noticed what impact this movement, which comes from the bottom, which is so ‘open’, may have for the whole society.
Transcript Details	‘I was not aware of this movement until I began to travel to all the maker fairs in the world,’ TD08. ‘It is more about education, learning, enabling people here in Germany,’ TD08. ‘I like to talk to people about their projects. To talk about their vision and mission,’ TD08. ‘It is sharing and the democratisation of things. It enables people to do things they did not believe in before,’ TD08. ‘Yes, of course, take a picture,’ TD08. ‘My vision is a Maker city,’ TD08.
Conclusion	Martin is interfacing between Maker community activities in Germany and activities in the US Maker Movement. Historically these are not interconnected.
Stimuli of Invention (SI)	I-F-SI02, D-D-SI06(!)// I-F-D-SI06, I-F-SI10
Themes from Literature Review	A, B, D, G, H, K

Artefact 38. Unit of Analysis (UA08) - Shipmaker

Unit of Analysis	UA14	**Location**	Hannover
Case	Maker Conference/ Faire	**Interview Parts**	ABCD
Gender	Male	**Age (approx.)**	42
Activities	Crew support, Film Making, Interviews	**Synonym**	Maker, Freddy
Description	Freddy helps to support the Maker Faire crew; Freddy's work is voluntarily like about eight others in one event/ fair. Support consists of interviewing people, filming the event, support the room and workshop management, supervise artefacts like the Lego car.		
Onsite Contribution	Crew support		
Offsite Contribution	-		
Transcript Details	'It is a great mood. The people are great. I come from the beginning,' TD14. 'It has grown steadily over the years,' TD14. 'Makey is cool,' TD14. 'I have never seen that,' TD14. 'Some Makers come regularly,' TD14. 'We are only the organiser, the platform. The fair is you makers,' TD14. 'I am a sociologist,' TD14. 'I come here with my son and my wife. Moreover, I help here at the Lego car,' TD14. 'The children are not afraid. Yesterday I had to pick someone from under the car,' TD14. 'The van is cool. Have you tried it?' TD14. 'I got into the submarine boat,' TD14.		

Conclusion	Freddy likes the people and the open atmosphere of the Maker Faire and sees the additional benefit that his wife and his young son also visit these fairs for educational reasons.
Stimuli of Invention (SI)	I-F-SI02, I-F-SI07, I-F-SI10, F-D-SI05
Themes from Literature Review	G, H

Artefact 39. Unit of Analysis (UA14) - Maker

In summary, the insight behind the scenes of the organisation of the Maker Fair has brought significant advantages. Especially the possibility to question visitors and Makers with video technology and analyse them later was helpful. The extended period of three days allowed for continual and in-depth interviews with Makers. Also, the interviews with the organisers and co-founders of the Maker community, especially in Germany, provided additional insights. Nevertheless, the principles like the interaction between researchers and subject; or the principles of multiple interpretations and suspicion mentioned in the research design must be carefully applied to critically reflect and to highlight possible prejudices and to discover false consciousness.

4.2 Contextualise the Data to Concepts

First I analysed if the data from the Units of Analysis (UA) provide any evidence in the context of economics I excluded so far. As I mentioned fees at the Maker Faires depend on the issue of making a profit on the fair or not, therefore, I analysed the type of contribution onsite and offsite (see Figure 33. Multiple-Case Dimensions of 'Contribution').

Context	Sustain		Invention		Tools			Art	Organisation
Cases	Waste- Art	Repair Cafe	Devices for Disabilities	Health Concept	CNC	Rings	3D Printing	Cosplay	Maker Conference
	UA07, UA09	UA06, UA15	UA10	UA11	UA5	UA02, UA12	UA01, UA03	UA13, UA04	UA08, UA14
Type of Contribution									
Onsite									
Presenting	X	X	X	X	X	X	X	X	X
Service	X	-	-	-	-	-	-	-	X
Workshop	-	-	-	-	-	X	-	-	X
Offsite									
Space	-	X	-	-	X	-	-	-	X
Service	X	X	-	X	-	-	X	-	X
Workshop	-	-	-	X	X	-	-	-	-

Figure 33. Multiple-Case Dimensions of 'Contribution'

All Units of Analysis (UA) provide onsite presentations, a selection of services or small workshops for free or seldom a small fee for materials as the silver coin for the ring making. Offsite the Units of Analysis (UA) are providers of spaces, services or workshops; often these offers are combined with donations, membership fees, fees for materials.

Context	Sustain		Invention		Tools			Art	Organisation
Cases	Waste- Art	Repair Cafe	Devices for Disabilities	Health Concept	CNC	Rings	3D Printing	Cosplay	Maker Conference
	UA07, UA09	UA06, UA15	UA10	UA11	UA5	UA02, UA12	UA01, UA03	UA13, UA04	UA08, UA14
Kind of Merit (social, economic)									
Fun	X	X	X	X	X	X	X	X	X
Help	X	X	X	X	X	X	X	X	X
Reputation	X	X	-	X	-	-	-	-	X
Passionate	X	X	X	X	X	X	X	X	X
Honorary Capacity	-	X	-	X	-	-	-	-	X
Self-Supporting	X	X	-	-	X	X	X	X	-
Income	(X)	-	-	-	X	(X)	(X)	-	(X)
Funding	-	-	(X)	X	-	-	-	-	-

Figure 34. Multiple-Case Dimensions of ‘Kind of Merit’

The next step was to analyse the kind of merit that was mentioned by the Units of Analysis (UA) and if these merits were social or economic driven (see Figure 34. Multiple-Case Dimensions of ‘Kind of Merit’). I did not exclude each other, so I analysed that social merits like fun, help, passion were present in each Unit of Analysis (UA). Social merits based on the reputation and the use of honorary capacity were found in the context of sustainability, new health care concepts and the organisation of Maker Faire themselves. If ‘money came into play’ I made the distinction between money that was used for materials, tools and replacement of tools, I would call self-supporting and is often related to ‘a hobby’. Secondly, if the money was used to be the income or to support in addition to a low income like the situation of students. Thirdly, if the money was needed as funding or was given as funding or by donations. Concluding in most of the Units of Analysis (UA) the economic merit was supporting the costs of the hobby, only for health care and therefore in the invention context funding for further technological developments or organisational enhancements was searched. Combining the evidence for the kinds of merit, the social merits seems the primary driver of all the Units of Analysis (UA), the economic merit if relevant as the secondary driver.

If you look at the different conclusions of the cases (see Figure 35. Contextualise Data from Conclusions about Units of Analysis (UA)), you get a picture of the diversity that drives people to participate actively in the Maker community. Nevertheless, this is very general.

Context	UA	Conclusions made from each UA
Sustain	UA07	Jenny does book art for her amusement; it is a hobby for spending time. There is no financial interest noticeable. She likes to present her work and get recognition for this work.
Sustain	UA09	Karl is passionate in making things, he loves the material/ matter, creating something new with material that is broken in the intended use, and earning some money seems more to maintain his tools and some additional materials like glue.
Sustain	UA06	George likes to help and to share his knowledge and experience with others, especially the young generation. George hopes that he provides insight into the society that somehow the throwaway society will change its behaviour and economic goals will be not only the increase in revenue. Technology, in general, is not dangerous; as he adores the benefits of medicine, but there have to be additional thoughts about its convenience, efficacy and potential destruction.
Sustain	UA15	Dean is not a Maker; he is an alike salesman. He points out the technical achievements made in history, and he is annoyed at the accusations made against car manufacturers.
Invention	UA11	Quite impressive under the aspect of passionate people in the interim phase retiring, second perseverate needed to scale from an initial idea upon a healthcare organisation of this size.
Invention	UA10	Unwanted enemy. However, Dan is proud that Bob enjoys his life again, only by starting to electro-weld some tubes.
Tools	UA05	Clara started as a hobbyist and is now a passionate professional; she also earns additional

		money from the workshops and books to support her life.
Tools	UA02	John values craftsmanship and likes to preserve craftsmanship.
Tools	UA12	For Lisa making rings is a ruminant relaxation.
Tools	UA01	Playful entrepreneurs that see the benefits of 3D-printers. The business model seems developing as the scope of application of 3D-printers gets clearer.
Tools	UA03	Christian tells the typical 'how to become a Maker'-story. The sharing of knowledge and the collaboration and support by a hackspace/ fablab environment.
Art	UA13	Peter started in making music and other art performances, later he stepped into fashion and making costumes.
Art	UA04	Mia reminds me being Cinderella.
Organisation	UA08	Martin is interfacing between Maker community activities in Germany and activities in the US Maker Movement. Historical these are not interconnected.
Organisation	UA14	Freddy likes the people and the open atmosphere of the Maker Faire and sees the additional benefit that his wife and his young son also visit these fairs for educational reasons.

Figure 35. Contextualise Data from Conclusions about Units of Analysis (UA)

4.2.1 Contextualise the Data to IFD Relations (Preconception V)

In the following, it will now be a focus of establishing a more apparent relationship to the concepts described in the preconception V and the themes developed from the literature review (see Figure 36. Contextualise Data and IFD Relations (Preconception V) and Themes (Literature Review)). Therefore, I analysed the data by ranking the specific Individual-Field-Domain (IFD) relations by their occurrence in the Units of Analysis (UA). As an example, the I-F-SI02, I-F-SI03 and I-F-SI07 were the most common Individual-Field-Domain (IFD) overall relation Unit of Analysis (UA). In Figure 37. Contextualise Data to the Stimuli of Invention (Preconception V, Table) a better overview of the outcome of this ranking is presented. In this figure, you can see that the Stimuli to Enable (SI02), the Stimuli to Explore & Discover (SI03), and the Stimuli to Change Environment (SI07) are the most common overall Units of Analysis (UA), followed by the Stimuli to Persevere (SI04), Stimuli to Sustain (SI05), Stimuli of Cultural Change (SI06), Stimuli to Take Risks (SI09). In addition to this ordered view, I visualised the data of the Individual-Field-Domain (IFD) relation in another diagram that was adopted from the preconception (see Figure 38. Contextualise Data to the Stimuli of Invention (Preconception V, Schematic)). This schematic view offers more insight about the involved Stimuli of Invention (SI) between the system Individual, the system Field and the system Domain.

Context	UA	Rank A	Rank B	Rank C	Themes
Sustain	UA07	I-F-SI03 I-F-SI07	I-F-SI04	D-D-SI01	(J),(K)
Sustain	UA09	I-F-SI03	F-D-SI05 D-D-SI06(!!)// I-F-D-SI06	D-D-SI01	A, B, (K)
Sustain	UA06	-	D-D-SI06 F-D-SI05	-	K, A
Sustain	UA15	I-F-SI07	F-D-SI05 D-D-SI06(!!)// I-F-D-SI06	D-D-SI01(!!)// I-F-D-SI01	K, A
Invention	UA11	I-F-SI02 I-F-SI03	I-F-D-SI06(!) I-F-SI04 I-F-SI09	I-F-SI08	H, F, B
Invention	UA10	I-F-SI02 I-F-SI03	I-F-SI04 I-F-SI09	I-F-SI08	F
Tools	UA05	I-F-SI02 I-F-SI03 I-F-SI07	-	-	A, B
Tools	UA02	I-F-SI02 I-F-SI07	I-F-SI04 I-F-SI05	-	D, B
Tools	UA12	I-F-SI07	-	-	-
Tools	UA01	I-F-SI02 I-F-SI03	-	-	C, D
Tools	UA03	I-F-SI03 I-F-SI02	I-F-SI09	-	B, C
Art	UA13	I-F-SI03 I-F-SI07	D-D-SI06	I-F-D-SI10	B
Art	UA04	I-F-SI03	-	-	B
Organisation	UA08	I-F-SI02	D-D-SI06(!)// I-F-D-SI06	I-F-SI10	A, B, D, G, H, K
Organisation	UA14	I-F-SI02 I-F-SI07	F-D-SI05	I-F-SI10	G, H

Figure 36. Contextualise Data and IFD Relations (Preconception V) and Themes (Literature Review)

Rank	#	Interrelation	System I	System II
A	SI02	Stimuli to Enable	Individual	Field
A	SI03	Stimuli to Explore & Discover	Individual	Field
A	SI07	Stimuli to Change Environment	Individual	Field, Domain
B	SI04	Stimuli to Persevere	Individual	Field
B	SI05	Stimuli to Sustain	Field	Domain
B	SI06	Stimuli of Cultural Change	Domain	Domain
B	SI09	Stimuli to Take Risks	Individual	Field, Domain
C	SI01	Stimuli to Preserve	Domain	Domain
C	SI08	Stimuli to Make Decisions	Individual	Field, Domain
C	SI10	Stimuli to Tolerate	Individual	Field, Domain
-	-	Stimuli of Competition	Field, Domain	Individual
-	-	Stimuli of Redirection	Field, Domain	Individual

Figure 37. Contextualise Data to the Stimuli of Invention (Preconception V, Table)

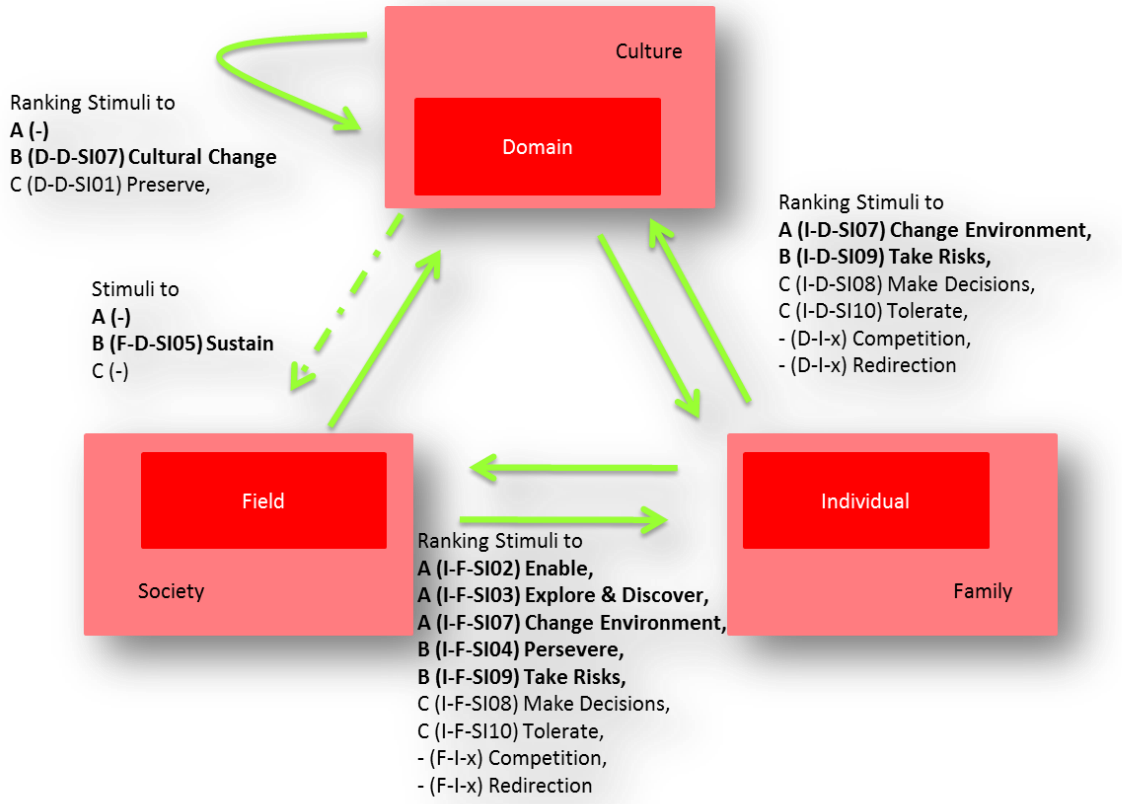


Figure 38. Contextualise Data to the Stimuli of Invention (Preconception V, Schematic)

The schematic view offers insight about the involved Stimuli of Invention (SI), starting from the interaction between the systems, much of the interaction is based on the relation directed from the Individual to the Field or Domain. The opposite relation seems to be mostly hidden in the context of the German Maker community. If you examine the Stimuli of Invention (SI) in detail, first between Individual and Domain, then the Stimuli of Change Environment (SI07) and the Stimuli to take risk (SI09) has a direct relation to Domain or culture. Also in the interrelationship between Individual and Field, there is a strong tendency to change the environment (SI07), the enabling of others (SI02), and the one's curiosity for knowledge (SI03). Coupled with more personal trait characteristics, such as perseverance (SI04) and the tendency to take risks (SI09). These observations could once again underline that the system Individual has a vital role to play in the German Maker community.

4.2.2 Contextualise the Data to Themes

In the next step, the cases are now compared with the themes created in the literature review. The themes are arranged according to their occurrence in the assigned context and then arranged in ranked order (see Figure 39. Contextualise Data to the Themes (Context Ranking)). It can be seen that the order varies depending on the context (see Figure 40. Contextualise Data to Themes II (Overview of contextualised Themes)); in the case of sustainability, the theme of critical engagement with the technology takes its place, while in the context of invention, the invention as the unwanted enemy is the relevant theme. In the cases of tools and art, it is the individual traits that come to the forefront. In turn for the context organisation, the themes about handling invention in institutions are at the forefront.

Context	UA	Themes of UA	Context Rank A	Context Rank B	Overall Rank A
Sustain	UA07	(J),(K)	A, (K)	(J)	A, B
	UA09	A, B, (K)	A, (K)	B	A, B, K
	UA06	K, A	A, K	-	A, K
	UA15	K, A	A, K	-	A, K
Invention	UA11	H, F, B	F	H, B	B
	UA10	F	F	-	-
Tools	UA05	A, B	B	A	A, B
	UA02	D, B	B	D	B
	UA12	-	-	-	-
	UA01	C, D	-	C, D	-
	UA03	B, C	B	C	B
Art	UA13	B	B	-	B
	UA04	B	B	-	B
Organisation	UA08	A, B, D, G, H, K	G, H	A, B, D, K	A, B, K
	UA14	G, H	G, H	-	-

Figure 39. Contextualise Data to the Themes (Context Ranking)

Interestingly, there are also themes that were not part of the Units of Analysis. In particular, the themes E. The Cultural Evolutionary Process - Systems Theory and I. Protection - Intellectual Property and Creative Commons. The absence of the theme about intellectual property could be interpreted regarding the openness among the makers and the lack or undeveloped economic interest of the makers beyond their inventions.

Context	Themes	A	B
Sustain	A. The Technology - Critical Engagement	X	
	K. Designed Obsolescence and Critiques of the User	X	
	J. How Reputation is given to People in a Community?		X
	B. The Individual - Personal Traits		X
Invention	F. The Inventions - Unwanted Enemies	X	
	H. How to Handle Invention in Institutions? - Part II		X
	B. The Individual - Personal Traits		X
Tools	B. The Individual - Personal Traits	X	
	A. The Technology - Critical Engagement		X
	C. The Juggling of Knowledge - When Irrelevant Knowledge becomes Relevant		X
	D. The Knowledge Society		X
Art	B. The Individual - Personal Traits	X	
Organisation	G. How to Handle Invention in Institutions? - Part I	X	
	H. How to Handle Invention in Institutions? - Part II	X	
	A. The Technology - Critical Engagement		X
	B. The Individual - Personal Traits		X
	D. The Knowledge Society		X
	K. Designed Obsolescence and Critiques of the User		X
Not ranked	E. The Cultural Evolutionary Process - Systems Theory	-	-
	I. Protection - Intellectual Property and Creative Commons	-	-

Figure 40. Contextualise Data to Themes II (Overview of contextualised Themes)

In the next step I will go deeper into the relationship between themes and context; first, the data is prepared in a table (see Figure 41. Relate Context to Themes (Data for Venn Diagram)) and then the data is plotted in a Venn diagram (see Figure 42. Venn Diagram - All Themes) to show potential interrelationships in this data generated initially from the fifteen Units of Analysis (UA).

Context/ Themes	Sustain	Invention	Tools	Art	Organisation
A	X		(X)		(X)
B	(X)	(X)	X	X	(X)
C			(X)		
D			(X)		(X)
E	-	-	-	-	-
F		X			
G					X
H		(X)			X
I	-	-	-	-	-
J	(X)				
K	X				(X)

Figure 41. Relate Context to Themes (Data for Venn Diagram)

Through the visualisation in the Venn diagram you can recognise the themes that were not part of a context, to be named theme E. The Cultural Evolutionary Process - Systems Theory and theme I. Protection - Intellectual Property and Creative Commons. One also recognises themes that occur in a specific context like F. The Inventions - Unwanted Enemies in the context of Invention or like C. The Juggling of Knowledge - When Irrelevant Knowledge becomes Relevant in the context of Tools. It becomes interesting with the themes that appear in the intersections with several dependencies to contexts. Here in particular in the context Organization the following themes: A. The Technology - Critical Engagement, B. The Individual - Personal Traits, D. The Knowledge Society, G. How to Handle Invention in Institutions? - Part I, H. How to Handle Invention in Institutions? - Part II, K.

Designed Obsolescence and Critiques of the User. All of these six themes stand in close relation to the context Organisation.

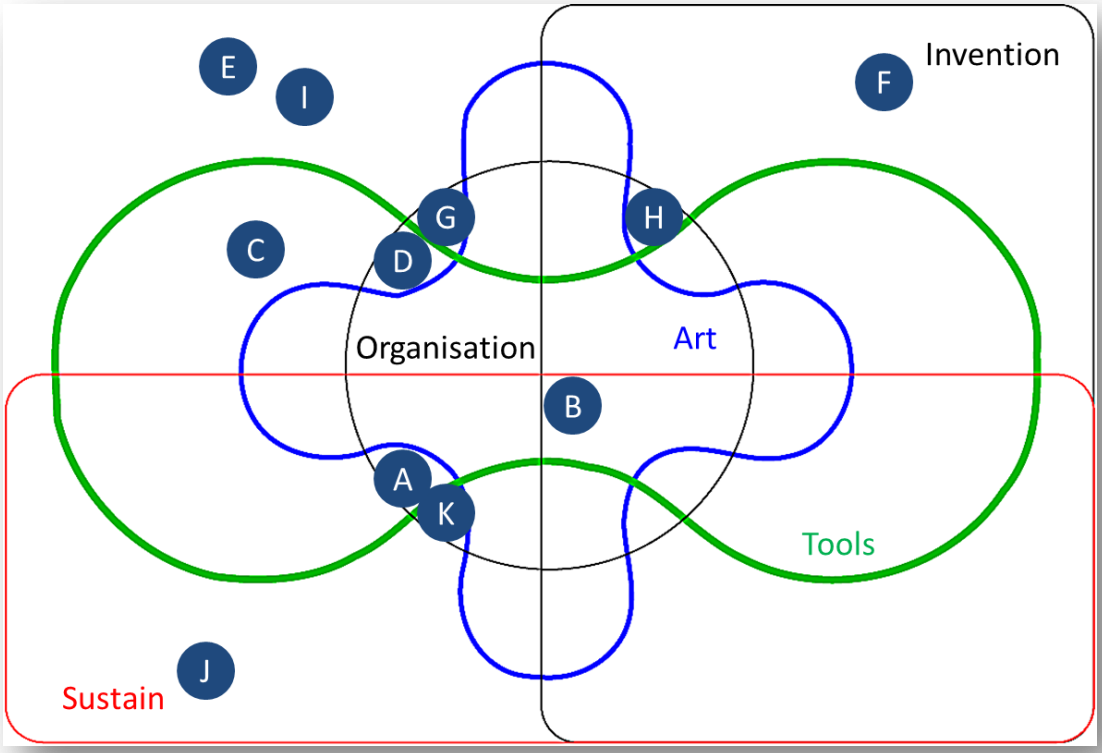


Figure 42. Venn Diagram - All Themes

To take up the prioritisation of the themes once again, they are prioritised in Figure 43. Prioritised Themes overall Contexts regardless of their context, whereby it is the themes A. The Technology - Critical Engagement, B. The Individual - Personal Traits, and K. Designed Obsolescence and Critiques of the User that are mentioned more often in the Units of Analysis (UA). The Venn Diagram is updated with this additional information (see Figure 44. Venn Diagram - Prioritised Themes).

Context	Themes	A	B
Overall Contexts Ranking	A. The Technology - Critical Engagement	X	
	B. The Individual - Personal Traits	X	
	K. Designed Obsolescence and Critiques of the User	X	
	C. The Juggling of Knowledge - When Irrelevant Knowledge becomes Relevant		X
	D. The Knowledge Society		X
	F. The Inventions - Unwanted Enemies		X
	G. How to Handle Invention in Institutions? - Part I		X
	H. How to Handle Invention in Institutions? - Part II		X
	J. How Reputation is given to People in a Community?		X

Figure 43. Prioritised Themes overall Contexts

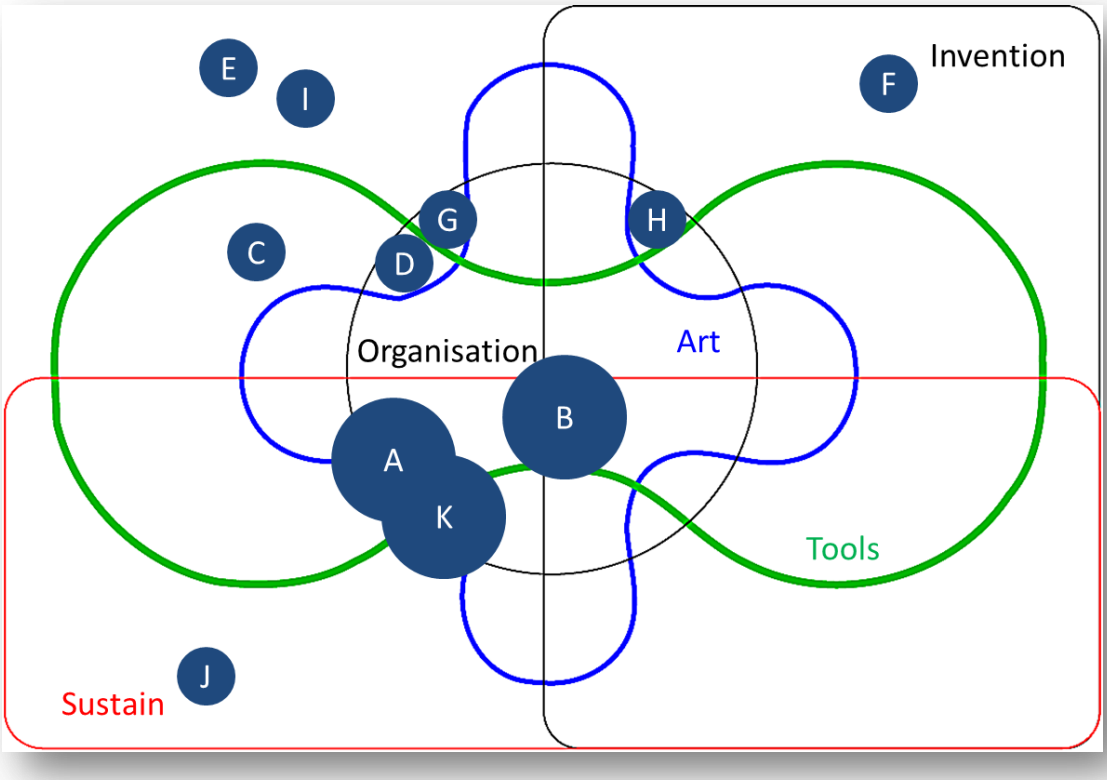


Figure 44. Venn Diagram - Prioritised Themes

4.3 Analyse the Data for Additional Themes (ATx)

This chapter could be named findings, but I decided to name it additional themes because I want to stress that there is additional information extracted from the sources of the Unit of Analysis (UA) that is so far not covered by the analysis done yet. The analysis so far was strongly focused to give answers on the research question one: What factors stimulate invention within the German Makers Community. What could be found from a research perspective and what of these themes and the preconception V could be found in the context of the community of German Makers. The chapter now is more to get answers on the research question two: In what ways could German Makers improve their skill for invention? - Therefore I step into another analysis creating additional themes using the transcript details given earlier in the description of the Units of Analysis (UA) based on the concept coding and pattern coding (see Figure 45. Overview Pattern Coding and SMoC IFD Relation and Appendix VI-4 Pattern Codes and Content Description). Consequently, I will evaluate these additional themes against research conducted internationally about Maker communities and the Maker Movement to identify potential new contributions to practice and knowledge (see chapter 6. Evaluation of Research Findings).

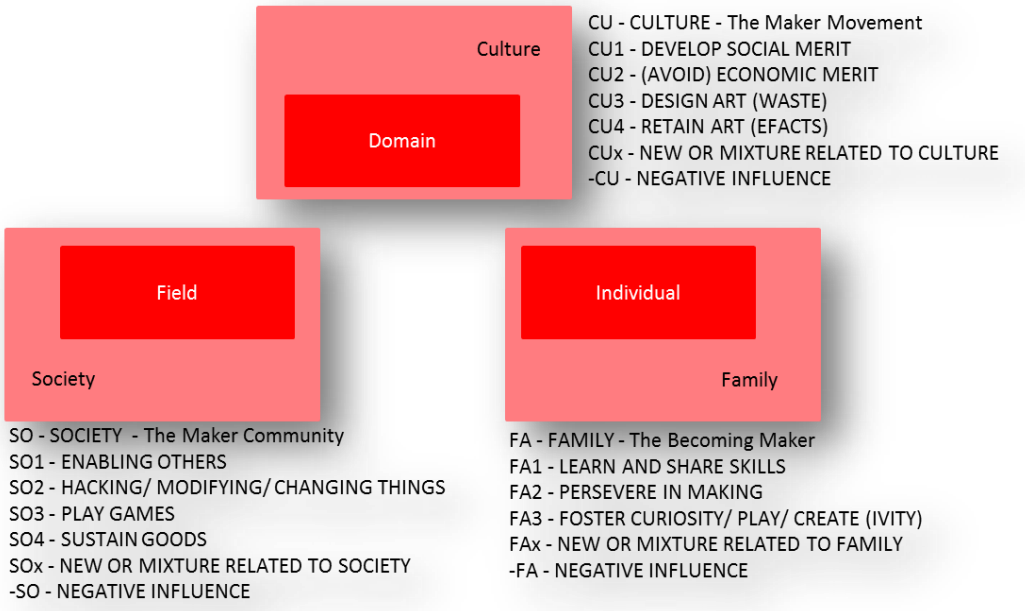


Figure 45. Overview Pattern Coding and SMoC IFD Relation

AT01 What is your project?

After a while, when you often speak to makers, you will find this repeating pattern. The maker will ask you, what your current project is. Coming from outside the Maker community it is not like; I present my project to you, it is about getting a picture of the other projects. Is he a maker? Is there another exciting project? - After this hurdle usually the discourse goes about the techniques you are using, depending on the area you are in. If it is artwork, it is different, if you are talking about control processes with Raspberry Pi's or Arduino's, or if you are talking with the 3D-printer maker or people from the Repair Cafes. However, this question I heard so often, 'what is your project?' Moreover, the answer is the way to emerge with the maker community and get into more profound discourse with them about their priorities in life, their professional life, their relations and insights into their work.

Intention/ Vision/ Motivation

Even if the motivation of the makers is not uniform, different types can be identified here as well. It is also noticeable that ultimately each of the makers is expressive on the matter of motivation. Feelings are expressed, such as joy and vitality, the 'good feeling', and the meaningfulness through the confirmation of others. 'It gave me new vitality,' TD10. 'It is a great mood. The people are great. I come from the beginning,' TD14. Some people respond with their senses, such as the use of their hands and seeing the outcome. 'I like to see something from my work. Made by my hands and easy tools,' TD12. 'I like to make them,' TD04. Some of the makers try to make meaning to their activities in the community. They also report that the meanings and the magnitude had only been adjusted over time. 'I was not aware of this movement until I began to travel to all the maker fairs in the world,' TD08. Sometimes it was individual incidents that triggered people to enter the community. 'I have built this scooter for my friend after he has fallen from a gantry,' TD10. Often the motivation is not to accept the status quo, but to initiate changes. 'It is not only to repair. It is to talk about things that could be repaired,' TD15. Whether it is the throw-away society or the helplessness of seeing people only talk about the developing countries and their problems '150 million people are ametropic. It would take 500 years with the current

number of opticians,' TD11, when community aid can find a solution. 'It is sharing and the democratisation of things. It enables people to do things they did not believe in before,' TD08. However, motivation is also to enable oneself and others. 'Idea is the primary health care. To see again. The ability to learn and work. To get the ability,' TD11. Moreover, to follow the belief, together it can be achieved. It is about the exchange and free access to knowledge 'We like to share, that there products that could be repaired and such designs that could not be repaired,' TD06, skills and ideas. 'I like to talk to people about their projects. To talk about their vision and mission,' TD08.

Support/ Get help/ Contribution

Another common characteristic mentioned in the context of projects is the help or assistance for and by others. 'People are asking, what or if we could do something with these 3D-printers. Like this men asked for a broken part of his Märklin railway,' TD01.

Participate: 'Currently, I am participating in a book [Die Welt reparieren/ Repair the world - Open source and DIY as post-capitalistic practice],' TD05; support and getting support are a guiding principle in the Maker community. 'I got help from the others to build this 3D-printer, a rep rap design,' TD03. The principle of sharing knowledge and skills, and together learn and improve skills (see Appendix III-13 Share Knowledge and Skills, Learn and Improve Skills). This also is the abbreviation DIT, do-it-together is used in the Maker community; instead of DIY, do it yourself, from outside.

AT02 The Fire Pitch Approach versus the Sales Corner

One of the findings, when you go to Maker Faires, is how Makers present their stuff. In most case, it will be more like a fire pitch, get around, get together, put the important part, what you want to present in the middle and let people discuss. Communication takes place peer to peer. There is no power relation as in a classroom between teacher and students. I know more you have to listen as I would call this traditional setting. Alternatively, what I would call a sales corner approach, customer, and seller. One to provide an offer and the other to select and buy. Not to say that there are these

approaches, sales corner, at Maker Fairs as well. Moreover, I think it is not intended; it is as the Maker were given table, chairs, that equipment they got from the event organiser. What I often recognised was that the Makers do not entrench themselves with desks that stand in front of these tables to get into the middle of the enthusiastic group of people. Maybe sometime you not even recognise who is the Maker as they tend to be equal to the visitors (see Appendix III-2 Fire Pitch Approach).

When you start to think about this distinction of the setting you might conclude that in the beginning, you as a child tend to play in this fire pitch approach, piling up the Lego in the middle and then start to build alone or with others incredible things, imitated or from imagination. As only a few people know that Lego as a company economically struggled in the year 2008, the initiated internal programs to get inventive and innovative again. As an outcome, not to say the already used, e.g. design thinking approach, of one of these programs was to get back to 'play'. As Christian Madsbjerg and Mikkel Rasmussen have written in their article about Lego's reinventing the wheel (C. Madsbjerg & M. Rasmussen, 2014; C. Madsbjerg & M. B. Rasmussen, 2014), for me, it sounds like the fire pitch approach was underestimated. Moreover, it became a renaissance.

My children at the Kita, a form of Kindergarten, but starting at the age of two already which also becomes a very common construct for children as both parents are working, had a circle of chairs (German: Stuhlkreis) every morning. Sit together, learn to express what is in mind, sing together, read books, and play certain games. So they learned to communicate very early which I think was not always fun as it sets some pressure to say a word. However, this setting for me is also following the fire pitch approach.

Who invented the table? However, this reminds me of a toy that supports the role play of a sales corner (German: Verkaufsladen). I did not know if it is still famous these days. It might have been invented in the ‘60s after the Second World War when food and other things were rare in Germany. Moreover, to remind children about the care given to buy things and how to spend money. This may lead to a discussion about consumer behaviour, including Amazon

and internet shops in general. Moreover, the early death of small shops called 'Tante Emma Laden' in Germany's city and town centres.

Sales corner and selling goods might be distinct these days. As eBay offers the opportunity to sell everything, or as the evolving Etsy's and Co, to present compelling new designed stuff.

Location/ Community/ Commitment

The typical places where makers meet, if not at the Maker Faires, are the so-called Makerspaces, Hackspaces or Fablab. ‘We have our makerspace. We are about eight people, the same as here on the fair,’ TD03. Most of them are organised as an association in Germany and often have a small membership fee, which is used to buy the rent for the facilities and smaller quantities of material. The tools are often donated or temporarily provided. Typical acquisitions or joint projects are laser cutters, 3D-printers, illuminated reading magnifiers, small hacks from old computer games, or in particular knitting machines. In exceptional cases, makers also operate their workshop. ‘I have my studio,’ TD09.

An exceptional example is the Repair Cafes, which are financed by donations and are usually provided free of charge by the municipalities and cities. ‘We use community facilities,’ TD06. In general, the average age in the Repair Cafes is also well over 40 years, ‘There are only a few young people joining us. However, some,’ TD06, and the elderly are concerned not only with repair but also with communication in old age. ‘The group we come together. It is a sit-in, sometimes there is a lot to do, sometimes not. Then we talk,’ TD06. Moreover, there are also older people who come to fix things. Sometimes the simplest things, like a broken LED lights for the Christmas tree, on which cables are loose, or the switch is already faulty after little use. In addition to repair, it is also often a question of communicating values for the sustainability of products. Parents are almost embarrassed when children have to learn that their beloved scooter is one of those that cannot be repaired. Moreover, what to consider the next purchase to ensure it is repairable. ‘All people, young and old come. Here is a boy with a scooter,

plastic is broken so we cannot fix it. However, there are others we could fix,' TD06.

The Maker Faires are events which are planned in the clubs and families and which are about making further contacts, 'I make my costumes. Here in this area are not that many making cosplay,' TD04, or where children learn early to introduce and explain things to others. Longer journeys of 400 - 600 km are also accepted, 'I travel from south of Germany to Hannover,' TD13, the journey and the stay are at own expense. New is that for the first time in Germany, in Berlin, a Maker Festival is organised, where you can tent and camp for low costs of 15 EUR in the area of the Maker Faire.

The Makers are a community, often you meet and arrange to meet at the Maker Faires. 'Let's stay in contact,' TD14. As already mentioned, distances play a minor role here. But not all makers travel to all places similar to a caravan; everyone has their favourite places to return. 'Normally we are at medieval festivals, but Dortmund was close to home. Moreover, it is nice, here the working atmosphere. The blast furnace. Alternatively, that guy on his high-wheel bike!' TD02.

AT03 Bottom-Up Creativity

The next section deals with whether creativity or acting creatively can be arranged. Even if many executives would wish for their organization, it does not work so quickly top-down. My research in the German Maker community suggests that this is a bottom-up occurrence. If you observe the people involved, it is themed such as curiosity, perseverance and the way in which people voluntarily take on tasks that stimulate them.

Curiosity

Curiosity is a broad field; it is about people who see, 'I have never seen that' TD14, try, 'The van is cool. Have you tried it?' TD14, and experience something for the first time 'I got into the submarine boat,' TD14. To the realisation of something that seemed simple but previously unattainable. 'I like to work outside. Here under the trees,' TD12. It is the 'aha'-effects, such

as getting to know the other in previously foreign cultures and languages. ‘In Africans is no word for spectacles/ glasses,’ TD11. The perception of the other and respect for others are also important factors in the German Maker community. ‘People are amazed, but they recognised our project for the first time,’ TD11. Of course, there are also simple promotional tools, such as the existence of a mascot. ‘Makey is cool,’ TD14.

Perseverance

The perseverance was also addressed again and again, on the one hand, it was only about the time and effort for specific activities. ‘Some only fold and some cut. Folding is more original but also more effort,’ TD07. On the other hand, it was also about the continuous tinkering until a technical solution for a problem was found. ‘This mechanism took me a while. Now it is easy; it works to relieve and control the pressure to his legs,’ TD10. The pleasure in the task and the degree of difficulty also play a role. The level of difficulty does not have to be high. ‘It is not difficult, but folding 400 to 800 pages takes your time. However, you could stop and take it with you,’ TD07. It seems that the task, ‘It is a little like knitting,’ TD07, and learning is an essential factor here. ‘After a while, you get used to,’ TD12.

Volunteering

The critical role of volunteers for the projects was mainly in the health sector addressed. ‘We always look for volunteers,’ TD15. Especially their role and that their support is needed to achieve the objectives of these health care projects was openly announced. ‘We look for volunteers, that after a while support our projects offsite,’ TD11. Finally one must also note that the association work mentioned earlier is also often based on the achievement of individual, volunteering aids.

Collaboration/ Relationships

While in research on creativity and inventions there are numerous statements about exclusion from society, often justified by the fact that this takes place on the fringes of society, these statements cannot be deduced from my analysis. ‘My friend is extremely important to me because he tries the new things,’ TD01. Rather, the social network of friends or family is often

exposed. ‘I come here with my son and my wife. Moreover, I help here at the Lego car,’ TD14. So this is rather the conclusion that motivation and impulse are drawn from personal relationships, i.e. a socio-cultural driving force. ‘We are the second time here at Dortmund; my friend is the driving force. He is responsible for the technique of the printers. He also bought these 3D pens from a Kickstarter to test them together with others at the table,’ TD01.

AT04 Innovation is Output; Invention is Input-Driven

A view more derived from my observation is that innovation ultimately focuses on the final result, the selection of an idea, the further development to market launch, the commercialisation with gains and perhaps a redesign necessary to fully exploit the economic potential. In this way, social, environmental, political and purely rational motives are increasingly pushed into the background; the economy and the economic principle are the basis of all progress. At the first observations of the German Maker community, I was already aware that money plays a subordinate role, not that the makers have too much of money, but it is not essential for their actions. In the course of my research, I then denied the economic principle of innovation and returned to the more fundamental concept of the invention and tried to understand its historical roots. This approach has led me to the idea, which can also be found in the literature that we should start with the input variables in the process of the invention. As the process, however, often does not last the eureka moment or aha moment, it is often the result of long preparation and the development of knowledge and skills, and therefore the influencing input variables for an invention start much earlier. The involvement of the other systems, individual, field and domain, as described by Mihaly Csikszentmihalyi, are also considered as potential input variables. The invention is thus a result of investment in human capital and the surrounding structures: family, society and culture.

AT05 DIY/ DIT in General

The following observations focus more on the obvious, but to consider what is specifically German in the maker community, they seem necessary to be mentioned. Since the 1980s, many things can already be found in the study of the DIY Society. Nevertheless, some makers refer to themselves more as DIT than DIY and thus emphasise the collaboration in the community, more than tinkering.

Object/ Haptic

Making is about creating. ‘Here is a creeper!’ TD01. The starting point is in each case a haptic object, ‘That is a tower,’ TD01, or a function, movement and its control, which ultimately also becomes visible and representable. ‘The last project was this box. I can move my wings now,’ TD13. Even if the original object, a CNC machine is too large to transport to any Maker Faire, a substitute is shown ‘This is only a small CNC I bring to the fairs. Normally I do workshops for larger CNC machines. This large that people can build bodies for their guitars,’ TD05. Even if this sounds very technical at first, it is also about the handling of materials, ‘I make my drawings first. Sometimes I play with the material, especially for capes,’ TD04, and different production processes. ‘We use paper mâché. Others make moulds,’ TD04. Reaching or generating emotions is also part of the repertoire of the makers. ‘That is a face,’ TD01.

Profession

The professional background is also asked for repeatedly, and the role whether it is only hobbyists or also a specialist, ‘I am a teacher for mathematics,’ TD13, vocational professionals, ‘I am an optician. Last year I sold my two shops,’ TD11. Of course, one can also take the intermediate steps, such as artists and craftsmen, ‘I am a precision engineer. I work on the bending machine,’ TD11, into this at first step black and white approach. From my observations, no definite outline emerges, the makers are at the beginning of a professional career, ‘we are students. Mechanical Engineering,’ TD01, or are retirees, ‘I am retired,’ TD06, who have left their professional life, ‘I worked in a company,’ TD06, but would still like to use and pass on their experiences. Nor does a definite outline emerge as to

whether they are primarily technically oriented makers, ‘I always tinkered. I am an engineer,’ TD03, or if they are also artistically inclined makers or makers who are interested in the socio-cultural ambience of society. ‘I am a sociologist,’ TD14, ‘We conduct interviews with all participants of the workshops,’ TD11. Some makers also reflect on their Maker career from its beginnings to its current success. ‘I started at a hackspace. I wrote an article for ct’hacks. People are building this CNC machine on their own now,’ TD05.

Timing/ Frequency of Meetings

When looking at the time, there is a regularity in participation, for example in the group activities, the monthly Repair Café, ‘we come together once a month,’ TD15, or the weekly rounds in Hackspace. Also, participation in the Maker Fair belongs here to be included. ‘Some Makers come regularly,’ TD14. It is of importance to those involved, ‘I am doing this for 20 years. I think it was not even called cosplay,’ TD13, and they also observe that during the years society grows. ‘it has grown steadily over the years,’ TD14. Also that the acceptance grows, if persons use the services, ‘once a month. People know that date and are prepared. For us, it is always new,’ TD06, or participate. ‘I am here for the first time,’ TD03.

AT06 The Zero Approach

In the German Maker community, it is noticeable that there is a tendency to reuse materials continually. On the one hand from an environmental point of view, but on the other hand also from an economic point of view. The German motto "Mach flott den Schrott" is already very appropriate here. For a project, the materials are not principally bought, the materials are often removed from somewhere, converted in their functionality, and in the end, the underlying idea is still to hack hardware. The other area of this zero approach is the most straightforward tools that are used, partially from the kitchen and cooking equipment. Here, too, there is a trend towards reuse and partial re-functioning of the tools used; safety aspects play a role, although often only a minor one, in the re-functioning process, e.g. the operation of an open CNC milling machine. An open CNC milling machine is

unthinkable in the industrial environment and also increasingly discussed in FabLabs, as injuries, cuts, crush injuries and burns have already occurred in the past. In FabLabs, some machines now require operating licences, which prove proper instruction on using the machines. Finally, a safeguard and precautionary measure for the providers of FabLabs against possible recourse claims of the practitioners.

The zero approach assumes that you start with the simplest and cheapest resources. Although there would indeed be no need for most Makers to afford other more costly resources, ‘It depends, some of these costumes are over 300 EURO. However, much more time. About a year until it is finished,’ TD04, it belongs to a kind of Maker Ethos in the German Maker community. ‘Start with nothing, start with less, make it cheap,’ TD10.

Zero Investment

An example of reworking is folding or cutting books. ‘You need only an old book to start,’ TD07. The special feature of folding does not destroy the books, the book remains intact and could be reread at a future time. With the cutting technique, the original function of the book is destroyed, reading is no longer possible, or only in fragments. The materials for learning the various techniques and original templates are freely available on the Internet, allowing you to start folding books without investing money. ‘This is book fold. You could do nearly every silhouette. In the beginning, there are templates available,’ TD07. The books are often distributed free of charge by libraries and schools.

Another example of reworking is to make belts out of bicycle tires, but the bicycle tires are first cleaned, ‘first I wash the pieces in the washing machine,’ TD09, and then cut into strips. ‘People bring me stuff, like these old bicycle tubes. I make waist belts of it,’ TD09.

An example for the handling of the simplest and cheapest resources is the glasses project "One Dollar Glasses", the costs for the glasses, which consist of the wireframe, the prefabricated plastic lenses, and a bit of heat-shrinkable tubing are only a few cents. ‘Simple resources, large effects,’ TD11.

Tools

On the one hand, only basic tools are necessary. ‘I do not need many tools, sometimes only a glue pistol. Sometimes a drill, some wire and a gripper, often superglue,’ TD09. In the example of the book fold a master template, which is printed using a conventional printer, and which then contains the required dimensions. ‘There are charts available with all the measures. Alternatively, black and white prints as a template to use,’ TD07. At the Repair Cafes, the tools are usually carried from home, one is familiar with them and can work with them. If one needs other tools, they ask around, or someone helps out. It was remarkable that the community coffee machine was important. ‘I have the tools I bring with me, but now we have a coffee machine,’ TD06. Moreover, it had been agreed that the donations would be used to purchase individual work lights.

More complex tools such as laser cutters or 3D-printers are often built in-house. ‘Yes. You are printing all the parts by yourself. Moreover, some metal sticks from the Baumarkt. Also, the Arduino with the controllers and the motors is bought in China,’ TD03. The electronic components are often procured in the Far East, precisely because they are partly only available from German electronics retailers at considerably higher prices. For wood, metal, screws the makers go to the local hardware store.

Revenue

If I mention the zero approach here, one could think that there is the market for 3D-printers and other tools. What about it? The question that arises are these Makers? Generally, in conversations with makers who hold workshops, the attitude is that only the material used should be paid for, or there is the approach that the material should be acquired by the participants themselves from the beginning. ‘I make four to five workshops a year with up to 10 participants. I support in doing this; the participants bring their materials, it is their project,’ TD05. Usually, the cost of service and one's hobby have to be covered. ‘The workshop is 360 EURO, and the material depends, about 600 EURO it starts,’ TD05. Maybe it is also possible to afford a replacement tool or to buy a more specialised tool. If there are donations here, the makers are

greatly impressed and are very appreciative. ‘One company donated this belt for my friend. It costs 2000 EURO. This belt!’ TD10.

In general, makers see the commercialisation of the Maker Faire ‘Over the years this fair becomes more commercialised,’ TD13, by suppliers of professional products, such as finished 3D-printers or electronics kits, as critical and not as an essential part of their community. It is particularly important that the exchange and sharing of knowledge and experience with the younger generations. ‘It is not for earning money. The 20 EURO is more or less the material and some money for tools. I like to share the craftsmanship with next generations,’ TD02.

AT07 Repair, Sustainability and Environmental Protection

The controversy about the maintainability and repairability of products is also present in the German Maker community. It should be noted that the relationship between the Maker community and the Repair Cafes in Germany is regionally different. The concept of Repair Cafes is very well established in the area of North Rhine-Westphalia, probably because of the proximity to Holland as the place of the concept's origin. Here, for example, the Repair Cafe from Cologne was also present at the corresponding Mini Maker Faire in the Cologne library; the same was true for Sindelfingen, also a Mini Maker Faire. In this respect, one may have to be careful with conclusions about the relationship between ecological issues and the general maker scene. This may be a mix-up that allows wrong conclusions to be drawn primarily in connection with the zero approach. That is why I want to focus on Obsolescence at first because these were the observations gathered by me.

Obsolescence

The part that can be easily described is the repair of garments, here there is also little discussion about the supposed ageing of the products, here it is about abrasion and the most straightforward repair with a sewing machine. ‘Now we also work on textiles. Here she made up my trousers again,’ TD06. In this context, it is also usually only a question of the general durability of

products. The situation is different with modern appliances of everyday life, such as smartphones or fully automatic coffee machines. On the one hand, these are very complicated for the users, for example with failed software updates of Smartphones, on the other hand, it also comes with the use to accidental damages, for example, the displays. ‘Smartphones are complex. We change screens,’ TD06. Here, too, the discussion is still more about the normal use and improper use of a product. It is different if the same products with similar lifespan or operating life, usually two years, fail because of the same fault. ‘Often capacitors. Things after nearly two years of use,’ TD06. Prominent examples are household appliances and coffee machines. Frequently detected faults are broken capacitors, which are usually only Cent items, but whose function is essential in the electronic devices. ‘Sometimes only on part fails, often capacitors, a part 1 Euro worth,’ TD06. It is almost impossible to prove whether components here have only been poorly designed or have been intentionally poorly designed. Nevertheless, the makers realise that devices fail very often here because of the same component and end up in the repair cafes. Special devices whose housings cannot usually be opened, or only with the destruction of the housing. ‘The sustainability of products is important,’ TD15.

AT08 DIY-Bio, an underestimated Field

In the German Maker community, the topic of DIY-Bio is not very well-developed. Experiments with fungi are among the few experiments to minimise packaging materials, for example (see Appendix III-8 Fungi - Upcoming Packing Material). In general, Germany is very critical of the handling of genetically modified substances, especially food, and the discussion in the field of medicine and the use of human stem cells for research has long been controversial and has also not been conclusively clarified. In the end, this could be the explanation of why the topic of DIY-Bio has so far had little presence in the German Maker community. Whether makers today are already making copies of the open source PCR (polymerase chain reaction) thermocycler (see http://openpcr.org/) available in the USA, is speculative based on my data.

AT09 Making and the Center of Educational Gravity

In this chapter, I would like to go back to the aspects of change, learning, and self-development. I have called the topic a bit risky as the centre of educational gravity, but it should express the fact that the role of the domain and its institutions in the German Maker community is perceived as not very important, it is here the self-directed learning, which is in the foreground, the family is supporting it. This leads to a shift in the role of schools, for example. In Germany, too, the number of people interested in the natural sciences and the number of graduates in German engineering is declining rapidly. What is known in the USA as the STEM is the MINT program in Germany and is intended to encourage schoolchildren's interest in the natural sciences once again. Unfortunately, this program starts in the 8th grade of secondary schools, i.e. with children about 14 years of age, probably on the justification that the cognitive skills required to learn the STEM skills are already being developed at this age. When you see the children at the Maker Faires specifically of the Maker families involved, these are primarily aged from 6 up to 18 years and older. Kid's and adolescents show paper gliders, egg-painting machines, self-made motorised skateboards and prototypes of laser 3D sinter printers. So I would express this theme as Making moves the centre of educational gravity from the Domain back to the Individual, from traditional institutions of education back to family and surrounding society. Therefore Field and Individual become closer, and the educational development is much faster iterated in the mostly STEM domain.

Initiate and Change

Initiating, making and changing is a general motto of the German Maker community. ‘Next, I build a larger one. However, this was a start,’ TD03. What is initially achieved, is not necessarily the final state, continuous, constant change is understood as being natural. ‘I start with comics. I look at the characters, and then we discuss it and how we could make this helmet, this cape, this weapon, and so on,’ TD04. The awareness changes purchasing behaviour being noticeable in the environmental area. ‘Maybe next time they buy something different because it could be repaired,’ TD15.

However, there are other biases, such as in the medical industry, where inventions and prototypes are studied but not carried on because they would cannibalise one's products or cause one's business model, such as the sale of glasses, to undermine. ‘I have spoken to a manufacturer of medical devices. They said my invention would substitute too much of their products at once. So they are not interested,’ TD10. The plans go far, like the influence of the maker community on the formation of cities, ‘my vision is a Maker city,’ TD08, but more practical implementations are the Maker Conference, where the aim is to bring together makers and industry. ‘This first conference is to connect business with the Maker Movement,’ TD08. However, also in the area of education, caution is required, only because schools and their schoolchildren participate in the school day, this does not trigger the immediate interest in the STEM topics, the teachers also recognise this. ‘There is always a discussion about the first day, the school day. In City X, it was skipped. Some pupils are interested some not. If there are not interested, they make nonsense. The teachers should give same free,’ TD13.

Sharing Skills/ Experience

A recurring theme is about collaboration and the passion for sharing with people. ‘I like to work with others. However, everyone has his piece he is working. I help, I show, and if a special skill is needed, I do. See here this drilling in the coin is the difficult part,’ TD02. No secrets are protected, who is interested also gets answers and the necessary instructions and assistance. ‘I gathered coins than I started in making rings out of these. It not that easy to find silver coins, but if you know where to search for, it is ok,’ TD02. Help is provided immediately; it is about solving issues, not about discussing problems. ‘If we could make a creeper? First, we have to look for the stl. File, then it is not a problem. About 15 minutes,’ TD01. The Internet plays an important role as a tool, but the experience of the individual or group is more important. ‘We look at the internet for help, but mostly it is our experience. When someone comes with an old record player nearly always the rubber rings are dissolved,’ TD06. Insights are openly shared, ‘look here at the wheels. I could switch them that the scooter gets into the bus. However, for

higher speed, it is better if they are outside,' TD10, many makers also have their blogs on the Internet, which they fill with their current activities and experiences. 'It is my skill to share with them,' TD05. In this respect, a certain affinity to technology can certainly be read here, but often the partners in life are also involved, it is a family hobby. Therefore you often find art and textile skills that make the culture colourful. The larger projects, such as the 1 Dollar glasses, definitely go further and are also interested in experienced people who can provide legal or financial support. 'We look for different skills, also clerks, and finance people. It is like social business, social entrepreneurship; we are doing,' TD11.

Education/ Play

Is it education? - In my view, it is rather to prepare the way to experience in safety, not 100% safe, but under observation of like-minded people who have a little more experience and can foresee possible, even worse consequences. 'The children are not afraid. Yesterday I had to pick someone from under the car,' TD14. It is a playground, 'I play with the material. Test some things, show others, speak with others,' TD09, but without the tendencies of child and parents, or students and teachers, the place has less power associated, than that is the case in the institutions of the domain, or even in the family. 'Look here. How the kids work with these 3D pens, nobody told them, he or she just start making,' TD01. Nevertheless, participation in these activities is an education, problems are solved together, support is received, and if interested, people approach the others, even if the other is interested, people actively approach them. 'It is to show people how some things work,' TD15. There is room for creativity that no company, even with the utmost willingness, will not be able to provide to its employees. 'It is more about education, learning, enabling people here in Germany,' TD08. It is about the desire to take things into one's own hands and make them happen. It is about helping, but not taking action out of one's hands. This presupposes a good interaction in power play, which is expressed by the collaboration and sharing aspects. The systems of school and company are still strongly based on hierarchical structures which include strong power and power relations.

Openness

Though it repeats the same thing, the makers are open. ‘Yes, of course, take a picture,’ TD08. The promoter also considers himself to be a platform, for instance, the new option of the Maker Festival, to intensify communication and reduce potential economic barriers. ‘We are only the organiser, the platform. The fair is you makers,’ TD14.

AT10 Making and the Gatekeepers

Finally, a look at the Systems Model of Creativity with the function of the gatekeeper in the field. Does this function exist in the German Maker community? Is this function hidden or is it open? The publisher certainly plays a role here, experiments that are too dangerous are not printed in the magazines. The declaration can be interpreted as too dangerous, as experiments with 220 volt supply voltage occur regularly, also experiments with cathode ray tubes and Tesla coils are part of it. DIY-Bio only finds marginal consideration and if then concerning projects in other countries, for example, Life Patch or the web page DIYbio.org. The registration forms for the Maker Faires also contain a paragraph that the content should be family-friendly or suitable for families, especially concerning children of a younger age. The question here is, where does fascination begin, so experiments with fire, flammable gases, flammable liquids, smoke, or fog are shown. Fascinating physical phenomena are also shown, generally or exclusively, without causing damage to the participants or observers.

There are no gender or age restrictions, no restrictions on group sizes, equipment such as electricity, internet, tables and chairs are provided free of charge in various arrangements and sizes. Free of charge, unless one would like to sell items. A well in advance registration is required; volunteers are welcome and will be asked for well in advance and will be advised on the days they help. Volunteers get a shirt of the event, provision of food and drink, and two additional day passes for friends or family. Also here, volunteers come more than once.

Reputation

In this context, the reputation of people, ‘I also presented my costumes in shows for Channel,’ TD13, groups of people and projects, ‘Martin got the Empowering People Award from the Siemens Foundation in 2013,’ TD11, should perhaps be pointed out once again, sometimes there are competitions whose winners are then welcomed on stage, but in the end this only happened once at the Maker Fair in Friedrichshafen. Apart from that, it is more the acknowledgement of the visitors that gives the Makers, ‘most of the people want to take pictures with me. Some steal my feathers,’ TD13, and the Makers among themselves, their reputation. ‘It is still more hobby,’ TD09. It is the project, the interest and the results in one's own and other projects that fulfil the acknowledgement here. ‘It creates workplaces and income for 25 people. As they have learned to make glasses from the beginning, they maintain the glasses as well,’ TD11. The personal success of your project also acts as a gatekeeper, of course, and on the other hand, promotes the continuous transformation in the German Maker community. Moreover, of cause people are proud if they were announced in media. ‘There was a one-page article in the newspaper about us,’ TD11. This whole discourse raises the question, is it about reputation or just perception and to what extent is reputation subsumed by being perceived in the Maker community? - One answer can be the Fire Pitch approach, with its use of the locations (e.g. Makerspace), in general, the way people interact and communicate with each other about their projects and a potentially significant role to social commitment.

5. Research Findings on Stimuli of Invention and Additional Themes

5.1 Stimuli of Invention (SIx) - Behaviour, Techniques and Skills that Stimulate Invention

Based on the data that I collected in the German Maker community, some insights into behaviour, techniques and skills can be drawn (see chapter 4.2.1 Contextualise the Data to IFD Relations (Preconception V)). On the one hand, proof that some of the topics addressed in the literature on the subject of creativity in the community can be proven partially by their social behaviour. The critical approach to technology (Theme A The Technology – Critical Engagement) and its influence on people and society, and in particular the controlled obsolescence of products (Theme K Designed Obsolescence and Critiques of the User) to ensure the continuous consumption of products. Moreover, this is where an explicit critique of Makers on commercial companies can be found. Another subject area, which can be demonstrated, deals with the personal traits of Makers which also focus on further consideration (Theme B The Individual – Personal Traits). Also, the roles of contributions and kinds of merit have to be reflected, which are overall not economically foremost. Furthermore, some of the predefined Stimuli of Invention (SIx) can be proven on the basis of the data and its analysis, how to enable (SI02 Stimuli to Enable), to explore (SI03 Stimuli to Explore & Discover) and to change and alter one's own environment (SI07 Stimuli to Change Environment) continuously. Within this context, it is also noticeable in the data that the relationship between the Individual and the Field is very prominent; much more than between the Individual and the Domain. Two things are dominant in the relationship between the Individual and the Domain. Mihaly Csikszentmihalyi implicitly assumes a loop of information from the Domain, to the Individual and into the Field. In my data with its distinct interpretation as Stimuli of Invention (SIx), it is noticeable that the Individual influences the Domain and also seek to change the Domain (SI07 Stimuli to Change Environment).

To reiterate, with the German Maker community we are in a creative Field or Society. Behaviours can be observed that demonstrate creative behaviour based on the preconceptions generated from contemporary literature and

recent creativity research. Furthermore, behaviours can be observed that have become established in this society, and that stimulate invention and thus sustain creativity. These behaviours are established and fostered in the community and the Individuals themselves and seem to be there not because of any significant economic interests. The roles of the Field (Society) and the Individual (Family) are of immanent importance, the role of the Domain (Culture) seems by first view subordinate.

The additional themes (ATx) were generated from the data and analysis about the German Maker community, to evaluated these ten additional themes for their validity the principle six of the hermeneutic circle is used. The principle six, multiple interpretations, challenge the additional themes in the context of international research in other, non-German, Maker communities or more general in the Maker Movement (see Figure 48. Use of the Principle of Multiple Interpretations to Evaluate Research). In order, to find commonalities as confirmation of my research findings so far, exemplarily thus whether my research concerns a Maker community or an insight to an initial Maker Movement in Germany. This is about aspects of the originality of a German Maker community and the potential parallels in the global development of the Maker Movement; moreover, the chronological sequence of socio-cultural development could play a significant role so that the German Maker community would develop slower. On the other hand, distinct aspects of the German Maker community may have an impact on the global movements. Secondly, to search for similarities and to identify and derive potential, universally valid schemes (generalisation). Moreover, last but not least, to identify German-specific findings which, concerning the international research results, represent a distinction in the German manifestation of the Maker community or Maker Movement; and so that it can also provide an impetus for further international research in the future.

5.2 Additional Themes (ATx) generated from the Research Data

The additional themes (ATx) are the result of an extensive analysis of my research data among the German Maker community; it is essential to consider what is already covered by other international research. Where new insights are for international research, as well as insights into significant distinctions between the German Maker community and the global Maker Movement. Ultimately, the intention is to include further perspectives to abstract the additional themes and to examine generalisability. In summary, the next chapter is for the evaluation of the ten additional themes (ATx) identified so far in the context of international research (see Figure 46. Overview and Indexing of Additional Themes (ATx) analysed from Data).

Index	Additional Theme (ATx) and the Subtopics
AT01	What's your project? (Vision/ Motivation/ Get Help)
AT02	Fire Pitch Approach versus the Sales Corner (Location/Community)
AT03	Bottom-up Creativity (Curiosity/ Perseverance/ Volunteering/ Relationships)
AT04	Innovation is Output-driven, Invention is Input-driven
AT05	DIY/ DIT in General (Object/ Haptic/ Profession/ Timing)
AT06	The Zero Approach (Zero Invest/ Tooling/ Revenue)
AT07	Repair, Sustainability, Environmental Protection (Obsolescence)
AT08	DIY-Bio, the underestimated Field
AT09	Making and the Center of Educational Gravity (Initiate & Change/ Sharing Skills and Experience/ Education and Play)
AT10	Making and the Gatekeepers (Reputation)

Figure 46. Overview and Indexing of Additional Themes (ATx) analysed from Data

6. Evaluation of Research Findings on Additional Themes (ATx)

The set of principles are applied to evaluate the results (see Figure 47. Set of Principles used for Research Evaluation). This is done primarily with the Principle of Multiple Interpretations, for this, I refer to additional literature and the international research about Makers which is documented in that literature. As previously documented in the literature review, as a result, there is research on the Makers, their community and the Maker Movement as a socio-cultural movement. This research is primarily based on quantitative approaches and includes studies in countries such as the USA, China, Australia, UK, Norway and Switzerland.

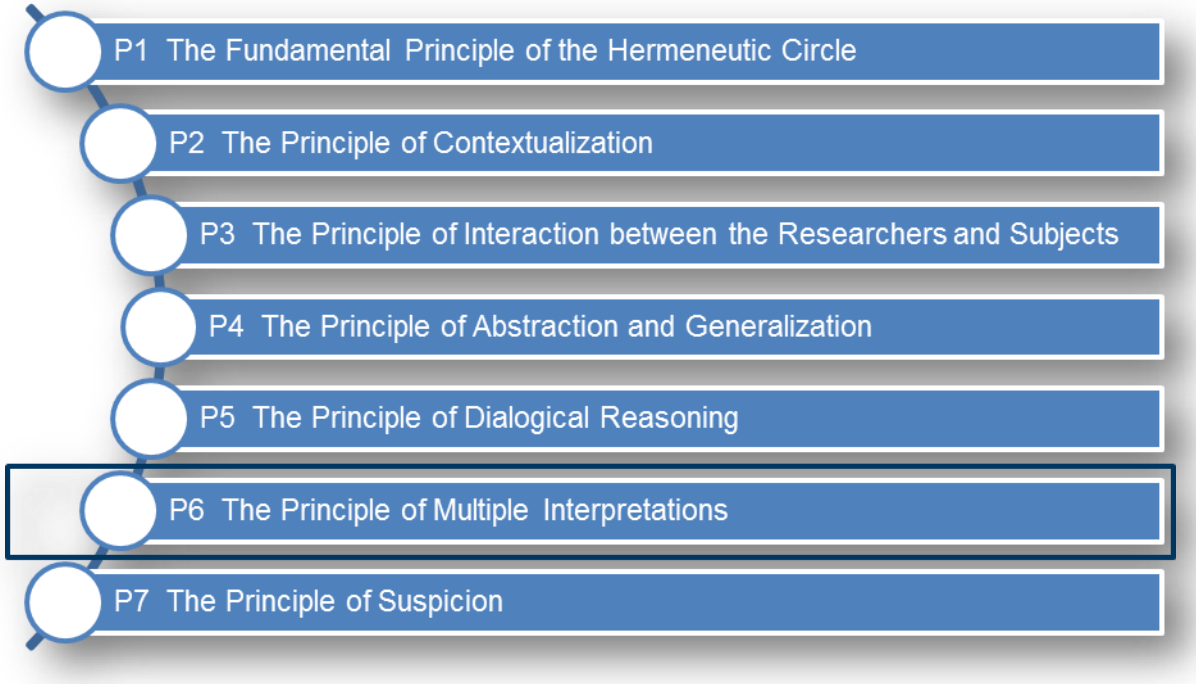


Figure 47. Set of Principles used for Research Evaluation of ATx

In this chapter, it is a matter of classifying the themes worked out so far in (A) Germany specific themes, (B) internationally or nationally similar themes, as well as (C) internationally same themes. Also, but not in depth, to uncover themes (D) that may be distinct from German Maker communities, not at all, or only in an insufficient way, such as DIY-Bio (see Figure 48. Use of the Principle of Multiple Interpretations to Evaluate Research). Attention is paid

to the possible localisations and a possible chronological pattern in the development of the Maker Movement.

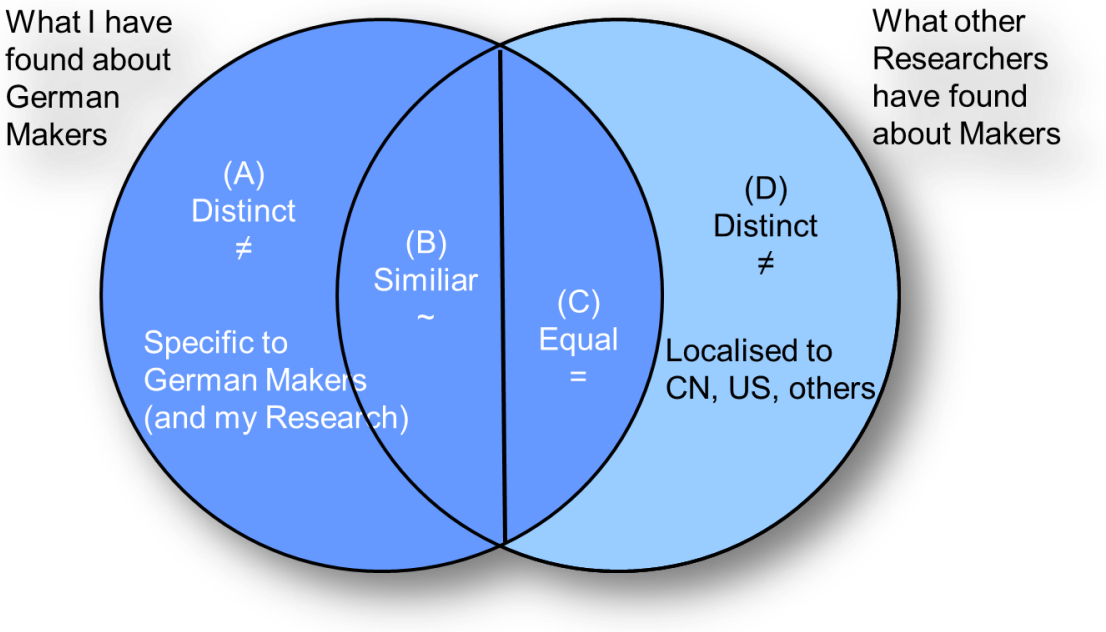


Figure 48. Use of the Principle of Multiple Interpretations to Evaluate Research

6.1 Evaluate Additional Themes (ATx) to Contemporary Research

At first sight, it is easy to say these are Makers and these are members of the Maker Movement. On the second sight you may recognise the differences to make in different countries, the differences in what Makers do, the distinct fields they are making their stuff. However, that seems not the only differences in how the research community has already recognised the Maker Movement; there seem to be differences between the Makers, Maker communities and the Maker Movement.

When reading about the Maker Movement and its members, it becomes transparent that it may affect an international oriented community with shared ideas and goals, but on the other hand, the groups are very national, regional oriented. Moreover, adapted to regional and national history. In my results, this is expressed in such a way that in the southern regions, as the

origin of the textile revolution in Germany, there were very many references to textile handcraft. In Central Germany, the Ruhr area, the origin of the metal industries in Germany, the focus was on 3D-printers to shape form and manufacturing aspects.

The individual in the Maker Movement may be situated in separate phases of this becoming a maker, actively join the community, share and articulate the values of the Maker Movement. When interviewing people some avoid the notion of being a Maker, like, I want to do my stuff, trying out, some help from others when needed. However, also here if you stand beside these people they will tell you what they do, why they do, what is important to them, what is their background, their profession, new skills they want to learn - they are open, communicate and share their knowledge.

This happens if you join a Maker Faire, a Makerspace, a Fablab, a Repair Café; this is about communication, building relationships with each other, except appearance, gender, age, meeting different people. However, these habits are not automatically confronting or lead to controversies this behaviour is accepted and part of the values within the community.

However, could you rush into this community? However, what if you put on the sociology lens onto what happens here?

> 'Some sociologists believe that in recent years, fundamental changes have taken place in Western societies. These changes have led to, or are in the process of leading to, a major break with the old concept of modernity. They suggest that people have begun to lose their faith in the ability of science and technology to solve human problems. People have become aware, for example, of the damaging effects of pollution, the dangers of nuclear war and the risks of genetic engineering. They have lost faith in political beliefs and grand theories that claim to be able to improve society,' (Holborn et al., 2013).

Thus, can the Maker Movement be seen as an ideology referring to a set of ideas, beliefs and values that present a partial view of reality. Alternatively, to be more precise perhaps a utopian ideology that rather than supporting the

status quo - the ways things are - advocate for a change in the structure of society. Alternatively, is the Maker Movement something in between?

6.2 Evaluate Additional Themes (ATx)

In the following the ten additional themes (ATx) will be discussed in detail, first summarized in their essence from my previous data analysis (see 4.3 Analyse the Data for Additional Themes (ATx)), then if in a theme subsections are contained, which were significant in context these will be interpreted against findings and other descriptions from international research. Finally, a conclusion will be given, and I categorise whether the final findings are different (A), similar (B), identical (C), or that were found internationally, but is not reflected in my research data (D).

AT01 What's your project?

Based on my data, I found the collective behaviour of German Makers that first they ask about your project, usually right at the beginning of any talk. There are no regional differences about this behaviour in the German Maker community, and the question is also regularly asked at the Maker conferences or when visiting Hackspaces or Makerspaces. Various interpretations of my data could be followed; on the one hand, the discourse of a tacit gatekeeper functionality that is expressed with this question. The reason for after having chatted a little about the contemporary projects, in the German notion 'fachsimpeln', the German Makers open up relatively quickly and access is given the personal information about the four subjects contained in my questionnaires. Another interpretation of this question is that people express that they are firstly interested in your contribution and secondly draw their motivation and further vision from it. A surplus result from the data analysis is worth mentioning, the emphasis of the German Maker on the use of senses and the importance of the creative act, as well as the free exchange of knowledge and ideas in the German Maker community. Thirdly an interpretation of this question could be about the supporting of others; to receive help and to give help, to learn together and to achieve things that an individual could not achieve or do not believe to achieve.

In the following, these three interpretations of the potential meaning of this behaviour and the question will be evaluated through international research contributions, whether there is a consensus, similarity or deviation, or

whether one does not exist at all. The question always asked about the own project maybe aimed at (i) intention, (ii) support or (iii) contribution and (iv) new insights.

(i) Intention: In the context of the Maker Faires, there is a potential field of tension or power relation between the visitors and the Makers. So one interpretation of the question about the project may work as a gatekeeper; first, show me that you are also a Maker! This also fits in with the interviews, in the sense that makers become talking when they become sure that they are faced with another Maker or when the counterpart is already aware of the objectives of Making. 'Initiative and Intentionality, a key dimension of tinkering is developing a purpose through personal authorship and the pursuit of a goal and idea', (Petrich et al., 2013 cited by (Bevan et al., 2015, p. 108)). So it is certainly a matter of exploring whether the other is a Maker, following the similar intention of Making. The author Evan Barba goes one step further and says there are people in the sense who pretend to be Makers. 'A poseur is someone who has a skateboard and thinks that makes them cool. After a recent visit to a local Maker Faire, I was tempted to give a new definition; a poseur is someone who has a 3D-printer and thinks that makes them a Maker,' (Barba, 2015, p. 641). To put it another way, for most Makers, creating and making is in the foreground, not the invention of things, and as Dale Dougherty states 'while people today may not treasure this ability out of the same sense of necessity as they once did, they are finding their lives enriched by creating something new and learning new skills,' (Dougherty, 2012, p. 11). Perhaps the understanding of the person as a Maker should be emphasised here. It is obvious that for most people it is not about any financial success to be Maker, so bridging the gap between being Maker and gets those becoming innovators or entrepreneurs, is perhaps even further than the bridging gap between Maker and the notion of the inventor. 'When I talk about the Maker Movement, I make an effort to stay away from the word inventor - most people do not identify themselves that way. Maker, on the other hand, describes each one of us, no matter how we live our lives or what our goals might be,' (Dougherty, 2012, p. 11). So we should be careful to present the Maker community as innovators and

entrepreneurs per se, or especially because they can create and make. The Makers' intention to be Maker is diverse as shown in the data collection and analysis as some other sources want to describe it narrower or broader by picking individual aspects of economics, technosolutionism, or even political interests. Moreover, to go one step further and to pick up Evan Barbas' reasoning for the notion of social evolution, 'the individual projects discussed run the gamut of activities that collectively define the Maker Movement: bespoke electronics, art installations, hacktivist blogs, and beyond. The aims of each project are often very different, yet they all address the important question of how and where the practices of Making and a do-it-yourself (DIY) mentality are influencing social evolution,' (Barba, 2015, p. 638). Thus, the intention of the project is not only the project result itself but the social change that may be initiated by and with the project, as well as the project result. Due to non-stringent planning in the sense of project management, each can contribute his or her bit at any time. The participation of the individual achieves besides social commitment and over the positive report, the confidence in other areas of life, social realm, and the social network.

(ii) Support: After looking again at the detail transcripts (TD) of my interviews with the lens 'support', I have to ask myself to what extent, the question 'what is your project?', and the potential meaning of this question is different. The interviewees always say 'what is your project?' However, what if the meaning is, 'how can I support you? How can I help you?' - Then the interpretations in the direction of learning, sharing and working together and the will for contribution are much more obvious. 'What do you want to make? They organised the space and used the teacher as a resource to find the materials and information they needed,' (Dougherty, 2012, p. 13). This citation is from a study of how children interact in a constructed Making environment and how the teachers invite the children to their 'project'. It also expresses that the teachers are acting as supporters and not in the traditional teacher's role in stressing a power distance. It also puts the children in another position to engage with their project. 'The Maker Movement has come about in part because of people's need to engage passionately with objects in ways that make them more than just consumers,'

(Dougherty, 2012, p. 12). Moreover, this is right twofold, not only for children, and not only for an educational Making setting. The Maker community acts in common as a supporter and the additional source for project ideas. So in the German Maker community, the question could have the significance of ‘what a joint project could look like?’ - ‘Making is not about DIY, but rather all about DIT, or Do-It-Together,’ (Lang, 2013, p. 10). Moreover, to add one more technological note to the theme of support; the opportunity to start your digital production with 3D-printers is valid. It is also in the private sector possible to quickly set-up own product ideas and create and make first products, certainly with previous knowledge of design, know-how in Computer-Aided-Design (CAD) software and the materials to build. ‘As digital fabrication increasingly enters the public consciousness, makerspaces are dramatically lowering barriers to entry, enabling anyone to create their solutions to problems or even bring products to market,’ (N. Taylor, Hurley, & Connolly, 2016, p. 1). It should be noted, however, that the 3D-printer will certainly not replace today's mass production, but the question naturally arises to what extent, especially in western regions with saturated markets, the mass markets will be partially replaced by more individual and open solutions that will be preferred by customers that perhaps had already become producing Makers.

(iii) Contribution: There are also some statements by other authors who have investigated the Maker Movement about their motivation to ‘contribute’. Here the group of observations I made and stated as kinds of contribution and kinds of social and economic merits concludes (see Figure 33. Multiple-Case Dimensions of ‘Contribution’ and Figure 34. Multiple-Case Dimensions of ‘Kind of Merit’). A 2010 quantitative study by the authors Stacey Kuznetsov and Eric Paulos show that fun and inspiration, new ideas for future projects, learning new concepts, a sense of belonging and shared interests are the leading motivators.

> ‘Motivations for Contributing to DIY Communities; above all else, our participants contribute to DIY communities to get ‘inspiration and new ideas for future projects’ (81% strongly agree, 16% agree) and to ‘learn new concepts’ (68% strongly agree, 29% agree). […] A large

> portion of free responses emphasises fun as a motivation: ‘have fun!’ or ‘it is fun!’ Other comments revolve around learning, for instance: ‘to learn new techniques’, and community bonds: to ‘socialise’ or ‘to feel connected to other like-minded people’. The majority of participants are not driven by ‘finding employment’ or ‘improving’,’ (Kuznetsov & Paulos, 2010, p. 299).

My findings of social merits were fun, help, reputation, passionate, and honorary capacity. Also, therefore, further evidence could be found; ‘whether it is arts and science or crafts and engineering, they seem to belong together, connected by the enthusiasm and a common passion,’ (Dougherty, 2012, p. 12).

(iv) New Insight: However, there is another aspect to this question, why do they call it a project? The project is a very organisational notion, nowadays closely linked to scheduling, resource planning, jour fixes, risk management, budgeting and so on. However, I have not yet seen this type of project planning, as is usually conducted in project management and a company environment. Of course, there are weekly meetings in the Makerspaces, and there is also an agenda for weekly courses and topics, but I did not notice plans in this organizational sense of project management. I do not want to derive anything from additional observations I made with the use of Github as a software configuration management tool, supporting the collaboration for software development and that is also used within the German Maker community. Moreover, I do not want to relate too much of my experience in agile software development here either. Just this much, the kind of planning the realisation of projects in the German Maker community is different, it feels completely different compared to any organisational setting. Maybe the notion of the project is to express a kind of importance? Thus born out of the tension in the field between being hobbyist or professional. Most makers develop into mastery and do not give up their diversity, a point that usually does not go hand in hand with specialisation in companies. ‘Of course, great ideas may be brewing inside a company as well, so companies should engage with their employees in ways that get to the heart of what they are passionate about and what they are working on outside the confines of the

company walls,' (Dougherty, 2012, p. 13). Moreover, this was also one of my first observations when visiting Makerspaces, most of the people leave their professional life outside the door and do not talk much about it, as sometimes it is very boring to them, especially organisational issues like being part of a hierarchy. In the UK in one of the Hackspace, I visited there was a Golden rule: 'No talk about jobs and politics!'

However, from my point of view, the companies can learn from the maker community, the discussion hobby or profession is borrowed initially from the DIY scene. Today, some DIY YouTube videos created by individuals are even more helpful and vivid than some outdated paper manuals that could be found in every company. About the negative stimuli, which I had excluded from my further investigation, there are indeed still some insights waiting here, why, e.g. enthusiasm of persons in companies can be destroyed so quickly or leads to their fluctuation after the invention had been made. So it is not only about a skill set to be administered, but also to be fostered and nurtured, to show its full potential. 'Suddenly, making is relevant for more than just the tinkerers and hobbyists who do it for fun. It is a new skill set that can help employees advance in larger organisations,' (Lang, 2013, p. 14). So the question in larger companies should more often, what is your project instead this is your project!

AT01 - What's Your Project?	**Contributions from Research**	**Category (A/B/C/D/)**
(i) Intention	Initiative and Intentionally Personal Authorship Pretend to be Makers Creating Something New Learning New Skills Lives Enriched Notion Gap between Maker, Inventor and Entrepreneur Influencing Social Evolution Social Change	A

(ii) Support	Space and Teacher as Resource	
	Engage Passionately	
	DIY & Do-It-Together (DIT)	
	Lowering Barriers to Entry	
	Enabling to Create Solutions to Problems	
	Bring Product to Markets	
	Contribute to Get Inspiration	
	New Ideas for Future Projects	
(iii) Contribution	Learn New Concepts	
	Fun as a Motivation	
	Learn New Techniques	
	Feel Connected	
	Connected by Enthusiasm and a	
	Common Passion	
	Companies to Engage with Employees	
	Get to the Heart	
(iv) New Insight	Working on Outside the company Walls	
	No talk about Jobs and Politics	
	New Skill Set that Advance Employees	

Figure 49. Categorised Additional Theme AT01 - What's Your Project?

Concluding about this additional theme AT01 What's your project? - There are similarities in the international research findings of the Maker Movement like the importance of the personal authorship and that Maker needs to engage passionately with objects. It is also shown in the international research findings that the aspects of Do-It-Together, to socialise and to feel connected by the enthusiasm and a shared passion are significant. Makers want to get further inspiration from others and see fun as motivation. Maker is distinct from inside and outside company walls which may hinder companies to adapt Making as a new skill set for employees easily. There are similarities about the characteristics of intention, support and contribution in the Maker Movement globally, but there is no evidence from the international research findings that the question 'What's your

project?' is a vigorous habit in other Maker communities as well, therefore I would argue that it is potential distinct (A) for the German Maker community.

AT01	**A**

AT02 Fire Pitch Approach versus the Sales Corner

The Fire Pitch Approach deals with the behaviour of how German Makers communicate. Based on my data it is noticeable that the power-distance is little too not at all present beside the ordinance described in AT01. The personal discussion is highly appreciated, and the enthusiasm for the idea and the contribution of further ideas is willingly rewarded. Being a little crazy in German 'rumspinnen', without having a concrete goal in mind, is part of this behaviour, it is not only tolerated, but it is also appreciated. With attentiveness, it goes a little beyond our concept of playing, which means playing from an adult's point of view, playing from a child's point of view or playing from a teacher's point of view. The question arises, which contents and values are being transmitted through this playing or 'rumspinnen', more about this in AT02 The Fire Pitch Approach versus the Sales Corner. Therefore, the Fire Pitch approach is first about how do people in the German Maker community interact. Like the location which besides the behaviour of the people, also plays a significant role I have extended my observations by using a large extent of the pictorial artefacts documented in Appendix III Extract of Images in Fieldnotes. That is, where do makers meet? Often the picture of the nerd retreating behind his computer at home or in the computer cafe is considered, that I could barely observe. German Makers are socially committed people, and here the notion of milieu and community also apply. This also raises the question of how this social commitment is created and fostered, why everyone has a favourite place to return.

In the following, these three aspects of where do Maker meet, how Maker communicate, and how social commitment is created are evaluated by referring to international research contributions. The outcome of this

evaluation between the German Maker community and the Maker Movement is whether there are coincidences, similarities or deviations, or whether there is no such thing at all. The Fire Pitch Approach is, on the one hand, (i) the design and the intended use of the locations and on the other hand the (ii) way people interact and communicate with each other, and its significant role to an (iii) social commitment.

(i) Design and Intended Use of Location: ‘Makerspaces - also referred to variously as hackerspaces and Fab Labs - are one of the most visible manifestations of an emergent maker culture,’ (N. Taylor et al., 2016, p. 1), and the Makerspaces may become synonym for other social spaces, also their intended use vary like ‘the Makerspace supports a range of structured making formats, including long workshops that dive deeply into a particular project or skill; short one-to three-hour workshops introducing maker skills; and open shop time, where members are free to work on whatever they want,’ (Peppler & Bender, 2013, p. 23). However, there is a variety of other activities and locations that Maker meet each other regularly, it may start for most people as a backyard and kitchen activity, but ‘since the first Maker Faire in 2006, making festivals, spaces, activities, conferences, and studies have multiplied around the globe,’ (Bevan et al., 2015, p. 99). Therefore the Maker Faire, as another location to meet, is characterised by Sylvia Lindtner as follows, ‘Maker Faire is a large-scale festival founded and organised by Make Magazine and features hundreds of exhibitors who celebrate the arts, crafts, engineering, technology and science projects with a DIY mindset,’ (S. Lindtner, 2014, p. 153). As a conclusion about the definition of Maker locations there are research findings globally available, about how Maker typically met over time, the notions may vary a little, but the design and the intended use to meet, make and socialise is clearly stated and equal (C) for all of these ‘social spaces’.

(ii) The Way People Interact and Communicate: Historically motivated, references to the international research document that in the western countries three communities are rooted for the initial localisation of the maker communities. On the one hand, the community of radio communication, which is not so often mentioned in the contemporary literature, and on the

other hand the community of hackers, which often mentioned in the forefront of discussion. As a third community, always mentioned is the DIY movement. Depending on the localisation in western and eastern countries, the notion of Makers and Hackers are a synonym or explicitly not. Using the western, US-laden notion ‘Makers at their core are enthusiasts, such as those engaged in the early days of the computer industry in Silicon Valley,’ (Dougherty, 2012, p. 12). However, based on the first two communities mentioned, the focus is on communication and electronics, initially analogue, then increasingly digital electronics and software. The authors Stacey Kuznetsov and Eric Paulos stated that the original roots go back to the year 1920 as ‘One of the earliest modern era DIY communities formed among amateur radio hobbyists. These hobbyists relied on amateur handbooks, which stressed imagination and an open mind nearly as much as the technical aspects of radio communication,’ (Kuznetsov & Paulos, 2010, p. 295). My interpretation is that through this fundamental understanding ‘the desire to communicate’ is an essential part of the Maker community until now. Radio communication is about overcoming physical distances, well, today the smartphone has replaced the Walky Talky, and the Long Term Evolution (LTE) antennas have replaced traditional radio and relay stations, but in the beginning, the possibility of unlimited communication has been democratised. Moreover, to this day, these radio enthusiasts are still among the makers in Germany, the clubs that deal with radio communication can be found at all Maker Faires in the attended places in Germany. This desire to communicate is also expressed by the creation of the makerspaces, which are social spaces for the exchange of knowledge, experiences, and ideas. ‘Many makerspaces have grown out of existing software clubs run by programmers and reflect the demographics of these groups,’ (N. Taylor et al., 2016, p. 1). Nick Tylor addresses demography here, and his quantitative research shows that in some of the social spaces there is a mixing of age groups. My results show a different diffuse picture, the desire to mix with the possibilities of passing on knowledge and experience is present, but the demographics observed convey a different picture for the makerspaces. Perhaps more quantitative research will be required in the German Maker community to collect quantitative data that show the demographics, gender mix and other basic

data for further analysis representatively. Due to the diversification of the German Maker community, caution is certainly required when assigning the data to locations such as Makerspace, Hackspaces, Maker Faires, but also the identified sub-communities such as Waste Art, Cosplay, Steampunk, and others.

In the community of German hackers, the possibilities of technology and its inadequacies are in the foreground of discourses. The vast majority of German hackers, who have no worries about being public, often show what issues or dangers can be associated with new technology. German hackers prove these issues or dangers right away by their actions (hacking) and therefore show how crucial it is to handle these issues even if industries and companies deny. In Germany initial to this proceeding are the Chaos Computer Club founded in Hamburg (1986) and the C-Space in Berlin.

> ‘The origins of the hackerspace movement developed in Europe, where the first Hackerspace C-base opened in 1995. Today, with an estimated 1,100 active spaces in existence worldwide, hackerspaces are a significant global phenomenon. Across the hackerspaces we visited, many people drew inspiration from the earlier hacker movement and its impact on IT culture,’ (Silvia Lindtner, Hertz, & Dourish, 2014, p. 441).

Prominent TV presenters of the WDR programme Computerclub from that time in 1983, for example, Wolfgang Back, are still present at the Maker Faires in Cologne as visitors, and in close conversation with Maker. In general, in Germany, we do not have the situation described by Sylvia Lindtner in eastern China that the notion of hacking or hacker is mainly negatively intoned, has politically banned and was substituted by another notion.

> ‘Chinese term heike 黑客became the widely used term to describe this illegal practice of hacking into a system. Makers working in China were anxious to come up with a term that did not have any immediate associations with heike or hacker. It was during the planning stages of

> the first international maker event, the Beijing Maker Carnival, when China's makers settled on an alternative term: 创客 (chuangke creative professional). Chuangke has the advantage of connoting chuangyi (creativity) and chuangxin (innovation), which are employed in positive terms in political and public discourse, as a way to foster social change and technological innovation,' (Silvia Lindtner et al., 2014, p. 443).

Two Hamburg software developers also initiated the Tor project and initially served other purposes than the access to the Dark Web. Till today the Tor's onion services are used by journalists for their protection; journalists who live and report in countries with restricted reporting laws like China. It is the current discussion about the rights to the protection of personal data, which has just been controversially initiated by the situation of personal data exchange between Facebook and Cambridge Analytica, and which is also closely related to the implementation of the German Data Protection Regulation (GDPR). In the end, the notion of Maker and hacker are relatively close in Germany, with the first focusing on making and innovation and the second on a way of observing and criticising the status quo and future, undesirable developments of technology. Although hacking has a lot to do with information technology, there are doubts about a technology-only view of solving current problems. This is followed by the discussion about the Repair Cafes, here too one sees one as a hacker, and in combination with the proof of planned obsolescence of products by the developer, there is a criticism of the lack of sustainability of products. This is then usually supplemented by the fact that the post-war generations who still knew poverty and necessities from their childhood and do not tolerate such a throw-away mentality are involved in the Repair Cafes. It should also be noted that it is the generation that witnessed the development of analogue media for communication when radio was still noisy, television was not yet colourful, and there was only one television set in the entire neighbourhood.

However, returning to the fireplace approach, the digital media today allow us to communicate worldwide, quickly and almost unlimitedly. 'Makers are,

above all, a connected and collaborative bunch. They meet online and share ideas on forums, blogs, and discussion groups. They give away their designs and collaborate on projects with people all over the world,' (Lang, 2013, p. 9).

Nevertheless, the proximity of collaborative communication at the Maker Faires, Makerspaces and Repair Cafes is noticeable. Through the mixing of age groups and the consideration of DIY subjects such as textiles, art and craft, information technology is only a tool and is only partially central to these two groups. 'Maker Faire is a large-scale festival founded and organised by Make Magazine and features hundreds of exhibitors who celebrate the arts, crafts, engineering, technology and science projects with a DIY mindset,' (S. Lindtner, 2014, p. 153). Thus I also observe that localisation and personal interaction is an essential part of the maker community, which is often not part of the research studied, perhaps only an essential part of the German Maker community.

> 'While the role of makerspaces in innovation and peer learning is widely discussed, we attempt to look at the wider roles that makerspaces play in public life. Through site visits and interviews at makerspaces and similar facilities across the UK, we have identified additional roles that these spaces play: as social spaces, in supporting well-being, by serving the needs of the communities they are located in and by reaching out to excluded groups,' (N. Taylor et al., 2016, p. 1).

As research that leads to similar results are for example the Men's Sheds, which, except for the gender emphasis, offer similar social space as the Repair Cafes in Germany. 'People come together to work together, they are hubs of community, where learn from each other, or socialise. Some of the spaces we visited, such as the Men's Shed, had dedicated communal areas, while others emphasised the value of socialising with others over the machinery itself,' (N. Taylor et al., 2016, p. 4). If you look again at how the makers interact and communicate, it is important to realise that the social settings are highly differentiated, as the authors Jeremy Hunsinger and Andrew Schrock describe, 'these movements have specific histories,

cultures, and traditions,' (Hunsinger & Schrock, 2016, p. 535). However, in this respect we are dealing with a socio-cultural environment that has strongly internalised creativity, making, communicating and dealing with its diversity as something positive. In addition to a social commitment, a concept of values is developing that goes beyond that of an economically shaped society and permits inventions that lead society out of ecological and social issues. However, here too, as Evan Barba puts it, there are critical voices that leave the future and the possible outcome open.

> 'This newfound control is being used to great effect by entrepreneurs, educators, artists, and everyday citizens, but it is less clear whether these new methods of control will result in any long-term reconfiguration of the social and cultural practices of an industrial society or whether they are simply new ways of reproducing existing socio-cultural relations,' (Barba, 2015, p. 639).

In this statement, it is once again the economy and industrial production as an assumed initial situation. However, it is also stated as a quasi-expressed hope to overcome this initial situation even if over an extended period.

(iii) Social Commitment: With the fireplaces approach, I would like to express that social commitment, and the social, physical space is essential and should not be neglected in the discussion about digital media and international networking of knowledge. Even though we speak of digital natives among the younger generations, social space and physical interaction in communication with one another play a role that should not be neglected. Children who haptically glue and solder, build racing cars or learn to morse have a different approach to STEM and the social concerns of communication.

> 'Today's makers enjoy a level of interconnectedness that has helped to build a movement out of what in the past would have been simply a series of micro-communities defined by a particular hobby or activity. Although the movement is largely driven by the Internet, events like Maker Faire allow people to mix with many different groups. People take a little bit from here and a little bit from there, and the resulting

> mash-up leads to some pretty exciting creations. Maker Faire has brought together makers of things who rarely rub shoulders in our everyday world,' (Dougherty, 2012, p. 12).

Therefore, communication serves not only to consume in a one way but also to produce, to communicate with others and other things, is a form of learning together, to make experiences with each other by using all the senses available to us. Moreover, communication, especially digital communication, is not only a marketing instrument that provides another sales corner by creating a thousand touch points daily to prepare individuals for further consume. This plays into the direction of ethical rules in computer science and ethics in general for business and economics.

> 'Serving Local Needs; While the makerspaces were broadly similar equipment and ethos, we were in their struck by the subtle diversity in their activities and goals. […]One of the maker space organisers spoke explicitly about the effort into this: that they put 'We have had to work hard to make this relevant […] there's a utility to what we do, it is useful in some way rather than just proving the concept,' (N. Taylor et al., 2016, p. 5).

As already mentioned in the two previous paragraphs, how vital the collective intention for the better and the communication in social spaces is, a social, local commitment must be achieved. Moreover, this is not created with general, transferred concepts, like MIT's FabLab concept, but the local implementation must serve local needs, which must prove its usefulness and benefits. Moreover, the members have to become socially committed to these places that these places become a social space.

> 'A significant aspect of a maker spaces identity: they are both a community space and space for communities Westhill Men's Shed is part of an international movement that originated in Australia in response to concerns about mental health in older men. Like makerspaces, Men's Sheds provide a communal workspace where members can come together to work on their projects - although the workshops provide traditional wood and metalwork tools rather than

digital equipment. The shed also provides communal areas outside the workshop and like many makerspaces fabrication they have expanded their provision into other areas, such as cookery lessons,' (N. Taylor et al., 2016, p. 2).

Artefact 40. Team Sport - Social Commitment

So it is that the social commitment may only start with a common goal, I use here the parallel to a team sport (see Artefact 40. Team Sport - Social Commitment), where the goal to win is first in the foreground. However, if one then takes a broader view of social commitment, it quickly turns out that if there is a strong social commitment, other areas of life are often involved, such as birthdays, celebrations, other sporting and non-sporting activities. In the next step, therefore, a location is usually needed that is in need of more frequent interaction, an association is founded, perhaps a clubhouse is erected. Makerspaces, if they have been created in this way, are locations based on a strong social commitment, which may fail if one only wants to implement the concept of a makerspace or FabLab. That is why I consider the concept of the fire pitch to be essential for the success of the German

Maker community instead of being just a sales corner for poseurs mentioned earlier.

AT02 - Fire Pitch Approach	Contributions from Research	Category (A/B/C/D/)
(i) Design and the Intended Use of the Location	Maker-, Hackerspaces, FabLabs, Synonym for Social Spaces Structured Making Formats Workshops & Open Shop Time Maker Faire, Festival Celebrate Arts, Crafts,…	B
(ii) Way People Interact and Communicate	Enthusiasts, Engaged Radio Communication Demographics Origin is Hackerspace Creative Professional (Chuangke) DIY Mindset Serving Needs of Communities Learn from Each Other Value of Socialising History, Culture and Tradition Reconfiguration of Social and Cultural Practice (Socio-Cultural Relations)	
(iii) Social Commitment	Level of Interconnectedness Micro-Communities Resulting Mash-Up Serving Local Needs Ethos & Subtle Diversity Make this Relevant Space for Communities Expanded Provision – Cookery Lessons	

Figure 50. Categorised Additional Theme AT02 - Fire Pitch Approach

Concluding about this additional theme AT02 Fire Pitch Approach versus Sales Corner - It must be reaffirmed that the usefulness of the

location is of great importance, the benefits must become apparent to the members and the surrounding participants. This is the case with the makerspaces since they were often started and designed by the members themselves. Communication is immanently essential in these locations; new contacts are in turn found and expanded through such events as the Maker Fair. The background is always the history, and it is very similar in the USA and Germany. To achieve comparability, quantitative research results of the German maker community would undoubtedly be an advantage to compare them with international results. A qualitative characteristic is a tolerance that can be observed well when dealing with the persons involved; openness and cooperation are social values that are held in high esteem and valued. Here one could identify some differences in the international maker communities, for example, if one considers the term is hacking to be significant. The term hacking is not tolerated in China, and the use of the term leads to fears of political persecution in the Chinese maker scene. This is not the case in Germany, where the term hacking has in the meantime been associated with the critical question of technological misdevelopments and the active reference to them by experts from these communities. Recent events by organisations such as the German Chaos Computer Club provide information about such irregularities, such as the annual fair Republica, which recently called for resistance against inappropriate data storage and use for private citizens. Here one aims at the needs of a majority, which in the end equals a kind of collaboration. Communication and collaboration with a tolerated goal in the form of a collective social commitment at the local level and joint success at a regional or even global level, because all citizens participate in their self-understanding. In the Fire Pitch approach, we search together for this course and the common understanding. Interests, as represented in the Sales Corner approach, and by economic principles go wrong. In summary, the authenticity of the maker and the compliance with values, such as the criticism of technology, are playing an important role and thus enabling a movement away from consumerism towards the invention for the better. There are similarities (B) about the design and the intended use of Maker locations, the way Maker communicate and collaborate, and following a collective social commitment in the Maker Movement globally, but there is

evidence from my data analysis and in the international research findings that the regional and local context for the Makers also show a significance for acceptance in the Maker community and further acceptance outside of the Maker community.

AT02 B

AT03 Bottom-up Creativity

About the issue of Bottom-up Creativity, and that developments have to start from the bottom up, there has undoubtedly already been extensively written, out of my observation of the behaviours in the German Maker scene there are four particular points that underline this principle. On the one hand, the curiosity to experience something new, to be surprised, to seek other than the known, culturally grounded knowledge. However, also the desire to pass this on, cultural aspects such as the perception of the other and respect for others are essential. Besides curiosity, it is also the perseverance, the continuous and constant trying out of things and activities. They do not have to be difficult, or even impossible challenges, but it is about the flow of allowing to go, doing other things, but then coming back to the point and repeating the last step or taking the next step. This is where learning comes back in: I am ready to apply what I have learned in the next phase, in a new environment. The third point is volunteering, which is supported by the fourth point, social relations. There is no obligation to help others, but you do it willingly and voluntarily. Because social relationships also play a role here, it is of course also an added value if you get to know new people over the network, for example, a hackspace, over and anew and can access their support and knowledge. The social network extends from family and friends into the maker community; the respect is social merit.

In the following, these four aspects (i) curiosity, (ii) perseverance, (iii) volunteering and (iv) collaborative relationships with international research contributions about Makers will be evaluated, whether there are similarities, deviations or not at all.

(i) Curiosity: Curiosity as a starting point for developing creativity. Curiosity is stimulated by the unexpected and the multitude and variety of projects that can be found within the context of the Maker Movement. 'The types of projects showcased through DIY communities, ranging from robotic gardening tools to three-dimensional art quilts to ladybug cupcakes, embody the members' drive for the unique, the whimsical and the artistic, to enable what one participant described as full expression of your creativity,' (Kuznetsov & Paulos, 2010, p. 302). The authors Stacey Kuznetsov and Eric Paulos ascribe the role of enabling through the diversity of the projects and thus the unfolding of full creativity. The author Dale Dougherty adds here the aspect of the environment and the attempt to control this environment. He also recognises the difference to institutions such as schools, which build up a defined learning environment and are no longer too indomitable and wild as a Maker Faire. 'At Maker Faire, we see innovation in the wild. It has not been domesticated or controlled, you have to look for it, and to turn a corner at any of our Faires is to see something you have not seen before,' (Dougherty, 2012, p. 12). Indirectly, Dale says that these institutions or even these defined learning environments lose some of the possible inspiration. However, it should be said once again that curiosity is the starting point for creativity that develops from the bottom up and that an imposed creativity raises certain difficulties.

(ii) Perseverance: My data and analysis of data indicate the importance of perseverance in the Maker's projects. On the way to the project's success, there are constant problems to be solved, and this makes the ability to cope with problems particularly important. The perseverance in Making and Hacking, or, as Bronwyn Bevan calls it; Tinkering is just as important as the initial engagement through curiosity in the beginning. 'Tinkering is a branch of making that emphasises creative, improvisational problem-solving. […] Problems or challenges are not assigned but are surfaced and pursued by the learner through initial exploratory engagement with the materials, people, practices, and ideas available in the tinkering setting,' (Bevan et al., 2015, p. 99).

It is the achievement of self-imposed goals paired with the ability to solve problems and the perseverance that characterise the Maker. Interestingly, Yuling Sun makes the further differentiation between the starting point when Making and when Hacking, where the former is building on scratch in the first place, with the latter building on top. ‘For instance, the term ‘making’ might be used to promote one’s work to a wider audience, such as schools and governments, while ‘hacking’ often connotes a commitment to produce technology by opening up and building on top of pre-existing devices and artefacts rather than building from scratch,’ (Sun, Ding, Lindtner, Lu, & Gu, 2014, p. 2). However, it can be said that there is insufficient evidence of the personal trait of perseverance in international research about Makers. International research here tends to focus on qualities such as inspiration and internal or external motivation, as I had previously explained in additional theme AT01 What’s your project? - under (i) intention of Makers.

(iii) Volunteering: The own decision to get engaged, to voluntarily initiate the activities, that is a theme, which arises from my data. However, despite the individual decision to engage in joint action, it becomes apparent that joint action for a community purpose is at the forefront of German Maker’s attention. In the international research on Makers, there is almost nothing to be found about this theme of volunteering. The fact that engagement is significant, for example, to establish successful learning processes, is expressed, but in the setting of volunteering work, for example, helping in the Maker Faire organisation, it is not. ‘Engagement has long been identified as a critical analytical dimension of learning in both formal and informal settings,’ (Bevan et al., 2015, p. 106). Of course, economic interests play a role here again, if these are being followed; in volunteering, exemplarily the contribution of time and one's skills and experience are of the utmost concern, other’s might the reputation and merit issues mentioned already.

(iv) Collaborative Relationships: Even if the observations in this theme up to now have tendencies towards the individual again, the socio-cultural role has to be explicitly emphasised once again, thus also forming the connection to the third wave in the field of Human Creativity and Invention. ‘However, in the last 20 years, scholars of innovation have discovered that innovation is

rarely a solitary individual creation. Instead, creativity is deeply social; the most important creative insights typically emerge from collaborative teams and creative circles,' (R. Keith Sawyer, 2006, p. 42). The collaborative relationships in the Maker Movement like collaboration and sharing, the democratisation of tools, the learning and the enabling of others are apparent threads found in the international research about the Makers and the Maker Movement.

AT03 – Bottom-up Creativity	Contributions from Research	Category (A/B/C/D/)
(i) Curiosity	Projects Showcased Full Expression of Creativity Innovation in the Wild See Something Not Seen Before Exploratory Engagement	
(ii) Perseverance	Tinkering Improvisational Problem-Solving Challenges are not assigned	B
(iii) Volunteering	Engagement as Critical Dimension Learning in Formal and Informal Setting	
(iv) Collaborative Relationships	Creativity is Deeply Social Collaborative Teams Creative Circles	

Figure 51. Categorised Additional Theme AT03 - Bottom-up Creativity

Concluding about this additional theme AT03 Bottom-up Creativity, it can be assumed that the aspects of perseverance and voluntarism have so far received only limited attention in international research on Makers. It can be supposed, however, that about bottom-up creativity the similarities (B), like curiosity as the initial and the collaborative relationships, between the German Maker Community and the Maker Movement prevail.

AT03	**B**

AT04 Innovation is Output-driven, Invention is Input-driven

Based on the observations and the conclusions drawn from the data analysis, one focus in the German Maker community is the inclusion of children, which may still vary from region to region, but was noticed in the research in Hanover, Dortmund and Friedrichshafen. In Friedrichshafen, the inclusion of extra-school activities also became apparent. In Germany, the maker community thus influences the next generation of STEM affiliates; compared to the USA, this was also intended in the USA, 'getting these makers involved in summer camps and afterschool programs at science museums and community centres are one good way to reach kids, but going where the kids are during the day—at school—is even better,' (Dougherty, 2012, p. 13). However, then developed into a more student activity at the universities. Primarily, international research in the USA and China about Makers focuses on the development of products and the companies that are grown from the grassroots; the developments in the home garage, which then comes to light and immediately becomes a success in the markets. This kind of success stories often become part of international research, especially in China.

> 'By making the authors refer to a series of grassroots initiatives from fablabs and makerspaces over open source hardware prototyping platforms to DIY science. This contemporary practice of technology production, the editors and contributors to the volume argue, can facilitate alternative futures and practices of 'future making' that move beyond market-driven concerns and challenge the pervasive managerial ethos of user-driven innovation,' (Kaiying & Lindtner, 2016, p. 171).

My observations in the German Maker Community are instead of the kind that despite all Kickstarter activities, the way to a product ready for sale is both long and stony. In particular, placing electronic devices on the market, in German 'in den Verkehr bringen' in Germany causes a series of rules and regulations that make it difficult for the maker to bring a product onto the market in compliance with the law. Therefore many makers limit their developments to pre-configured kits instead of ready-to-use devices or

consumer products. Meanwhile, an own market of established service providers for electronics development is evolving, which supports German Makers in the industrialisation and scaling of their product ideas and the further development of prototypes into a legitimated product. Nevertheless, this is very specific for the development of legitimated electronic devices from the German Maker community and in contrast to developments in China or the USA where products only follow a few of rules and regulations, even if they are imported to Germany. ‘Today, Seeed Studio is internationally renowned in maker circles and amongst design professionals, with 98 percent of its revenue stemming from product sales and contracts with clients in the United States and Europe. According to Pan, Seeed Studio might not have survived if it was not for Shenzhen’s shanzhai production,’ (S. Lindtner, 2014, p. 158). Shanzhai production, in a nutshell, is the notion of primarily organised, illegal copycat activities like an imitation of goods and trademark infringing brands and the copying of electronic PCB schema in China.

Going back into the context of the Maker Faires the picture is again very diverse, and the aspect of having fun and being creative comes back to the fore. It is the making and not the result of a product that counts for the German Maker. ‘Makers as Socially Progressive Subjects here, we describe several ways in which maker culture is characterised as a social movement with positive, democratic attributes. The hands-on nature of DIY and crafts is frequently celebrated for having a positive social benefit in addition to its benefits,’ (Roedl et al., 2015, p. 15:11).

In summary, for the German Maker community, the situation is such that a more substantial contribution is made to the progression of the parameters for the next generation of inventors. Ultimately, however, there are restrictions in the transition from the idea to a product in Germany, which may then lead to the conflict with the law, instead of acting in legal grey areas but construing, inflecting or reinterpreting it accordingly. As already mentioned, the notion of hacking is still socially acceptable in Germany; for criminal activities, the notion of cybercriminals is becoming established in Germany. ‘Arguably, hackers can be situated in between a social movement,

with a common history, a collective identity and shared goals, and a multiplicity of users, who lack such defining traits,' (Söderberg & Delfanti, 2015, p. 795).

Even if the topic 'Innovation is Output-driven, Invention is Input-driven' seems to be a well-known one, the effects are to be considered internationally in a very diversified way and in this context only few research currently exists. Therefore I will divide the international research findings to support my arguments into (i) invention-oriented and (ii) innovation-oriented research.

(i) Invention-Oriented: The research that is concerned with invention, of course, takes place in the early stages, and will often be related to the themes of creativity, and formation of relationships. From research, there are a few examples that show a shift in the mindset of investments in the research and development (R&D) activities. In the nineties, a first example is the International Business Machines (IBM) company that failed in their developments of an in-house operating system (OS/2) for desktop and backend systems like Microsoft did with Microsoft Windows and Windows NT. Instead, a revamping their development activities the company decided to follow open source activities. 'Two years later IBM announced a three-year, $1 billion initiative to support the Linux open-source operating system and put more than 700 engineers to work with hundreds of open-source communities to jointly create a range of software products. […] IBM reasoned that the crowd was beating it at the software game, so it would do better to join forces,' (Boudreau & Lakhani, 2013, p. 65). This early investment allowed IBM to establish a new formation of relationships to developers and end-users. In addition, it enabled IBM to innovate from a hardware and service provider into an integrated internet solution vendor with its WebSphere platform. A second example is how Silvia Lindtner argues about the relationship between open, collaborative software development and the engagement with digitalisation.

> 'To draw an analogy with open source software, open source is both a form of collaborative programming and a new institutional form, with

> all its regional, technological, organizational, and political consequences. However, also a community that reshapes the very meaning of innovation. It is a place where people are experimenting with new ideas about the relationships amongst corporations, designers, and consumers. HCI will continue to produce radical visions of the future of human engagement with information technologies,' (Silvia Lindtner et al., 2014, p. 447).

As already mentioned there are tendencies in the Maker Movement to adopt this invention-driven paradigm of open source software to open hardware solutions using creative commons as a foundation for solving intellectual property issues. Secondly, as Silvia Lindtner argues that the Maker Movement will change traditional relationships amongst corporations (as manufacturers), designers (as inventor and innovator), and the consumers; this will then lead into research about Maker Cities.

(ii) Innovation-Oriented: Research on innovation will often deal in the early stages with the selection of inventions, the forming of an organization, the founding, start-up financing and the selection of location and employees, fundamental questions in business management. Then go further with markets, market entry risks, production, pricing and sales. If we start from the innovative capabilities in existing organisations, it will often be about exploration versus exploitation, and the possible structuring within and outside the existing organization, for example, traditional Research and Design (R&D) departments, or today's InnovationLabs, Incubators or fostered Start-ups. The adaption of process and organisation to achieve economic output.

For the additional theme, AT04 Innovation is Output-driven, Invention is Input-driven, current research describes the change of existing economic infrastructures into open systems to generate innovations faster and free. The author Eric von Hippel describes the democratising of innovation that leads to free innovation (von Hippel, 2005, 2011, 2016). However, the industry sees free innovation only from minimising its economic risks and reducing its financial investments into new product development. In this

respect, the notion of innovation still fits here about the economic, output-driven result. From my observations in the German Maker community, however, there could also be a change that questions the existing economic infrastructures, so I agree with Silvia Lindtner's statement that we could be facing a radical transformation initiating another era by information technology. Moreover, that is linked to the fact that we decide to prefer open structures for software and hardware, as the example of IBM has shown previously in the nineties.

AT04 - Innovation is Output-driven, Invention is Input-driven	Contributions from Research	Category (A/B/C/D/)
(i) Invention-Oriented	Summer Camp and Afterschool Programm Good Way to Reach Kids Series of Grassroots Initiatives Practices of Future Making Beyond Market-Driven Concerns Challenge Ethos of User-Driven Innovation Copycat Activities, Imitation Socially Progressive Subjects Reshapes the Meaning of Innovation	B
(ii) Innovation-Oriented	Future of Human Engagement Evolution of Maker Cities Selection of Invention Start-Up Financing/ Crowdsourcing Exploration versus Exploitation Ambidextrous Organisation Achieve Economic Output Free Innovation	

Figure 52. Categorised Additional Theme AT04 - Innovation is Output-Driven, Invention is Input-Driven

Concluding about this additional theme AT04 Innovation is Output-driven, Invention is Input-driven my observations in the German Maker Community are similar (B) to the international research findings, even if the socio-cultural effects to society have to be left as a potential outlook at the Maker Cities (https://makercitybook.com/).

AT04	**B**

AT05 DIY/ DIT in General

Some roots of the Maker Movement are indeed to be found in the earlier Do-It-Yourself (DIY) movement, that is why I have summarised the areas that have been raised by my data about DIY and compared them with findings from international research on DIY and Maker Movement. Based on the observations and analysis of my data three areas had been identified (i) object/ material/ haptic, the (ii) professional circumstances and the (iii) timing or frequency of the meeting at the locations, such as Hackspace, Makerspace, Maker Faire, and Repair Cafe.

(i) Object/ Material/ Haptic: First, research results regarding the consideration of object/material and haptic. The author Jeffrey Bardzell emphasises the particular role of hackers and their sensitivity in dealing with materials. If we look at the artefacts for artwork (see Appendix III Extract of Images in Fieldnotes, III-1 Art and Craft) created in the German Maker community we can underline Jeffrey Bardzell's result, also for that reason that the results are used for communication with others.

> ‘We suspect that the hackers’ habituated ability to see objects simultaneously both as wholes and as deconstructable assemblages of pliable materials supports a creative sensibility for perceiving how to invest the world with meaning both directly with the use of existing tools, and indirectly with the ad hoc (re-) invention of new ones. […] To instil such a creative sensibility, along with the practical skills to act

> on it, appears to be one of the primary purposes of the hackerspace,' (J. Bardzell et al., 2014, p. 476).

The authors David Roedl and Jeffrey Bardzell's also underline the special relationship, particularly about the craft, which already in its German word meaning of 'Handwerk' focuses on creating by hand with materials a good. Important here once again that the Maker identifies himself with his work and derives his identity. This is very much in line with my observations and analyses of how Makers present themselves and their work at Maker Faires. 'Numerous other authors have discussed themes of personalisation, attachment, care, and appreciation for materials about DIY and craft practices. In this way, making is imagined as personally empowering in the sense that it facilitates a deeply satisfying relationship to objects that aid in a cultivation of one's identity,' (Roedl et al., 2015, p. 15:11). Also, other authors like Yuling Sun describe this relationship between the Maker and his materials and objects as 'authentic engagement with making - a making with one's hands that's in touch with the affordances of physical materials, tools and machines,' (Sun et al., 2014, p. 2). It seems irrelevant whether something is newly created, or something existing is modified, whether the function is maintained or changed, even scrap without its original function becomes art and is used for communication. All these observations I also made in many different ways during my visits at the Maker Faires in Germany (compare Appendix III Extract of Images in Fieldnotes).

(ii) Professional Circumstances: On the subject of DIY, craft and making, there are also many approaches to their interrelationships. Other authors report on the variety of objects and numerous projects in the Maker community, and here too there is an evident similarity of my observations with research results for example by Leah Buechley and Daniela Rosner.

> 'People are driven to customise their objects and build things. Passionate makers sew dresses, build furniture, cook meals and write computer programs. People also spend copious amounts of time tinkering with the things they own. They decorate their notebooks, hack their cell phones and fix their cars. Groups often get together to

> share these techniques for building, modifying and embellishing artefacts, and vibrant social communities develop as a result. All of these activities are part of a rich do-it-yourself (DIY) tradition,' (Buechley, Rosner, Paulos, & Williams, 2009, p. 4823).

There are also further descriptions of the culture of making, which are to be found identically in the shape of the German Maker community. The role between hobbyist, craftsman and professional is also discussed, and the author Jeffrey Bardzell emphasises the part as a hobbyist, which should be of particular interest for the other professions, up to the designer.

> 'Coinciding with and supporting these cultures of making are new educational environments, conventions, shared working/hobby spaces, local meetups and events and online knowledge exchange and alliances that support the activities and ongoing learning of these hobbyists,' (J. Bardzell et al., 2014, p. 473).

In particular, this propagation of the hobbyist underlines once again the low entry level into the maker community that is so often propagated, and that is supported by the magazine, like the 'Make magazine. Such publications often helped people to start a hobby and learn new skills. Moreover, they helped the new hobbyist find a community of like-minded tinkerers to talk with about it,' (Dougherty, 2012, p. 11). Here, however, the networking aspect also plays a role and new skills are learned without formal training or documented materials. They help each other, and new insights and results also emerge from communication and collaboration. As an example, the authors Stacey Kuznetsov and Eric Paulos describe developments in electronic music.

> 'Later in the 1980s, low-cost MIDI equipment enabled people without formal training to record electronic music, evolving into the rave culture of the 1990s. During this time, computer hobbyists also formed communities to create, explore and exploit software systems, resulting in the Hacker culture. Today's DIY cultures reflect the anti-consumerism, rebelliousness, and creativity of earlier DIY initiatives,

> supporting the ideology that people can create rather than buy the things they want,' (Kuznetsov & Paulos, 2010, p. 295).

The two authors also address the changing consumer behaviour in the DIY and maker communities. Also here again the rebel behaviour and hacking are mentioned as a counter movement. This is strongly reminiscent of Johann Melchior Beseke's comments on the self-thinker (German: 'Selbstdenker') and inventor at the beginning of the historical approach of this thesis (see 2.1 The Definition of Invention - Historical Approach). Also interesting are Jeffrey Bardzell's remarks, whether Maker or Hacker, I use it here once synonymously, are notions for the determination of skills. Jeffrey Barzell describes a statement by a hacker named Charles, who passes the notion on to a personal trait and making an identity. 'Charles characterises his hacking not regarding skills, but rather regarding his identity: "I would say just my nature of curiosity and wanting to tinker. It is not a skill. It is just a personality trait, I guess. Moreover, I would say that I do not go into a situation already having a skill. I kind of walk away from a project or a situation having learned the skill." His skills do not make him a hacker; his "personality" makes him a hacker, and expertise are a by-product of that,' (J. Bardzell et al., 2014, p. 475). Ultimately, this leads to the last point of professionalism, namely that Makers develop into mastery over time and thus build up professional skills of equal rank. Moreover, this in fields that were previously undocumented, i.e. makers is breaking new territory and developing new ideas in previously unexplored fields.

I would translate this fact into a conclusion like Makers cannot be professional right from the start because of these unexplored fields, and instead, they have to take a new path with their behaviour, habits, techniques and skills that will enable them to become professional.

(iii) The Frequency of the Meetings: In research, there is not only a discussion about how often one visits makerspace but what role it plays as a social space. The discussion is derived from the so-called third place, a notion that is also repeatedly used in the context of Starbuck's cafes. In short, this is the space between the workplace and the housing. Whereby

this third space is to be regarded as intermediate, a kind of living room with old and new people we know.

> ‘Some scholars have already argued that makerspaces be effective effectively third places. The notion of third places - social spaces separate from the home and workplace that play a critical role in public life - has been a popular one in HCI. […] Third places were […] places where one can find both regulars and friends old and new, places that never became overly serious,’ (N. Taylor et al., 2016, p. 9).

In this segment, in addition to the makerspaces and hackspaces described in this discourse from Nick Taylor in Germany, so-called co-working spaces are developing with two main intentions: to create a social space for self-employed and freelancers, where they have access to more advanced resources and, secondly, to create opportunities for the free exchange of ideas.

AT05 - DIY/ DIT in General	**Contributions from Research**	**Category (A/B/C/D/)**
(i) Object/ Material/ Haptic	Ability to See Objects Simultaneously Creative Sensibility for Perceiving Ad Hoc (Re-) Invention Care and Appreciation for Materials Satisfying Relationship to Objects Cultivation of One’s Identity Authentic Engagement	
(ii) Professional Circumstances	Passionate Makers DIY Tradition New Educational Environments Ongoing Learning of Hobbyists Without formal Training Create, Explore and Exploit Systems Computer Hobbyists End in Hacker Culture Hacking is not Skill but Personality Trait Expertise as By-Product	C

(iii) The Frequency of the Meeting	Profession, Craft Effective Effectively Third Spaces Critical Role in Public Life Find Regulars and Friends Old and New	

Figure 53. Categorised Additional Theme AT05 - DIY/ DIT in General

Concluding about this additional theme AT05 DIY/ DIT in General, there are probably the most significant similarities between what I have found about the German Maker community and the findings of the Maker Movement by other researchers. This may be due to the fact that the DIY movement has been going back long in time, but also with its modifications over time, such as hacking, the evolving of computer clubs, has undergone the same changes in Germany as described in the global research findings. Therefore I would describe the interrelationship between the German Maker community and the Maker Movement as equal (C) for DIY in general.

AT05	**C**

AT06 The Zero Approach

The Zero Approach is about the observations and insights regarding the circumference with the money of the makers; different aspects have to be considered. On the one hand, what the makers use their money for, e.g. the investment view, on the other hand, which tools do they use, where do they come from, are these tools in their inventory, have these tools been borrowed or purchased, and thirdly where does the money as income come. Moreover, this money primarily serves to cover costs, or to support the existence, or to finance fully.

In the following, these three aspects of (i) investment, (ii) tools and (iii) revenue are evaluated through international research contributions, whether there is agreement, similarity or deviation, or whether one does not exist at all.

(i) Investment: Other references also talk about the low costs of Maker projects, and here too the emphasis is on the fact that the entry barrier should be low. ‘Low Barrier to Entry; With the majority of DIY projects costing less than $50, a low financial threshold enables people to work with a range of materials across different project domains,’ (Kuznetsov & Paulos, 2010, p. 301). My observation coincides with that of entry, but you also have to observe that the Maker community is being discovered as a market with potential, promising customers who are purchasing a 3D-printer for over 2000 EUR for their homes. Here, however, the intention of such an acquisition is also questioned by the author Evan Barba. ‘A Maktivist is a maker who is authentic - not a poseur or someone just following a trend or doing it for money, to get tenure, or to be popular,’ (Barba, 2015, p. 641). Ultimately, the intention and motivation of the Makers are also reflected in the idea of sustainability, and thus in their consumer behaviour. A transformation of the mindset of a consumer-oriented and consumer-driven society is happening in which the industrial revolution has brought prosperity on the one hand, but on the other hand, has also uncovered ecological and social dysfunctions. The trend towards DIY, therefore, leads back from an economically and service-driven society with strong dependencies towards new forms of society, and in this case, the Maker community is the nucleus to inquire about this change.

> ‘Modern societies oppose the principle of self-reliance with mass-production and consumer economy. Tangible things can be bought. Professionals can be hired to build and repair. Artists can be employed to decorate or customise. Nevertheless, people all over the world continue to create and modify objects with their own hands, ranging from knitting to gadgets, music, and software,’ (Kuznetsov & Paulos, 2010, p. 295).

Thus the expression ‘Beyond Make or Buy,’ (Boudreau & Lakhani, 2013, p. 62) from the authors Kevin Boudreau and Karim Lakhani has a special meaning; industrially, economically it concerns as a purchase decision in business. In the Maker community, it expresses the choice that has already been made: to make it by yourself, together with other - DIY and DIT.

In combination with the Zero Approach, however, there is growing doubt as to whether the services that are to be paid for in monetary terms are worth the money. Whether outsourcing services, such as cooking, shopping, truly lead to added value in life. Alternatively, perhaps, especially about this insight to stimulate creativity, it does not make a significant contribution to preparing cooperative meals or enjoying the time at a weekly market with all its real impressions. The artefacts of all Maker Faires show how parents and children enjoy tinkering and spending time together (see https://www.facebook.com/makerfairevienna/). In the Maker community, the rediscovery of community and communal experiences are significant and that are not monetary or comparable to a ready-made experience in an amusement park. In summary, the investment is not as crucial as in business and even more for the German Maker community to avoid investments.

> ‘Making also can’t be divorced from broader techno-capitalist processes such as the utilization of (free) user participation and open innovation as business model, e.g., companies that remained open source long enough to build up a robust product and user base and then switched to a proprietary model, e.g., MakerBot and 3DRobotics,’ (Silvia Lindtner et al., 2016, p. 1392).

As a result of this the author Silvia Lindtner leads indirectly via to the next point of the tools in the Zero Approach. Usually, the tools in the Makerspaces and Hackspaces were built and improved in the Maker groups themselves, but there are newer trends to buy finished, often high-priced, ready-to-use machines for serviced Fablabs or private use. I had already quoted Evan Barba's comment about the ‘poseurs’, and I have heard similar statements from German Makers regarding the intention of making in a sense to democratise tools versus consumerism. In this respect, it is always a free offer from the Maker community that other people participate in discovering something new and making better inventions collaboratively. ‘The principles embodied by DIY communities - low barrier to entry, learning, open sharing and creativity - can benefit a variety of other corporate, academic and nonprofit collaborative environments. These values drive the exchange of ideas that lead to discoveries and innovations,’ (Kuznetsov & Paulos, 2010,

p. 302). The more far-reaching discussion about the tools and economic interests involved in their exploitation is exciting, as company interests have undermined these values. This ultimately addresses the third issue of revenue.

(ii) Tools: First, I would like to go deeper into the discussion about the tools and the 3D-printer serves as an example of economic interest. The original project was the RepRap 3D-printer, a 3D-printer that replicates itself, e.g. can print itself. This objective has been achieved in no small extent; even today, prefabricated kits still contain printed connection parts for building up your 3D-printer. These complete 3D-printer kits are offered at a price between 200 EUR and 300 EUR today. The prices of ready-to-use MakerBot 3D-printers or Ultimaker 3D-printers are definitely over 2000 EUR, whether these ready-to-use 3D-printers are low-cost in price?

> ‘The RepRap project was also open source and benefited from a global community of experimenters building, testing and refining ideas. Over the years, the RepRap went through several iterations. In 2009, some members of the RepRap community founded MakerBot industries, and they achieved much success in bringing low-cost, 3D printing technology into the homes of makers worldwide,’ (Mohomed & Dutta, 2015, p. 42).

However, behind the company, MakerBot is an entirely different dilemma, which is not a secret in the Maker community, but rather an example of the ‘techno-capitalist’ processes mentioned by Silvia Lindtner. Therefore, a Maker has no MakerBot 3D-printer at home.

> ‘MakerBot Industries. In 2012, MakerBot announced that they went closed-source with their new printer models of the Replicator 2. […] Many of their fellow makers and even one of their co-founders heavily critiqued this decision as decidedly moves away from the openness that MakerBot was evangelising in the past,’ (Silvia Lindtner et al., 2014, p. 445).

If the former hidden rules of the Maker community are broken, such as the open use of knowledge and open sharing, and if in addition this resource of Makers is used to initiate open projects in order to close and continue to work closely on them, this is a severe violation of the shared values, and that is the reason why the MakerBot founder no longer has an excellent reputation in the Maker community, and people like the inventor of the Prusa designs (https://www.prusaprinters.org/) has a good reputation. The Prusa 3D-printer designs are the 'low-cost, 3D printing technology that is in the homes of Makers worldwide'! Nevertheless, the founder of MakerBot is the person that connoted Making as the next industrial revolution, 'from the rising number of hackerspaces to an increase in hardware start-ups, maker culture is envisioned as an enabler of the next industrial revolution - a source of unhindered technological innovation, a revamp of broken economies and educational systems,' (Silvia Lindtner, 2015, p. 854). In summary, I believe there will always be two sides to the development of tools, the Makers whom to overcome limits will also improve, redevelop or invent their tools and Makers who will use the tools to become creative and improve, redevelop or invent things. Therefore, there is the group of Maker following the Zero Approach for tool investments and another group of Makers that will afford investments for kits, tools and semi-professional machinery; poseur or not.

(iii) Revenue: The question of profit can be seen in different parts. The first part begins with the intention to make a profit, to cover its costs as a possible source of revenue and perhaps to make a profit. Alternatively, secondly, making is just a hobby, which primarily generates costs, but does not generate any revenue. The third part is the application of the funds, i.e. if a profit is made, it is reinvested with preference, or is it in an amount that it can serve partially or fully for a living. International research focuses primarily on the aspect of making a profit. In the form, the Maker community as an alternative to the company's own research and development department, which reduces costs and potentially also risks for new and early product development and secondly the maker as an entrepreneur. Of course, it is stories like the following that bring a shine into the eyes of the managers:

> ‘Companies clearly can benefit enormously by embracing the Maker Movement. I recently talked to an individual who worked in research and development at a large semiconductor company. He attended a Maker Faire to take pictures and talk to people, then went back to his company and told them that a 14-year-old had exhibited something remarkably similar to the home-automation system they had spent $10 million to develop. The lesson here is that companies need to look outside of themselves and into the maker community as a source of talent and ideas,’ (Dougherty, 2012, p. 13).

The subject is that it is correct. The home automation system currently used in Germany is an open source and does not come from any well-known brand. Also, the number of unsuccessful home automation systems is immense, but since once again, as is usual in sectors, everyone is re-creating his standard. ‘For certain types of problems, crowds can outperform your company. You just need to know when - and how - to use them,’ (Boudreau & Lakhani, 2013, p. 61). However, in some management levels, it is not yet common sense that collaboration in some areas, in particular, leads to better results. But not only that managers have difficulties perceiving these people from the Maker community, not to mention knowing them, but it also cannot be about the use of Makers for free research and development. However, of course, this is in the calculus for profit, which, as I have proved, is not a primarily observable calculus of the German Maker community.

> ‘Managers remain understandably cautious. Pushing problems out to a vast group of strangers seems risky and even unnatural, particularly to organisations but on internal innovation. How, for example, can a company protect its intellectual property? Isn't integrating a crowdsourced solution into corporate operations an administrative nightmare? What about the costs? Moreover, how can you be sure you will get an appropriate solution?’ (Boudreau & Lakhani, 2013, p. 62).

In this respect, it may be good if managers who think in this way ‘free innovation’ remain cautious and stay away from the Maker community.

Ultimately they will have to experience similar consequences as the company MakerBot did. However, the positive example should also be mentioned here: IBM, which as a software company recognised the potential of open source and the open approach very early.

> ‘Crowd Collaborative Communities - In June of 1998 IBM shocked the global software industry by announcing that it intended to abandon its internal development efforts on web server infrastructure and instead join forces with Apache, a nascent online community of webmasters and technologists. The Apache community was aggregating different inputs from its global membership to rapidly deliver a full-featured - and free - product that far outperformed any commercial offering,’ (Boudreau & Lakhani, 2013, p. 65).

The next is to enlighten the entrepreneurial spirit in Makers which means the intention to start making a profit from the hobby and the fun to create their own businesses. In a global context, we are talking here about platforms such as Kickstarter, which serve to bring finance and product ideas together and also to keep the financial risk for investors small. At the last Maker Conference, there was a statement that families and friends donated 70% of the initial expenses for these product ideas. Does this have to do with reputation? Will Kickstarter thus not shift the financial risk from the industrial sector to the private sector? In the end, is not Kickstarter earning its money from the private sector? - I would be as cautious here as Silvia Lindtner describes it, there is access to financial backers, but they are not doing it out of pure courtesy and may be running completely different business models.

> ‘Second, making is linked to global capital, though its flows are social, institutionally, and technologically concentrated in contingent ways. For instance, making as start-up culture has in part proliferated because of new channels such as crowdfunding, which remains predominantly accessible to a fairly elite network of technologists,’ (Silvia Lindtner et al., 2016, p. 1392).

In summary, there are also efforts in Germany to turn makers and their ideas into entrepreneurs, how these efforts will work over time will have to be

observed. Currently, other observations are primarily in the foreground from my data, and these are related to the fact that the intention to achieve profits is not superficial, but rather things like contribution and fun in the sense of a hobby with tinkering and the communal experience are a priority. This sets the German maker community apart from the other observable, internationally reported research results (A).

AT06 – The Zero Approach	Contributions from Research	Category (A/B/C/D/)
(i) Investment	Low Barrier to Entry Project Costing Less 50 USD Society Oppose Self-Reliance on Mass Production and Consumer Economy Techno-Capitalist Process Free User Participation Open Sharing Funding, Crowdfunding	A
(ii) Tools	Open Source Benefit from Global Community Low-Cost 3D Printing Technology Source of Technological Innovation Revamp of broken Economies	
(iii) Revenue	Source of Talent and Ideas Crowds can Outperform Protect Intellectual Property Making as Start-Up Culture Elite Networks of Technologists	

Figure 54. Categorised Additional Theme AT06 - The Zero Approach

Concluding about this additional theme AT06 The Zero Approach, the challenges in this theme are multi-faceted, and there is still a lot to be worked out in the future. The authors Robert Bauer and Thomas Gegenhuber summarise it and describe it as a leitmotif. In addition, it also shows once again the social significance of what is currently unfolding in the Maker community, how ideas at the periphery of society can turn into the centre of

social interest and may replace other values and concepts, e.g. the status of the economy.

> ‘The trend toward working consumers and consuming producers has a particular twist to it: amid the dynamics of changing roles, it preserves a power advantage of producers over consumers that might otherwise erode due to increasingly saturated and fragmented markets. […] We conclude by maintaining that rigorous and relevant research on crowdsourcing requires more of both: pragmatic search for its underlying mechanisms and superior understanding of how to make use of it, as well as critical examination of its social effects and side effects, informed by cui bono as a leitmotif: who benefits - how, when, where, why, and from whom?’, (Bauer & Gegenhuber, 2015, p. 676).

The following additional theme provides an answer to these questions of the leitmotif; the benefits are given directly to the people, socially and financially.

AT06	**A**

AT07 Repair, Sustainability, Environmental Protection

The additional theme Repair, Sustainability, Environmental Protection (AT07) has undoubtedly to be seen in some different perspectives, from my previous observations and the perhaps changing relationship between the Repair Cafes in Germany in combination with the German Maker Community and the construction and expansion of the Makerspaces, Hackspaces, Fablabs. Despite different attitudes, tensions can undoubtedly arise here, as some operate voluntarily, while others are increasingly trying to include financial aspects. The latter will certainly also lead to tensions within the German maker community as to what extent the maker is being taken as a market participant. Based on my data and its analysis, I will limit myself here to the aspect of obsolescence, since it has been addressed in various forms.

In the following, the aspect of designed obsolescence is evaluated by international research contributions, whether there are similarities, deviations or not at all.

The discussion about the companies' desire for profit also follows here; products are designed in such a way that they cannot be opened easily or not at all for maintenance or repair. ‘Companies also use legal mechanisms to prohibit or tightly control the repair of devices. iFixit is attempting to organise opposition to these and other practices in the form of public and political advocacy for the right to repair,’ (Roedl et al., 2015, p. 15:19). The illegal form is, in any case, the built-in or designed obsolescence. Components or assemblies fail shortly after warranty. Often, as my observations about the Repair Cafes show, these failures can be fixed with simple, inexpensive measures if it allowed by the product design. Software and continuous software updates are also used today to urge users to purchase new devices, such as smartphones, sooner or later. Also, these companies hinder the use of these devices when donated to developing countries. ‘Restrictive design measures are also implemented via software. For example, Jackson et al. [2012] observe that mobile phone repair in Namibia is hindered by the fact that most phones do not allow easy access to manipulate or reset foundational software settings,’ (Roedl et al., 2015, p. 15:19). The example from South Africa of course also shows the connection between sustainability and obsolescence that the latter leads to a misuse of natural resources. ‘Alongside the growing interest in DIY culture, some researchers have studied practices of repair and reuse from the perspective of sustainability. A recurring theme of this research is that for people to avoid the wastefulness of obsolescence, significant amounts of skill, creativity, and time are required,’ (Roedl et al., 2015, p. 15:17). This leads me once again to the opinion that people in the Repair Cafes are also hackers, must be. Moreover, that could also be the reason why a lot of active people in the Repair Cafes have a great and sincere interest in the Maker Faires, as they can get information here, especially regarding newer topics, such as software, operating systems, programming. Ultimately, an immense skill set

is combined with the repair of today's products, and this is not about inventions, but instead about the use of creativity and experience.

> ‘These examples illustrate the extent to which makers are faced with the material, economic, and legal barriers that hinder their ability to practice repair and reuse. […] However, we argue that, for the most part, researchers have failed to acknowledge the full severity and complexity of these challenges, and that this failure can be attributed to the discursive limitations described earlier,’ (Roedl et al., 2015, p. 15:20).

AT07 - Repair, Sustainability, Environmental Protection	Contributions from Research	Category (A/B/C/D/)
(i) Obsolescence	Companies Prohibit Repair of Devices Advocacy for the Right to Repair Restrictive Design Measure by Software No Easy Access to Manipulate Avoid Wastefulness of Obsolescence Significant Skill, Creativity and Time Material, Economic, and Legal Barriers Hinder to Repair and Reuse	B

Figure 55. Categorised Additional Theme AT07 - Repair, Sustainability, Environmental Protection

Concluding about this additional theme AT07 Repair, Sustainability, Environmental Protection, the theme of obsolescence in the German maker community is similar (B) to international research, but here too the outcome and social implications have still to be researched as expressed and documented by David Roedl. In any case, it is one of the drivers that disregard the interests of a profit-oriented economy.

AT07	**B**

AT08 DIY-Bio, the underestimated Field

The theme DIY-Bio is an emerging theme for the German Maker community; today only a few projects can be found within the context of the Maker Faires, which may also be because one can only rarely transport one's plantations or experiments in the form without these perhaps coming to harm. In my investigations there was only the particular approach with fungi as packaging material, a further questioning on the latest Maker Conference showed that the area of aquaponics is a subject in Germany as well, and PCR thermocyclers are currently not an issue. One also has to consider to what extent the sowing and cultivation of old vegetables and fruit varieties are not a DIY-Bio topic in Germany, just as one classifies the home brewing of beer? Alternatively, generally the installation of a pond in the garden to create a wet biotope? All topics which are already present in Germany. Moreover, this has to be said, in very few cases would be considered to belong to the German Maker community. In the following, the aspect DIY-Bio will be evaluated by international research contributions, whether there are similarities, deviations or not at all.

Based on the research of Johan Söderberg and Alessandro Delfanti, the field of DIY biology is a relatively new field of activity for makers and hackers in their countries as well. ‘The association of hacking with computer software is gradually changing, as new walks of life are being explored with a hacker mindset. […] has facilitated the spread of hacker practices to new fields of engagement, such as […] do-it-yourself (DIY) biology,’ (Söderberg & Delfanti, 2015, p. 793). It is also a field that has quickly caught the attention and interest of national institutions in the USA and created a strategic partnership. ‘This led the Federal Bureau of Investigation (FBI) to include DIY bio members as part of its Outreach Program for biosecurity,’ (Söderberg & Delfanti, 2015, p. 796). Other DIY-Bio research goes in the direction of better use of limited resources or environmental protection. An example, which probably also comes in Germany, is Aquaponic, even though I could not observe it at the visited Maker Faires or in included workshops. I only heard it in the last Maker Conference this year by one participant. ‘Aquaponic planting. What made aquaponic planting […] interesting […] is that the water

stayed in the system to be reused, whereas the plants receive nutrition from the fish in the water and turn to clean the water from the fish's excrement,' (Silvia Lindtner, 2015, p. 855). Of interest are also Silvia Lindtner's further remarks, which she researched in China, about the circumstance that in some Chinese cities the air pollution and other environmental damages are hazardous for humans.

> 'Our conversation then moved to the topic of reuse and e-waste. Many hackerspaces promoted principles of resourcefulness, reuse, and peer production. They shared the belief that the rise of open source hardware constituted an opportune moment to proliferate civic engagement in matters of public concern such as preserving the environment, sustainability, pollution, health, and so on,' (Silvia Lindtner, 2015, p. 856).

The Maker Movement in China may reflect what is necessary under the aspect mentioned in the additional theme Repair, Sustainability, Environmental Protection (AT07) for the Germany Maker community.

AT08 - DIY-Bio, the Underestimated Field	**Contributions from Research**	**Category (A/B/C/D/)**
-	New Field of Activity, Engagement Biology Explored with Hacker Mindset Better Use of Limited Resources Environmental Protection Reuse and E-Waste	D

Figure 56. Categorised Additional Theme AT08 - DIY-Bio, the Underestimated Field

Concluding about this additional theme AT08 DIY-Bio, the underestimated field, if I focus on the specific theme of DIY-Bio, then it is not present (D) at the German Maker community and an underestimated field.

AT08	**D**

AT09 Making and the Centre of Educational Gravity

This theme is based on the observations within the German maker community and is indeed dependent on the adopted research design; it was already noticeable that theme B. The Individual – Personal Traits has come to the fore as a result of the first analysis. In combination with the SMoC approach and the characteristics of the Stimuli of Invention (see chapter 4.2.1 Contextualise the Data to IFD Relations (Preconception V)), explicitly SI02 Stimuli to Enable and SI07 Stimuli to Change Environment, the weight of the Individual had again been shown. In general, however, it can be said that the social, educational influences of the German maker community not only affect the community itself, but also other communities through the streams of visitors to Maker Faires; certainly always with a more STEM-related background, but not only. The age structure of the visitors, from toddlers to adolescents and ambitious adults, and who usually also participate as a family, results in exciting, observable situations, which were also portrayed in the interviews with the makers. As mentioned above, a changed research design extended to families and family members could certainly provide even deeper insight here.

However, first, the aspects supported by the available data and their analysis. The following aspects I analysed (i) initiate and change, (ii) sharing skills and experiences, and (iii) education and play. In the following, these four aspects will now be evaluated by international research contributions, whether there are matches, similarities or deviations, or whether they do not exist at all.

(i) Initiate and Change: Making changes the learning process; on the one hand, it places the initial commitment in the hands of the learner, without the learner perceiving it at the same time. ‘The learner must negotiate between her ideas and goals, her self-imposed aesthetic concerns, the available materials, and the physical phenomena and constraints at the heart of the activity,’ (Bevan et al., 2015, p. 100). Some also ask, ‘it looks like fun, but what are they learning? Indeed, the need to articulate learning outcomes has been felt keenly by practitioners seeking support to continue and expand the Maker Movement in educational contexts,’ (Bevan et al., 2015, p. 100). In

general, the senses are addressed more strongly during the making, curiosity is aroused and the desire to discover and experience something new. In our virtual world, we forget the experience with all our senses and the tangible result at the end, unlike with media like television. ‘The idea is to fundamentally transform educational practice to support the embodied learning that has been underrecognized and underutilised,’ (Barba, 2015, p. 648). So there is a change in the learning environment, and this is done by helping teachers to make things real. This varies from region to region in Germany, but in the end, every Maker Faire has a number of schools or universities, or it turns out that a teacher exhibits privately with his children at the Maker Faire.

> ‘There are a variety of ways to bring this learning strategy and many other positive aspects of the Maker Movement to education, some of which we have started to employ already. Our first wave has been to find teachers who are themselves makers. They understand the relevance and importance of making things and can act on it, and also to connect with their students as mentors,’ (Dougherty, 2012, p. 13).

The extent to which the change goes towards the future generation of entrepreneurs must continue to be observed, but overall the Maker Movement promotes the access of generations to technology in the sense of STEM. ‘Making is promoted as advancing entrepreneurship, developing science, technology, engineering, and mathematics (STEM) workforce, and supporting compelling inquiry-based learning experiences for young people,’ (Bevan et al., 2015, p. 98). That, of course, the buzzwords also attract the media and politics is inescapable. The question is, who or what is changing here. It should be noted, however, that the Maker Movement with its Maker Faires with in some cases significantly more than 10,000 visitors has an impact on German society. Time will tell whether the other promises can be kept. ‘The promises of better integration of society, the economy, technology, and science are roped into a powerful vision of change, drawing media attention, political and corporate interest, and investment,’ (Silvia Lindtner, 2015, p. 857). However, one thing can already be noted: fundamental

changes are already taking place for the Individual and their surroundings, such as the family or friends.

(ii) Sharing Skills and Experiences: As a child, a mistake is admitted, maybe there are statements like, you could have known that after all. Alternatively, you might have guessed that. Both questions have to do with both experience and creativity. However, one could have shared both in advance, and that is probably where the strength of do-it-together lies. 'Creativity serves as a prerequisite for sharing, with nearly a quarter of the community refusing to share their work because it is self-perceived as uninteresting, not novel, or too simple,' (Kuznetsov & Paulos, 2010, p. 302). Gaining experience together and sharing skills by not passing them in the meaning of paying for them. What is, of course, common in the business of consultants and trainers in parts of educational systems. However, the commercial benefit is not in the foreground, as is repeatedly emphasised.

> 'Maker culture describes a worldwide movement […] underpinned by an ethos of openness and skill sharing rather than a commercial benefit. There is a belief that individuals with the right skills can produce solutions that are better and cheaper than mass produced products - or at the very least, they can learn something and have fun while trying to do so,' (N. Taylor et al., 2016, p. 2).

Having fun is one of the motivators, and at least you also learn from making mistakes.

The Arduino is a small microprocessor developed at an Italian university. It was supposed to be easy to handle and give artists the possibility to enable simple operations in their installations. Due to its simplicity and the possibility to connect real things like motors, lights and sensors, it has become the core component of most maker projects in the maker community, up to the control of 3D printers and laser cutters. It is now slowly being replaced by other systems, such as the Raspberry Pi. 'For Banzi, this is perhaps the most important impact of Arduino: the democratisation of engineering. […] Now, even my mum can program, Banzi says. We have enabled many people to create products themselves,' (Kushner, 2011, p. 6). The simplicity of the

Arduino has enabled many people to regain access to information technology which is a great success. Moreover, the Arduino has brought many people together as a crowd, worldwide and even now the integrated programming environment (IDE) enables easy access to a new microprocessor generation, such as the ESP8266, which enables immediate access to the Internet, and this is vital for own Internet of Things (IoT) application.

> ‘A well-functioning crowd is loose and decentralised. It exposes a problem to widely diverse individuals with varied skills, experience, and perspectives. Moreover, it can operate at a scale that exceeds even that of the biggest and most complex global corporation, bringing in many more individuals to focus on a given challenge,’ (Boudreau & Lakhani, 2013, p. 62).

In the past, information was only accessible to a few, but today this has changed with the Internet, tutorials are available for almost any and everything. Moreover, with their blogs, the makers are also revealing more and more shared information and their experience about the new technologies, what can be done with Arduino, Raspberry Pi, and ESP8266 on the Internet of Things in the future, a given challenge.

(iii) Education and Play: Learning and playing have to do with each other, trying it out, taking it apart, maybe not getting it back together again, all this has to do with learning you will often forget in the company society today. ‘However, those makers in the early days of the computer industry were essentially playing with technology. […] They learned by making things and taking them apart and putting them back together again, and by trying many different things,’ (Dougherty, 2012, p. 12). However, many new ideas started exactly in this way, many achievements of the computer would not be conceivable or affordable without the game industry, for example, the performance of today's graphics cards in computers.

I would also like to mention demography in this context, in the sense that all age groups are represented and, for example, family friendliness is sought in all respects, right down to the prices for food and drink. ‘We have made the

Faires a family-oriented event that features many exhibits by younger makers. We also hold workshops and competitions for people of all ages,' (Dougherty, 2012, p. 11). As access to schools is not always successful, extracurricular activities take place more frequently, as is the case here from England: 'Maker camps, such as Technocamps in Wales. […] Their goal is to get kids interested in digital making as a way to cultivate both STEM and computer science in youth communities,' (Peppler & Bender, 2013, p. 26).

AT09 - Making and the Center of Educational Gravity	**Contributions from Research**	**Category (A/B/C/D/)**
(i) Initiate and Change	Learner Must Negotiate Articulate Learning Outcomes Transform Educational Practice Embodied Learning as Strategy Positive Aspects to Education Inquiry-based Learning Experiences Integration of Society, Economy, Technology, and Science Drawing Media Attention Political and Corporate Interest Investment	C
(ii) Sharing Skills and Experiences	Creativity serves as Prerequisite for Sharing Ethos of Openness and Skill Sharing Individuals produce Solutions Better Democratisation of Engineering Exceeds even Global Corporation	
(iii) Education and Play	Playing with Technology Family-Oriented Event Get Kids Interested in Digital Making Cultivate STEM and Computer Science	

Figure 57. Categorised Additional Theme AT09 – Making and the Centre of Educational Gravity

Concluding about this additional theme AT09 Making and the Centre of Educational Gravity, what can be noted here is that the individual and the family are of immense importance in an international context, as is the STEM field and the parties involved in it. The role of the domain and its institutions are not very clear in this respect. This coincides equally (C) with my observations in the German Maker community.

AT09	**C**

AT10 Making and the Gatekeepers

First, I would like to go back to the function of the gatekeepers in Mihaly Csikszentmihalyi's System Model of Creativity (SMoC), as Stacey Kuznetsov and Eric Paulos describe it, for example, and how they consider the function is implemented in the environment of DIY communities: 'Creative outcomes are validated by a field of experts who recognise and validate the innovation. DIY communities provide this mechanism through open sharing and feedback. The field of experts in DIY communities consists of hobbyists and enthusiasts who critique and learn from others' work,' (Kuznetsov & Paulos, 2010, p. 302). Therefore, the Gatekeeper function is distributed among the community. However, is it so simple, do we not find ourselves in the change to more and more individuality coupled with empowerment, where does this lead us in terms of a social gatekeeper function? Is there not then a risk that self-proclaimed experts will take over? Alternatively, is there a special role of the civic hackers upcoming? - 'Today, we find ourselves in the middle of new hacker culture (or 'maker culture') that both harkens back to this model of technology production as individual empowerment and departs from it in significant ways,' (S. Lindtner, 2014, p. 146). Is the notion of making also becoming somehow more blurry as it is already? 'Claims about the nature and purpose of Making that range from capitalist entrepreneurialism to subversive critique, to artistic self-expression, and democratic participation.

This evolution has inevitably resulted in conflicting aims of different Makers and Making communities,' (Barba, 2015, p. 649). There are further statements about the different roles and how they will position themselves in the future. 'Concurrently, this public forgetting allows hackers to regain their spaces of creativity and action. Maker culture, too, forgets to find a perpetual sense of novelty in their very existence,' (Hunsinger & Schrock, 2016, p. 535).

On the basis of these expressions, I, for my part, have two opposing views, one being the ideology pursued by the founders of the Maker Movement, which is strongly based on common Western history, derived values and comparable political governance systems :

> 'We can outline more strategies for maker-friendly cities and maker-inspired development as they relate to policy and governance. Many cities have economic arms that try to attract new businesses to establish headquarters within their borders but simultaneously have strict, often misinformed zoning restrictions that prohibit potentially valuable maker spaces. Therefore, we need to improve local policymakers' understanding of the actual liability and risk involved in creating these spaces and encourage their growth as potential cradles of innovation and job creation,' (Dougherty, 2012, p. 14).

Following this approach, the Gatekeeper function is within existing systems of governance and politics.

My second, opposite view is expressed by Jeremy Hunsinger and Andrew Schrock:

> 'The Democratization of Hacking and Making to draw attention to the relationships between action, knowledge, and power. Mainly, hacking and making are about how practices of creation and transformation generate knowledge and influence institutions. These acts concentrate and distribute power through publics and counter-publics. The very mutability of hacker and maker relations makes them a challenge to identify and research. Hacking and making collectives

> have proven capable of constituting and reconstituting themselves in physical and virtual spaces. They integrate across infrastructures, collaborative systems, socio-economic divides, and international boundaries,' (Hunsinger & Schrock, 2016, p. 535).

Following the approach sketched by Jeremy Hunsinger and Andrew Schrock, the Gatekeeper function will be perceived by Hacking and Making collectives hidden and difficult to locate, and internationally distributed, supported by virtual spaces. Therefore, it would be of interest on which common history and common values these Hacking and Making collectives would operate.

AT10 - Making and the Gatekeepers	**Contributions from Research**	**Category (A/B/C/D/)**
(Reputation)	-	A

Figure 58. Categorised Additional Theme AT10 – Making and the Gatekeepers

Concluding about this additional theme AT10 Making and the Gatekeepers, due to my knowledge, there is no research based on the System Model of Creativity (SMoC) and the Gatekeeper function in the Maker Movement. Based on my data and analysis the Gatekeeper function is currently embedded in mechanisms of the socially-constructed reputation of people. Reputation is built by two factors as social merit (see Figure 34. Multiple-Case Dimensions of 'Kind of Merit') and the recognition of others. As there is no multiple interpretations possible, I would categorise this additional theme as distinct (A) and specific to the German Maker community until further international research findings are available.

AT10	**A**

6.3 Contribution to International Research about the Maker Movement

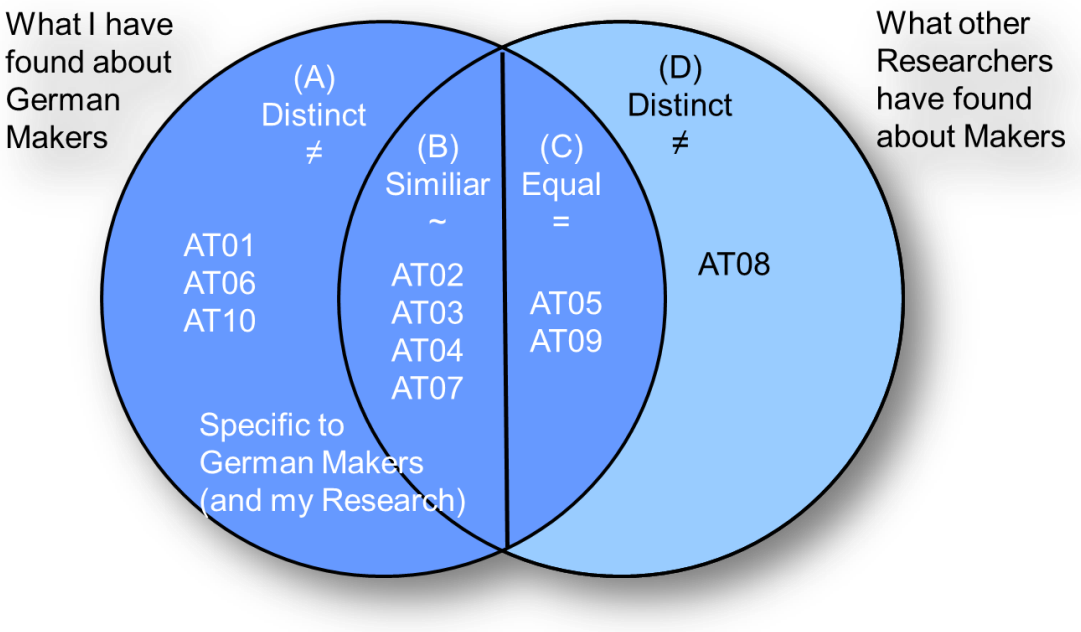


Figure 59. The contribution of Additional Themes (ATx) to my and International Research about the Maker Movement

As the comparison of the results of international research in the Maker Movement and my data and analyses has shown, the additional themes that are equal (C) and similar (B) predominate (see Figure 59. The contribution of Additional Themes (ATx) to my and International Research about the Maker Movement). Concluding that the German Maker community can indeed be considered a subcultural community of the global Maker Movement. Nevertheless, I will stay with the notion of German Maker community until the end of my thesis, because the magnitude and the self-awareness of being a movement in the German Maker community have still to emerge over time. Therefore, I underline with the notion as a German Maker community the communities' consciousness within the global, international Maker Movement. Here one must perhaps also become careful and ask how many at all have a comparison of all regional, national and international characteristics of the maker movement. Perhaps this is the first thesis that has tried to approach the subject-matter.

If we dedicate ourselves now to the additional themes, which are in categories (A) and (D). Starting with (D), it was about the additional theme

DIY-Bio, the underestimated field (AT08), which in Germany in the international formats is not, or only weakly developed. I have already mentioned legal considerations and the general attitude in Germany towards gene experiments. It, therefore, remains to be seen to what extent there will also be a movement here in Germany in the coming years.

Index	Additional Theme (ATx) and Subthemes	Category (A/B/C/D/)
AT01	What's your project? (Intention/ Support/ Contribution/ New Insight)	A
AT02	Fire Pitch Approach versus the Sales Corner (Design and Intended Use of Location/ Way People Interact and Communicate/ Social Commitment)	B
AT03	Bottom-up Creativity (Curiosity/ Perseverance/ Volunteering/ Collaborative Relationships)	B
AT04	Innovation is Output-driven, Invention is Input-driven (Invention-Oriented/ Innovation-Oriented)	B
AT05	DIY/ DIT in General (Object/ Material/ Haptic/ Professional Circumstances/Frequency of the Meetings)	C
AT06	The Zero Approach (Investment/ Tools/ Revenue)	A
AT07	Repair, Sustainability, Environmental Protection (Obsolescence)	B
AT08	DIY-Bio, the underestimated Field	D
AT09	Making and the Center of Educational Gravity (Initiate and Change/ Sharing Skills/ Experience/ Education and Play)	C
AT10	Making and the Gatekeepers (Reputation)	A

Figure 60. Overview and Categorised Additional Themes (ATx)

In the additional themes one (What's Your Project?), six (The Zero Approach) and ten (Making and the Gatekeepers), in addition to visible equal

(C) and similar (B) aspects, there are also aspects that lead me to evaluate them with a clear distinction (A).

The question of ‘What is your project?’ was so present in my research that I am surprised that it has not already attracted the attention of other researchers. In general, I have not found any research results in the Maker Movement about this simple initiation ritual, although there is probably enough socio-cultural research on initiation rites in ethnography. Therefore I regard it, until further international research about the Maker Movement, as a speciality in the German Maker community.

The Zero Approach is unique in the German Maker community in that there is no financial need to adhere to it. I also consider the effects on behaviour about decreed entrepreneurship to be specific in the German Maker community, effects that also became visible in the format of the last Maker Conference at Heidelberg. Formats like the Science Festival in Cheltenham, UK, will be much more targeted to the audience and the attractiveness. Otherwise, we have the dilemma in Germany that the bridging of Makers, Inventors and Entrepreneurs may not work well.

Related to the function of the question ‘What is Your Project?’, further research questions arise regarding the gatekeeper function. In the research of Mihaly Csikszentmihalyi, he located the function within the Field, by his definition of the Field is meant somehow narrowly, with specialisation and thus a filtering function by a specialised group of experts. In the German Maker community as well as in the Maker Movement we have the situation of diversification instead of specialisation of Makers. The question arises on how is the group of experts defined? According to the state of my research, the gatekeeper function exists and is projected to the members and perceived by them. However, I do not consider these results to be the final truth, and I, therefore, see the need for research on gatekeepers in general in the sense of the Systems Model of Creativity (SMoC) and the localisation of the gatekeeper function in diversified Fields. Secondly, in the perspective of modern and digital societies, where gatekeeper functions are installed for protection and safety of family, society and culture.

Artefact 41. Maker Enthusiast at Hannover Faire on World tour

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Looking back, looking ahead from Part II

To summarise part two with data collection and data analysis has now become very elaborate (e.g. data related to Six, new ATx derived, possible further data to be required). In the process of research, in parallel with the actual answering of the two research questions, further fundamental questions have arisen which were further explored or even solved. For example, the relation between Creativity and the Maker community. To put it in a nutshell, what if Makers in their community are no more creative than other people in other communities? In this respect, it was essential to investigate the question of the Stimuli of Invention to conclude that within the German Maker community the creativity of the individuals is firstly high and secondly get more insight what triggers are there.

However, I also examined how vigorously the socio-cultural aspects take influence. In the current result, there is evidence that the individual with his personality traits is critical and their passion for impacting the field continuously. On the other hand, there are the behaviours anchored in the Maker community, such as sharing, learning, and collaborating.

The result from the data analysis, the point, how influential the family situation in the ‘Maker families’ is, is too loosely illuminated to newly potential trigger. The answers and the experiences with my children in the Maker community show me the need for future research with a stronger focus on the ‘Maker families’. This is also one aspect where the concept of social evolution comes into play, empowering and human engagement as recurring, overarching themes; as exemplarily instances the waste art, the Repair Cafes, or the development of alternative health care systems voluntarily.

Again, this leads to the question of merit for both the Maker community and society. What is the driving force behind the passion for contributing again and again?

Looking ahead to part three, there will be questions answered, but also open questions left about the German Maker community and the Maker Movement. However, on the journey of this research, lots of knowledge and insights are created, for me and hopefully for you as a reader as well.

To recap Johann M. Beseke: ‘The torch of this inventor is his knowledge; he carries them wherever knowledge still seems to be wanting. Thus he traverses his sphere of knowledge by the sunshine, or by the torch; and because this sphere often conflates with the sphere of another thinker, it is true that the other thinker is already versed in some parts of the world where the other is still seeking,’ (Beseke, 1784, p. 41).

So even if I draw implications and conclusions in Part three now, please take the initiated discussion and the opportunities for further discourse. There is always considerable latitude for improvement, further insight and enlightenment.

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PART III - Discussion, Implication and Conclusion

7. Discussion on Research Outcomes and Implication

The research aimed to establish Preconceptions of Stimuli of Invention (PSI) based upon the contemporary research in Human Creativity and Invention. It was about exploring opportunities to influence Creativity and to explore the presence or absence of these Stimuli of Invention amongst the German Maker community as a subcultural community of the global Maker Movement. The research questions focused on:

1. What factors stimulate invention within the German Makers Community?
2. In what ways could German Makers improve their skills to invent?

7.1 Research Outcomes

Originating from the inquiries about the subject of creativity to the historical subject area of how invention take place and the further analysis of a community or society that is associated with these subjects, now a multitude of information have been collected about this community and its settings. It was initiated from the literature review generating original themes and a draft preconception (see Figure 10. Preconception II - Including Results of Literature Review), then additional insights from the contemporary research were added that iterated the preconceptions (see Figure 3. Overview Preconceptions from History to Contemporary (I-V)), latest, the own data collection in the German Maker community (see Figure 17. Adding Context and Data for Analysis and Report) and its data analysis leads into prioritisation, prove of the preconception V (see Figure 38. Contextualise Data to the Stimuli of Invention (Preconception V, Schematic)) and additional themes (see Figure 46. Overview and Indexing of Additional Themes (ATx) analysed from Data. The results in the form of the preconception ‘Stimuli of Invention’ (e.g. seven Stimuli of Invention and three extended Stimuli of Invention, see Figure 22. Preconception V - Extended Stimuli of Invention (SI-Schematic)) and the additional themes (e.g. ten ATx) were repeatedly evaluated in the hermeneutic circle and subject to further research through adapted data collection (see Appendix VIII Questionnaire for Semi-Structured Interviews). Further information contributed to (see Figure 59. The contribution of Additional Themes (ATx) to my and International Research

about the Maker Movement) the final picture of the German Maker community and the international Maker Movement, resulting to be impressive. The results of the German Maker community are convincing and provide a coherent picture (see Figure 44. Venn Diagram - Prioritised Themes), interesting also the parallels to the international Maker Movement, as well as the significant distinctions (see Figure 60. Overview and Categorised Additional Themes (ATx)). Even if the Maker Movement is commonly seen as a global movement, particular attention must be drawn to regional and local circumstances. In particular, this localisation leads to acceptance by the community members, communities and society. It is not always, or at least often not, the economic interests that matter, but by which issues are pushed through more quickly and may be resolved more quickly before any institution or political parties may react at all.

7.2 Originality

Concerning the previous research on the Maker Movement, DIY and Craft, the concerns for the personal traits, the behaviour and techniques in the community, and the underlying cultural values, can be proven; it is that the German Maker community broadly presents these behaviours, techniques, and habits. With the concept of Stimuli of Invention, it can also be argued that the accepted behaviours, techniques and skill in the Maker community influence their creativity for the individual and the socio-cultural context. Collaboration and contribution play a significant role and provide substantial support for further research on human creativity and invention. As a distinctive characteristic of the German Maker community is the influence of the family, which can lead to accelerated and early learning in the field of STEM but also in current social matters (e.g. participation in Repair Cafes), coupled with the factor of creativity, opens up a unique potential of a new generation of adolescent inventors who consider not only economic and technological aspects, but in particular up-to-date ecological and social aspects. Thus, the technology for solving all problems steps a little behind the fact that social problems often have to be solved by socio-cultural resolutions.

7.3 Contribution to Knowledge

This thesis provided the following contributions to knowledge.

Firstly, the historically rooted distinction of the notions of invention and innovation was explored based on German history sources from the 18th century and prolonged onto contemporary Research about Creativity. The historical references indicate the importance of the interrelation between society and the individual. Besides the mental processes of the individual, his talent for perception and his behaviours to reflect and document things, his stance towards society and society towards him and his ideas and inventions is inherently linked to the other. On the one hand, there is the skill to acknowledge existing knowledge and, on the other hand, to consistently deny this in order to free the path for creativity, new thought, the new idea or invention. At the same time, reputation, acknowledgement of family, society and culture repeatedly play very different roles, from encouragement to the demarcation (see Figure 5. Preconception I - Invention). The more important the individual's way of coping with these disparities, conflicts and the perseverance of one's personal doing are the more critical characteristics which must be retained. Contemporary research on creativity and invention has resulted in comparable concepts that are more oriented towards individuality or a more social approach. In general, however, contemporary research is becoming more interested in the dynamic, increasingly complex and socio-cultural aspects. In this process, disciplines that were initially focused on the individual, such as the cognitive abilities of the individual, are being transferred to social systems. As a result (see Figure 10. Preconception II - Including Results of Literature Review), we then progress from the apparent matters, such as criticism of technology and personal traits, to criticism of wastefulness and inappropriate design. The outdated protection of the individual by an obsolete patent system is replaced by a socially founded approach of commendation and acknowledgement, reputation. The role of educational institutions is challenged and substituted by social systems and communities in parts of the field, such as STEM. Culture is perceived in its positive role of tradition, as well as in the hindrance of new ideas. All these themes will then dissolve into unison in the image of a

future-oriented knowledge society. The findings of this work in the German Maker Community then came into play here, how cohesive this impression can be both now and in the future, and based on the insights documented, contextualised and prioritised in nine themes (A.-J.; see Figure 43. Prioritised Themes overall Contexts, Figure 44. Venn Diagram - Prioritised Themes) and ten additional themes (ATx; see Figure 46. Overview and Indexing of Additional Themes (ATx) analysed from Data) about Human Creativity and Invention.

Secondly, the preconception Stimuli of Invention (SI) as a theoretical framework was developed based on knowledge about the socio-cultural approach of Human Creativity and Invention, and in specific based on the Systems Model of Creativity (SMoC) from Mihaly Csikszentmihalyi. The transition in research from a Ptolemaic perspective towards a Copernican perspective has just been described in the last section, though the varieties of Models in Creativity research are worth mentioning at this point. The overview of models in creativity research (see Figure 14. Tabor Greene's 42 Models of Creativity (Greene, 2001)) has meanwhile grown to 60 models, new categories were added and are systematically explored, especially in the areas of how groups influence the creative process, and knowledge evolution, the dynamics of ideas and inventions themselves. Therefore, the first step to identify the Models of Creativity and the approaches that focus on the object of study as a society or community is essential. Also, to take the intent for the use of these Models of Creativity one step further. Moreover, question how to actively develop inventors in this society of culture using the Systems Model of Creativity (SMoC; see Figure 12. The Systems Model of Creativity (SMoC)). In order to replace the mechanisms of transmission of information with the Stimuli of Invention (SI) in the origin Systems Model of Creativity (SMoC) model, and to emphasize these Stimuli of Invention (SI), to extend the Stimuli of Invention (SI) by contemporary, multidisciplinary research results (see Figure 23. Preconception V - Extended Stimuli of Invention (SI)) and to contextualise them in the context of the German Maker Community (see Figure 38. Contextualise Data to the Stimuli of Invention (Preconception V, Schematic)). This new idea for the

further development of the Systems Model of Creativity (SMoC) contains the essential contribution to the current knowledge and may overcome the ‘lack of multidisciplinary that had blocked our understanding of creativity (Kaufman & Sternberg, 2010)’. It may also have opened a new path to future creativity research.

Thirdly, the German Maker community as a subcultural community of the global Maker Movement was explored. The application of the preconception Stimuli of Invention (SI) identified seven significant Stimuli of Invention (SI). Also, from this exploration, ten additional themes (ATx) were identified and evaluated against contemporary Research about the Maker Movement. As a result, the historical progression of the German Maker Community needs to be mentioned because this community was not established as a follower of the global Maker Movement in the USA. Certainly, there are similarities like the development of Home Brew Computing in communities. However, initially, the German Maker Community is a community that developed from the early areas of telecommunications and a kind of white hacker scene in Germany. The German Chaos Computer Club, which is officially recognised for its political and social advice to the German government on technological developments, has continuously developed to the present day. In today's communities, the term ‘hack’ is often simply transformed into ‘make’ in the names of the long-lasting associations, and these terms are also to be regarded as synonymous in the community. Sociologically, this community is also undergoing demographic change, but and this is the fascinatingly beautiful one, with a high proportion of young people and children, and a high proportion of families of all ages and gender. If one includes other movements in Germany, such as the Repair Cafes, in the analysis, there is an even wider field of application from sustainability to art (see Figure 28. Overview - Context Sustain). Based on this diversity and this credo of creativity, it was then natural to apply and discover the concept of Stimuli of Invention (SI) and the application of the System Model of Creativity (SMoC) in this context. On the one hand, the significance of the Stimuli of Invention (SI) has been demonstrated. The complex interrelationships with the Systems Model of Creativity (SMoC) with its three systems Domain, Field

and Individual, have been assigned and structured to data gathered (see Figure 37. Contextualise Data to the Stimuli of Invention (Preconception V, Table)). Also, ten additional topics were identified, categorised, evaluated and organised into the global research context of the Maker Movement (see Figure 60. Overview and Categorised Additional Themes (ATx)). It should also be noted that global research had up to now overlooked Germany (see Figure 11. Studies included by the Research of Emma O'Sullivan, compiled from (O'Sullivan, 2016, p. 1)), so this work is the first and most comprehensive social study on the German Maker Community. Four additional themes are to be explicitly mentioned here as well: Firstly, the admission procedure of the German Maker Community and the associated values, contributions and expectations of the community (see Figure 49. Categorised Additional Theme AT01 - What's Your Project?). Secondly, about the use of resources, which is highlighted here as the Zero Approach regarding investment, the procurement of tools and profitability (see Figure 54. Categorised Additional Theme AT06 - The Zero Approach). The third additional theme refers to the construction of gatekeeper functionalities, as they are part of the Systems Model of Creativity (SMoC) concept; in the German Maker Community, in combination with the admission procedure, the gatekeeper functionality seems to be distributed over the diversified fields of participants, and this indeed contributes significantly to the inventiveness of the German Maker Community (see Figure 58. Categorised Additional Theme AT10 – Making and the Gatekeepers). While the three mentioned themes could be regarded as particular findings in the German Maker Community, there is a fourth theme in which the German Maker Community stands out due to its absence. This fourth theme is the subject of DIY-Bio (see Figure 56. Categorised Additional Theme AT08 - DIY-Bio, the Underestimated Field), which is a minor or shadowy theme in Germany compared to other countries.

Finally, this dissertation provides extensive historical and socio-cultural details concerning and surrounding the German Maker Community, as well as references to subject areas and projects, research institutions and

researchers, country-specific and country-unspecific findings based on contemporary global research on the Maker Movement.

As an outlook, the potential enhancement of the conception of Stimuli of Invention (SI) into a taxonomy was drawn for further research.

7.4 Contribution to Practice

This thesis provided contributions to practice. Following the contribution to practice will be firstly defined, secondly, the implications for the individual maker, the Maker Community, will be explained, and thirdly, further potential economic and social impacts will be emphasised.

Firstly, this thesis contributed insight into the German Maker community as a subcultural community of the global Maker Movement. Global, local and regional dimensions of the Maker Movement were covered to identify and evaluate equalities and significant distinctions. The Maker Movement emphasises the global role of the Maker Communities, while in practice the significant role of reputation appears as regional acceptance (see 6.2 Evaluate Additional Themes (ATx)). Thus from the observations of the German Maker Community, it can be concluded that traditions and attained knowledge, manifested in the established sectors of industries, are carried on at the regional level. At the same time, new communication technologies are intensively used by the individual Makers and combined with existing, localised knowledge, such as industry and object design in North Rhine-Westphalia or strong ties to the textile industry in southern Germany. The roles, on the one hand, the communal acceptance and on the second the direct participation of the individual merge at this point, whereby the respective local or regional Maker Community is characterised individually, exemplifying at this point in the Repair Cafes (see Additional Theme AT07 Repair, Sustainability, Environmental Protection, page 284). Through these differences, community and social tendencies become visible more quickly, as the Makers organise themselves and their common economic activities (see Additional Theme AT06 The Zero Approach, page 276), to some extent, or even independent of the existing institutions that determine the context. The institution here is understood as legal constraints with laws

and enforcement mechanisms, as well as informal constraints such as norms of behaviour. This independence enables the Maker Community to implement changes more quickly, both locally and regionally (see Additional Theme AT09 Making and the Centre of Educational Gravity, page 289). Consequently, the long-lasting political parties in Germany are continuously losing their votes and political singled direction, such as the Green Party, which no longer represent just environmental objections, but is also addressing the necessary social transformation in institutions of education, healthcare or geriatric care (see Context Invention – Cases Health Concepts and Devices, page 172). It is here where the German Maker Community will encounter the international Maker Movement, which addresses more global issues such as climate protection objectives and social welfare function (see 6.3 Contribution to International Research about the Maker Movement).

Secondly, the Maker Movement and its subcultural community of German Makers confirmed the significance to accelerate topics of Science, Technology, Engineering and Mathematics (STEM / MINT) in German society. The Makers are enthusiastic and share the enthusiasm around topics of science and technology (see Additional Theme AT01 What's your project?, page 244). Intellectual and technical skills, such as soldering, glueing, tinkering, as well as the necessary calculations in the dimensioning of electronics, or the application of well-known and unfamiliar phenomena of physics and chemistry, are communicated in the participants' group in a simplified way, playfully learnt, willingly continued and shared with others. In this manner, the Makers support their capabilities for innovation as an individual, as well as the capabilities for sparking innovation on a society level (see Additional Theme AT03 Bottom-up Creativity, page 262), - in this way, Makers intuitively support essential concepts that are necessary to build an innovative ecosystem. Essential concepts as environment encourage collaboration (see Additional Theme AT02 Fire Pitch Approach versus the Sales Corner, page 251), fostering connectivity, creativity, diversity and confrontation and finding solutions across different visions and angles. This collaborative and interdisciplinary opportunities combined with fast knowledge accumulation creates a socio-cultural capacity to generate

new ideas, new products, new services and new business models. In the final consequence, the German Maker Community and the global Maker Movement stimulates business dynamism. Also, there is now an insight that Maker habits support and develop creativity and may influence to create adolescence inventors that invent to the better. In the same direction, the habits of the Makers, which are accentuated by the concept of Stimuli of Invention (SI) (see Figure 38. Contextualise Data to the Stimuli of Invention (Preconception V, Schematic)), lead to more conclusions about the business dynamism in practice. The cultural elements within the German Maker Community as encouraging change, risk-taking and new business opportunities will enable the community to re-invent themselves (see Additional Theme AT04 Innovation is Output-driven, Invention is Input-driven, page 266). The habits will generate and adopt new technologies, new ways to organise work and will cause the frequent disruption and redefinitions of businesses and sectors (see Additional Theme AT08 DIY-Bio, the underestimated Field, page 287). Therefore, the Maker Movement and its subcultural community of German Makers significance to accelerate topics may be not even limited to Science, Technology, Engineering and Mathematics (STEM / MINT) but also gains momentum to increase the quantity and quality of education, to develop digital literacy and to foster the abilities to think critically and creatively at a larger, global scale (see Building Themes A. The Technology - Critical Engagement, page 63).

Thirdly, the Systems Model of Creativity (SMoC) as a socio-cultural approach to Human Creativity and Invention confirmed its importance in practice. Mihaly Csikszentmihalyi as an author is better known today for his concept of flow, which in itself focuses very intensely on the individual and mental processes. From my point of view, the Systems Model of Creativity (SMoC) with the interaction of the three systems, domain, individual and field is fundamental, on the one hand as information flows as it was initially designed. However, also in particular about my new conception of which Stimuli of Invention are vital for developing inventors in a system view that consists of institutional education, family and the divergent fields of experts. As shown in numerous research studies it is not easy to identify the inventor

or innovator in the community and society, so it may seem even more challenging to develop a skill set for individuals to become inventors and innovators. Precisely in the application of the Systems Model of Creativity (SMoC), however, this thesis shows clear directions to potential future answers. The Stimuli of Invention are to become an established part of the research of Human Creativity and Invention. Furthermore, the Stimuli of Invention should be institutionalised to become part of educational systems and the curriculum of people to foresee an agile and dynamic private sector's capacity that leads to generate and adopt new technologies, to develop new ways to organise work and to foster a culture that embraces change, allow risk-taking including business risks and the development of new business models. This kind of business dynamism combined with innovation capabilities that are reflected in the behaviour of the German Makers like encouraging collaboration, establishing connectivity, fostering creativity, permitting diversity and the confrontation across different visions and angles will lead to an effective innovation ecosystem. Such kind of an innovation ecosystem will be the foundation of frequent disruptions and redefinition of businesses and sectors, an engine of economic growth and the capacity to turn ideas into inventions and innovations for the better of the socio-cultural system, not only economics.

Finally, this thesis identified that the much-needed issues of better sustainability and environmental protection are addressed by the German Makers, to name the Repair Cafes and initially DIY-Bio, and action is taken by these individuals/ Makers to foster socio-cultural change. The German Makers reflect a tendency towards sustainability in thoughts and actions that are developing in Germany. The foundation for municipal activity develops an impact at the municipal or local community level that focuses on health and well-being, high-quality education, sustainable consumption and production, climate protection and collaboration to achieve the objectives. The German Maker Community, therefore, follows not only social aspects but also economical and, in particular, ecological aspects, less in a co-ordinated agenda but rather in an embodied value framework, which is continuously pursued while also being changed. This transformation requires

further research in the form of longitudinal research projects, but a first step towards describing and documenting the current status in the German Maker Community is represented in this thesis.

In this respect, the Maker Movement, which is currently engaged in developing its cities and urban concepts in the USA, is perhaps also already part of the activities in Germany but is not yet perceived in that entirety. The question is also to what extent this understanding is necessary for Germany since the German past has not only gained experience of the right kind with its ambitious objectives. Nevertheless, Germany has the culture of associations and festivals that enable a lively exchange, and that is reflected in a part of the German Maker Community.

8. Conclusion

8.1 Most Relevant Conclusions

What is left now? What more needs to be added after this journey through the world of history and current research in the field of Human Creativity and Invention, the development of own concepts, which is the stimulus to initiate and progress new developments, up to the observations and in-depth interviews in the German Maker community and the conclusions drawn from them? Moreover, finally the comparison with what has already been researched and what is new?

Though the Maker Movement is a global movement that allows and incorporates many perspectives, the local concerns, which are the meaningful considerations and create acceptance in the society, are critical. Moreover, these local concerns also reflect the different focus, in the USA as the pioneer, people are thinking about the Makercity, more than that, there is a current realisation, as exemplarily in Portland, and further planning for other cities. The political focus in China, to prepare with all the political authority, the technological adaptation to the USA, with special economic zones (SEZ) for further technical development, exemplarily Shenzen, where the focus is on technological progress and the development of a young entrepreneurial structure oriented towards Western values. Moreover, Germany? Where do we stand? A mixture of everything? Historically we

have the same roots as people like Werner von Siemens, Robert Bosch or Carl Lorenz, pioneers of the industrial revolution and initiators of the transition to the era of communication technology. The next step in the information technology era could be people like Heinz Nixdorf, or the four SAP founders Dietmar Hopp, Hasso Plattner, Klaus E. Tschira and Hans-Werner Hector. Culturally we Germans are on our foundations, well, with the best support from France and the United Kingdom of England and a wealth of cultural assets. Perhaps it is this dichotomy between tradition and innovation that allows Germany to focus on the education of the next generation. The development of new skills in the next generation coupled with the experiences of seniors, autonomous from the constraints of a school system that seems to be an essential asset of the German Maker Community. Thus this German Maker Community with its habits, its techniques and its skills holds and develops the human capital for future ideas, inventions and innovations.

8.2 Research Limitations and Areas for Further Research

As a critical reflection of the work, what would I do differently today? - On the one hand, of course, it has now become quite wide-ranging research, which in some areas would have required more knowledge and detailed knowledge from my side. Nevertheless, since there has been no information and insights of the nature of the German Maker community up to now, I am glad to have approached some aspects perhaps inexperienced. The approach of hermeneutics as an approach has been beneficial to me individually, as it has been beneficial to my way of working step by step, always questioning and iteratively acquiring knowledge. Nevertheless, questions remain on the way from time to time, or due to constraints, one must actively accept them to a certain degree. A very important and urgent question for me is the negative Stimuli of Invention (SI), especially in the organisations there seems to be an unknown number of them and if one believes the effect described in Artefact 16. Transcript Details about Stimuli of Redirection, then these have a powerful and direct negative effect on the creativity of individuals or employees. Besides the existence of Stimuli of Invention (SI) as a concept or an instrument to bring together research in the fields of psychology, human

creativity, invention and innovation and sociology, a more comprehensive taxonomy, as David and Arthur Cropley and others try to develop to measure the creativity tendency of an organization (D. Cropley & Cropley, 2012; D. H. Cropley, Cropley, Chiera, & Kaufman, 2013; D. H. Cropley & Kaufman, 2012), would of course be helpful in the long run.

Furthermore, from my present-day knowledge, I consider the role of the family, or family members, in my research to be inadequately investigated. In the sense of the Systems Model of Creativity (SMoC) and the extension in Culture, Society and Family this was indeed an integral part and was observed up to the interviews, but the interviews took place with the Maker himself about it and not his milieu directly, e.g. with parents, siblings. The same applies, for example, to the professional work environment of the Maker, how do colleagues and superiors react to the employee, who is also a Maker in his or her recreational time. In summary, through the Systems Model of Creativity (SMoC) approach I was attuned to socio-cultural concerns, but as a result, the type of Units of Analysis (UA) could have been extended even more towards family members and professional colleagues.

8.3 Closing Note

In the end, I have tried to integrate the international setting as best through the research of others, which, in my opinion, has been a success and, through evaluation, has strengthened my view on my results and those results of others. Nevertheless, it would have been interesting to make further comparisons through own observations internationally. Unfortunately, however, the financial constraints come into play here, since the doctoral thesis was already self-financed and travel and participation in conferences also continually use a particular financial scope. Nevertheless, I will undoubtedly look repeatedly in the future when travelling abroad, whether not also a Maker Faire or a Makerspace is in the proximity to be attended.

Looking back, looking ahead from Part III

To summarise the discussion, implication and conclusion; my mayor thought about this research these days is that I started the journey to find these Stimuli of Invention (SI), maybe as searching the philosopher's stone, but I ended up with some profound insight about learning and education I never thought. The relations and interactions between the three systems as they were described by Mihaly Csikszentmihalyi and the possibility to influence these interactions to accelerate the process of learning and education in early years. As the Maker community is a strong linkage of the fields of arts, design and STEM activities, together with the 'individual', explicitly named young people and their families. This strong linkage accelerates the making of experience and the transfer of knowledge, leaving the domain(s) outside the play, and eventually slowing down this process by losing curiosity getting older. The Maker community offers the play area for young people and young at heard adults to live and produce this ongoing curiosity but what I have to leave open to you as a reader if this stimulates young people and their adults to be inventive and innovative in the long run.

'Ensure that you continue to offer children many opportunities to follow their passions and interests as the interaction with others, use cultural tools and solve problems,' (Smidt, 2009, p. 116).

My next project is to visit the Maker Faire at Hannover, not only as a supporter of the crew but as a Maker together with my children and to experiment what this thesis had to leave open. The project Linus want to show is the experiments with Non-Newtonian liquid, Leonard wants to give introductory information to adults for Minecraft and the use of Teamspeak, and I will support. And hopefully, our project 'Roller 3001' will come to a fruitful end…

So, what's your project?... to invent to the better!

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APPENDIX

Appendix I Literature Review Summary

Overall 903 sources, documented in Endnote

Keyword	Number of Documents
DESIGN THINKING	29
ABDUCTIVE	20
ACTION_RESEARCH	11
CHANGE	17
CORE	13
CREATIVITY	18
CROWDSOURCING	2
CULTURE	17
EDUCATION	6
INNO_LEADER	24
INNOVATION	19
KNOWLEDGE	2
LEARNING	8
HAKERS	49
M0MENT OF CLARITY	3
MOTIVATION	3
OPEN INNOVATION	5
OPEN XXX	1
PERSONALITY	10
SYSTEMS	15
METHODOLOGY CRITICAL REALIST	5
METHODOLOGY OVERVIEW	12
DESIGN THINKING	1
KAI KIRTON	14
TTCT TORRANCE	10
Total	**314**

Figure 61. Qualified Sources for Literature Review by Keywords

Number of qualified documents (Star rating given by me after reading) and the specific KEYWORD search

KEYWORD HACKER and 5 STAR	37
KEYWORD INVENTION and 4 STAR	8
KEYWORD INVENTION and 5 STAR	32
KEYWORD INVENTION less 4 STARS	42
KEYWORD MAKER and 4 STAR	0
KEYWORD MAKER and 5 STAR	41
KEYWORD MAKER CLEAR TITEL	38
Total	**198**

Qualified Sources of Literature by Publishing Date

Publishing Date	Number of Sources
2017	9
2016	14
2015	26
2014	19
2013	15
2012	14
2011	18
(2011 - 2017)	(115)
2000 - 2010	55
1980 - 1999	13
1950 - 1979	10
1784	1
Gesamtergebnis	**194**

Figure 62. Qualified Sources for Literature Review by Publishing Date

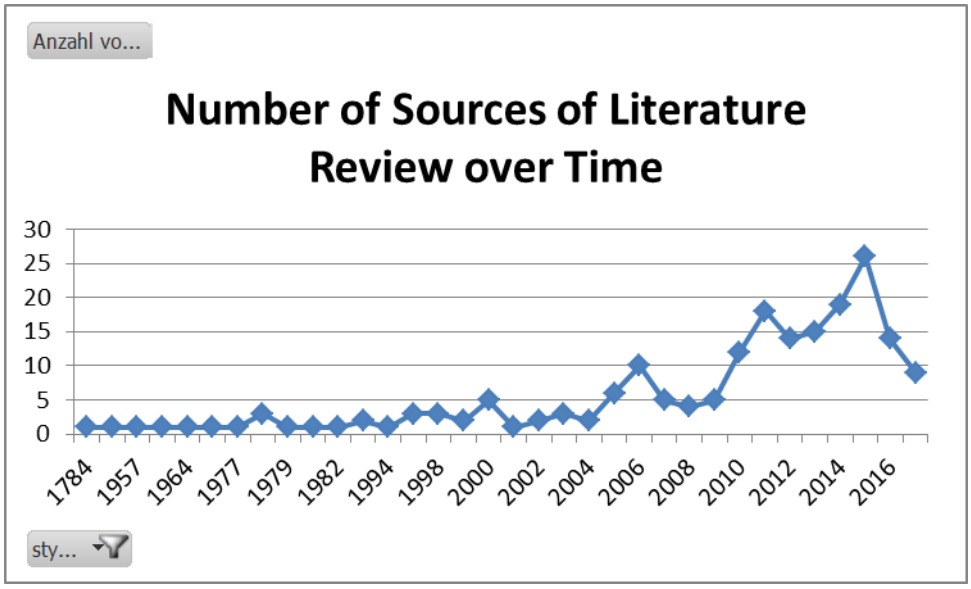


Figure 63. Visualisation of Qualified Sources by Publishing Date

Qualified Sources of Literature by Publisher, ranked

Publisher (Book/ Journal)	**Number of Sources**
ACM - Association for Computing Machinery	6
Wiley-Blackwell	6
Harvard Business School Publication Corp.	4
Academy of Management	4
Psychological Reports	4
Oxford University Press / USA, London	5
Routledge	5
John Wiley & Sons, Inc.	3
President and Fellows of Harvard College, Cambridge University Press	2
Perceptual & Motor Skills	2
California Management Review	2
Time Inc.	2
Elsevier Inc.	2
American Psychological Association	2
Lawrence Erlbaum	2
Taylor & Francis	2
SAGE - SAra and GEorge	3
Total	**55**
Others: OECD Publishing, Elsevier Science Publishing Company, Inc., Foreign Policy, De Gruyter, Forum Qualitative Social Research, Spiegel & Grau, Gabler Verlag, Cambridge University Press, Baywood Publishing, Education Today Limited, IESE Business School, INSEAD, Springer Science & Business Media B.V., IUP Publications, MIT Press, Bloomberg, L.P., Chartered Institute of Personnel and Development, Constructivist Foundations, Superintendent of Documents, Polity Press, Taylor & Francis Ltd, Association for Computing Machinery, Brunner / Routledge, Annual	

Reviews Inc., Sloan Management Review, CEPR Discussion Papers, Springer Berlin Heidelberg, McGraw-Hill/Open University Press, Springer-Verlag, Milton Keynes : Open University, 2005., MIS Quarterly & The Society for Information Management, London : Continuum, 2000., Taylor and Francis, University of Chicago Press, VS Verlag für Sozialwissenschaften, Wiley-Blackwell Publishing Ltd., Lucius & Lucius Verlagsgesellschaft mbH, Mansueto Ventures LLC, McGraw-Hill International	
Total	**97**
Journals	
Harvard Business Review	7
Psychological Reports	4
Organization Studies	4
Creativity Research Journal	4
Industrial Marketing Management	4
Psychology of Aesthetics, Creativity, and the Arts	3
Science, Technology & Human Values	3
European Journal of Innovation Management	2
Perceptual and Motor Skills	2
Research Policy	2
Research-Technology Management	2
Procedia - Social and Behavioral Sciences	2
Journal of Organization Design	2
Administrative Science Quarterly	2
Organization Science	2
California management review	2
Academy of Management Journal	2
International Journal of Management Reviews	2
Total	**149**
Other Journals: Journal of Business Venturing, Sloan Management Review, China Information, Design Issues, Economic Record, Computers and Composition, Education	

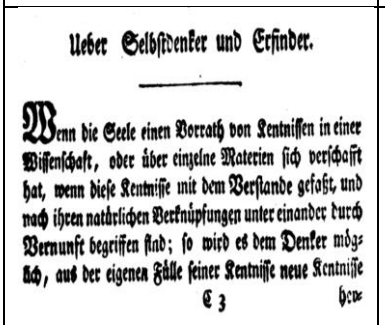
Today, The Business History Review, ACM Transactions on Computer-Human Interaction, Business & Society Review, European Journal of Work and Organizational Psychology, Columbia Journal of World Business, Foreign Policy, ACM Inroads, Futures, Studies in History and Philosophy of Science Part A, GetMobile: Mobile Comp. and Comm., Trends in Ecology & Evolution, Gifted Education International, New Media & Society, Harvard, Organization Studies (Walter de Gruyter GmbH & Co. KG.), Academy of Management Perspectives, Politics & Society, Harvard Business Review Digital Articles, Proceedings of the National Academy of Sciences of the United States of America, ICFAI Journal of Managerial Economics, Research in Organizational Behavior, IEEE Spectrum, Science Education, IESE Insight, Social Networks, Imagination, Cognition and Personality, Technological Forecasting and Social Change, Inc., Thinking Skills and Creativity, Industrial & Corporate Change, Wirtschaftspsychologie, Annual Review of Psychology, New Horizons in Adult Education & Human Resource Development, Information Society, Organization, innovations, Academy of Management Review, Innovationsgesellschaft heute: Die reflexive Herstellung des Neuen., Organizational Dynamics, INSEAD Working Papers Collection, Phi Delta Kappan, Bloomberg Businessweek, Proc Natl Acad Sci U S A, International Journal of Psychotherapy, Procedia Computer Science, International Social Science Journal, Communications of the ACM, Journal für Betriebswirtschaft, Public Administration Review, Journal of Adolescent & Adult Literacy, Constructivist Foundations, Journal of Business Anthropology, Review of Social Economy, 2014 IEEE Frontiers in Education Conference (FIE) Proceedings, DABEI-Handbuch für Erfinder und Unternehmer, Journal of Occupational &	

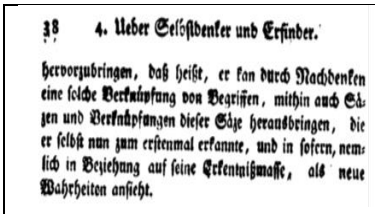
Organizational Psychology, Small Business Economics, Bulletin of the Business Historical Society, Structural Breakup by Interaction Kyklos, Systems Research, Leadership, The Academy of Management Annals, Literary & Linguistic Computing, The Journal of Socio-Economics, Logic Journal of the IGPL, Time, Management, USA Today, Media, Culture & Society, MIS Quarterly, New Directions for Evaluation	
Total	**228**

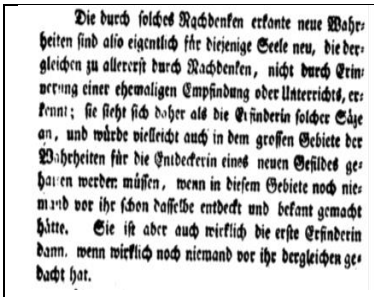
Figure 64. Qualified Sources for Literature Review by Publisher

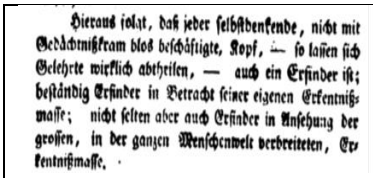
Appendix II Further Artefacts

II-1 Additional Literature (Transcribed and Translated from Origin)

Selbstdenker und Erfinder, Johann Melchior Beseke (1746-1802)		
Origin	Transcription	Translation
 Ueber Selbſtdenker und Erfinder. ——— Wenn die Seele einen Vorrath von Kentniſſen in einer Wiſſenſchaft, oder über einzelne Materien ſich verſchafft hat, wenn dieſe Kentniſſe mit dem Verſtande gefaßt, und nach ihren natürlichen Verknüpfungen unter einander durch Vernunft begriffen ſind; ſo wird es dem Denker möglich, aus der eigenen Fülle ſeiner Kentniſſe neue Kentniſſe C 3 her-	Über Selbstdenker und Erfinder. ——— Wenn die Seele einen Vorrat von Kenntnissen in einer Wissenschaft, oder über einzelne Materien sich verschafft hat, wenn diese Kenntnisse mit dem Verstand gefasst, und nach ihren natürlichen Verknüpfungen untereinander durch Vernunft begriffen sind; so wird es dem Denker möglich, aus der eigenen Fülle seiner Kenntnisse neue Kenntnisse hervorzubringen,	About self-thinkers and inventors. ——— When the soul has procured a store of knowledge in science, or of individual matter when this knowledge is conceived with the understanding, and by its natural connections are reasoned by reason; It is possible for the thinker to produce new knowledge from his abundance of knowledge,

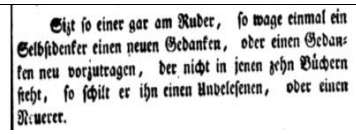
	Hervorzubringen, daß heißt, er kann durch Nachdenken eine solche Verknüpfung von Begriffen, mithin auch Sätze und Verknüpfungen dieser Sätze herausbringen, die er selbst nun zum ersten Mal erkannte, und insofern, nämlich in Beziehung auf seine Erkenntnismasse als neue Wahrheiten ansieht.	then it is possible, by means of reflection, to bring out such a combination of concepts and, consequently, also sentences and links of these propositions, which he himself now recognised for the first time, and, in so far as it is concerned, as new truths.

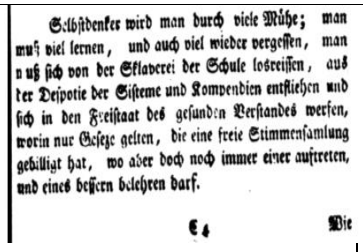
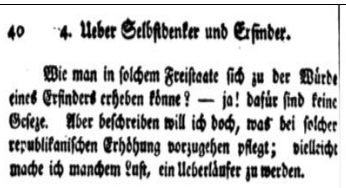
 Die durch solches Nachdenken erkonte neue Wahrheiten sind also eigentlich für diejenige Seele neu, die dergleichen zu allererst durch Nachdenken, nicht durch Erinnerung einer ehemaligen Empfindung oder Unterrichts, erkennt; sie sieht sich daher als die Erfinderin solcher Sätze an, und würde vielleicht auch in dem grossen Gebiete der Wahrheiten für die Entdeckerin eines neuen Gefildes gehalten werden müssen, wenn in diesem Gebiete noch niemand vor ihr schon dasselbe entdeckt und bekant gemacht hätte. Sie ist aber auch wirklich die erste Erfinderin dann, wenn wirklich noch niemand vor ihr dergleichen gedacht hat.	Die durch solches Nachdenken erkannte neue Wahrheiten sind also eigentlich für diejenige Seele neu, die dergleichen zu aller erst durch Nachdenken, nicht durch Erinnerung einer ehemaligen Empfindung oder Unterrichts, erkennt; sie sieht sich daher als die Erfinderin solcher Sätze an, und würde vielleicht auch in dem großen Gebiete der Wahrheiten für die Entdeckerin eines neuen Gefildes gehalten werden müssen, wenn in diesem Gebiet noch niemand vor ihr schon dasselbe entdeckt und bekannt gemacht hätte. Sie ist aber auch wirklich die erste Erfinderin dann, wenn wirklich noch niemand vor ihr dergleichen gedacht hat.	The new truths, recognized by such reflections, are, therefore, really new to the soul, which first recognizes such things by reflection, not by memory of a former sentiment or instruction; She would, therefore, regard herself as the inventor of such propositions, and would perhaps also have to be held in the great realm of truths for the discoverer of a new field, if no one had ever before discovered and made known to her before. However, she is also really the first inventor when really nobody has ever thought of her before.

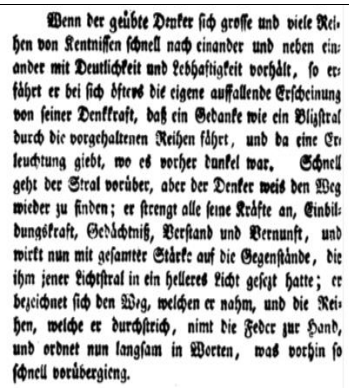
 Hieraus folgt, daß jeder selbstdenkende, nicht mit Gedächtnißkram blos beschäftigte, Kopf, — so lassen sich Gelehrte wirklich abtheilen, — auch ein Erfinder ist; beständig Erfinder in Betracht seiner eigenen Erkenntniß-masse; nicht selten aber auch Erfinder in Ansehung der grossen, in der ganzen Menschenwelt verbreiteten, Erkenntnißmasse.	Hieraus folgt, dass jeder Selbstdenkende, nicht mit Gedächtniskram bloß beschäftigte, Kopf, - so lassen sich Gelehrte wirklich abteilen,- auch ein Erfinder ist; beständig Erfinder in Betracht seiner eigenen Erkenntnissmasse; nicht selten aber auch Erfinder in Anlehnung der großen, in der ganzen Menschenwelt verbreiteten, Erkenntnis Masse.	From this it follows that every self-thinker, who is not merely concerned with the memory of the memory, is also an inventor; Constantly inventor in consideration of his faculty of knowledge; Not infrequently but also inventors, in accordance with the great mass of knowledge spread throughout the human world.

In Anſehung dieſes ganzen Gebiets der Wahrheit ein Erfinder zu werden, iſt ein ſeltner Fall; aber wenn er entſteht, doch immer der glückliche Fall des ſelbſtdenkenden Kopfs. Er wandelt nie über ein Wahrheitsgefilde, wo er nicht hier ein noch unbekantes Gewächs entdecke, dort eine neue Blume finde, hier eine Frucht zuerſt ſchmecke, dort eine neue Pflege für eine Pflanze bemerke.	In Anlehnung dieses ganzen Gebiets der Wahrheit ein Erfinder zu werden, ist ein seltener Fall; aber, wenn er entsteht, doch immer der glückliche Fall des Selbstdenkenden Kopfs. Er wandelt nie über ein Wahrheitsgefilde, wo er nicht hier ein noch unbekanntes Gewächs entdecke, dort eine neue Blume finde, hier eine Frucht zuerst schmecke, dort eine neue Pflege für eine Pflanze bemerke.	To be an inventor of this whole domain is a rare case; But when it arises, it is always the happy fall of the self-thinking head. He never walks over the truthfulness of truth, where he does not discover a still unknown plant, finds a new flower, tastes a fruit here, and see new care for a plant.
Solte alſo auch der denkende Kopf nicht immer die Maſſe der unter allen Menſchen verbreiteten Wahrheiten vermeh:	Sollte also auch der denkende Kopf nicht immer die Masse der unter allen Menschen verbreiteten Wahrheiten vermehren,	If, indeed, the thinking head does not always increase the mass of the truths spread among all men,

4. Ueber Selbſtdenker und Erfinder. 39 vermehren, ſo wird er doch wenigſtens in der Form derſelben, in ihrer Verknüpfung, in ihrer Berichtigung, in ihrer Erleuchtung, in ihrer Verſchönerung, immer etwas eigenes leiſten. Ja ſofern er nur dieſes leiſtet heißt er eigentlich ein Selbſtdenker; in ſofern er jenes leiſtet führt er den ſtolzen Namen eines Erfinders.	Vermehren, so wird er doch wenigstens in der Form derselben, in ihrer Verknüpfung, in ihrer Berichtigung, in ihrer Erleuchtung, in ihrer Verschönerung, immer etwas eigenes leisten. Ja sofern er nur dieses leistet heißt er eigentlich ein Selbstdenker; insofern jenes leistet führt er den stolzen Namen eines Erfinders.	at least in its form, its correlation, its enlightenment, and its embellishment, it will always do something of its own. Yes, if he does this only he is actually a self-thinker; Insofar as he does, he carries the proud name of an inventor.
Wer ſchon Selbſtdenker iſt, kan leicht Erfinder werden; denn jenes iſt die erſte Stufe, dieſes die zwote. Aber ſo wenig die zwote Stufe erreicht werden kan, wo nicht vorher die erſte betreten worden, ſo wenig kan jemand die Hofnung faſſen, Erfinder zu werden, wo er nicht vorher ſich zum Selbſtdenker mühvoll erhoben hat. Ohne Selbſtdenker zu ſein hat es wol hie und da einem Manne durch einen Zufall geglückt, einen neuen Gedanken zu ergreifen, aber dann wars auch nur das Tappen eines Blinden im Finſtern. Ich weis nicht leicht ein ſchicklicheres Beiſpiel von ſolchen, durch bloſſen Zufall glücklichen, Erfindern zu geben, als die Schriften der Männer, die aus 9 Büchern das zehnte zuſammenklauben, aus einem Folianten ein Kompendium fädeln.	Der schon Selbstdenker ist, kann leicht Erfinder werden; denn jenes ist die erste Stufe, dieses die zweite. Aber so wenig die zweite Stufe erreichen werden kann, wo nicht vorher die erste betreten worden, so wenig kann jemand die Hoffnung fassen, Erfinder zu werden, wo er nicht vorher sich zum Selbstdenker mühevoll erhoben hat. Ohne Selbstdenker zu sein hat es wohl hier und da einem Manne durch einen Zufall	The self-thinker can easily become an inventor; For that is the first stage, the second. However, as little can be attained to the second stage, where the first has not been entered before, no one can hope to become the inventor, where he has not previously laboured to self-thought. Without being a thinker, a man might have succeeded in taking a

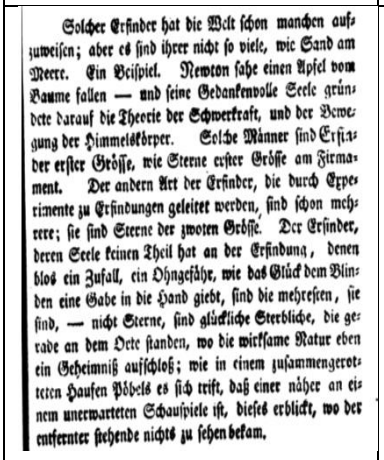
	geglückt, einen neuen Gedanken zu ergreifen, aber dann war es auch nur das Tappen eines Blinden im Finstern. Ich weiß nicht leicht ein schicklicheres Beispiel von solchen, durch bloßen Zufall glücklichen, Erfindern zu geben, als die Schriften der Männer, die aus 9 Büchern das zehnte zusammenklauben, aus einem Folianten ein Kompendium fädeln.	new thought here and there, by chance, but then it was only the tapping of a blind man in darkness. I can not easily give a more fitting example of such fortunes, fortunate by mere coincidence, than the writings of the men who composed the twentieth book from a book is a compendium of a folio.
 Sizt ſo einer gar am Ruder, ſo wage einmal ein Selbſtdenker einen neuen Gedanken, oder einen Gedanken neu vorzutragen, der nicht in jenen zehn Büchern ſteht, ſo ſchilt er ihn einen Unbeleſenen, oder einen Reuerer.	Ist so einer gar am Ruder, so wage einmal ein Selbstdenker einen neuen Gedanken, oder einen Gedanken neu vorzutragen, der nicht in jenen zehn Büchern steht, so schilt er ihn einen Unbelesenen, oder einen Reuerer.	If such a man is at the helm, once a self-thinker dares to recite a new thought or a thought which does not stand in those ten books, he reproaches him an unbeliever or a rebel.

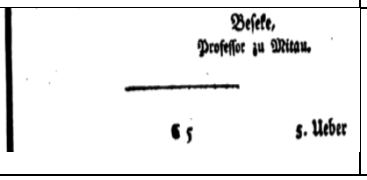
 Selbſtdenker wird man durch viele Mühe; man muß viel lernen, und auch viel wieder vergeſſen, man muß ſich von der Sklaverei der Schule losreiſſen, aus der Despotie der Syſteme und Kompendien entfliehen und ſich in den Freiſtaat des geſunden Verſtandes werfen, worin nur Geſetze gelten, die eine freie Stimmenſammlung gebilligt hat, wo aber doch noch immer einer auftreten, und eines beſſern belehren darf. E 4 Wie	Selbstdenker wird man durch viel Mühe; man muss viel lernen, und auch viel wieder vergessen, man muss sich von der Sklaverei der Schule losreißen, aus der Despotie der Systeme und Kompendien entfliehen und sich in den Freistaat des gefundenen Verstandeswerfen, worin nur Gesetze gelten, die eine freie Stimmensammlung gebilligt hat, wo aber doch noch immer einer auftreten, und eines bessern belehren darf.	Self-thinkers are made by much trouble; One has to learn a lot, and also to forget a lot, to get rid of the slavery of the school, to escape from the despotism of the systems and compendia and to freeze in the founding of the founding of intellect, Where, however, one still may occur, and may teach a better one.
 40 4. Ueber Selbſtdenker und Erfinder. Wie man in ſolchem Freiſtaate ſich zu der Würde eines Erfinders erheben könne? — ja! dafür ſind keine Geſetze. Aber beſchreiben will ich doch, was bei ſolcher republikaniſchen Erhöhung vorzugehen pflegt; vielleicht mache ich manchem Luſt, ein Ueberläufer zu werden.	Wie man in solchem Freistaat sich zu der Würde eines Erfinders erheben könne?- Ja! Dafür sind keine Gesetze. Aber beschreiben will ich doch, was bei solcher republikanischen Erhöhung vorzugehen pflegt; vielleicht mache ich manchem Luft, ein Überläufer zu werden.	How in such a free state could one rise to the dignity of an inventor? There are no laws for that. However, I will describe what is going on with such a republican increase; Perhaps I will make many breaths of air, a transient.

 Wenn der geübte Denker ſich groſſe und viele Reihen von Kentniſſen ſchnell nach einander und neben einander mit Deutlichkeit und Lebhaftigkeit vorhält, ſo erfährt er bei ſich öfters die eigene auffallende Erſcheinung von ſeiner Denkkraft, daß ein Gedanke wie ein Blizſtral durch die vorgehaltenen Reihen fährt, und da eine Erleuchtung giebt, wo es vorher dunkel war. Schnell geht der Stral vorüber, aber der Denker weis den Weg wieder zu finden; er ſtrengt alle ſeine Kräfte an, Einbildungskraft, Gedächtniß, Verſtand und Vernunft, und wirkt nun mit geſamter Stärke auf die Gegenſtände, die ihm jener Lichtſtral in ein helleres Licht geſezt hatte; er bezeichnet ſich den Weg, welchen er nahm, und die Reihen, welche er durchſtrich, nimt die Feder zur Hand, und ordnet nun langſam in Worten, was vorhin ſo ſchnell vorübergieng.	Wenn der geübte Denker sich große und viele Reihen von Kenntnissen schnell nach einander und neben einander mit Deutlichkeit und Lebhaftigkeit vorhält, so erfährt er bei sich öfters die eigene auffallende Erscheinung von seiner Denkkraft, dass ein Gedanke wie ein Blitzstrahl durch die vorgehaltenen Reihen fährt, und da eine Erleuchtung gibt, wo es vorher dunkel war. Schnell geht der Strahl vorüber, aber der Denker weiß den Weg wieder zu finden; er strengt alle seine Kräfte an, Einbildungskraft, Gedächtnis, Verstand und Vernunft, und wirft nun mit gesamter Stärke auf die Gegenstände, die ihm jener Lichtstrahl in ein helleres Licht gesetzt hatte; er bezeichnet sich den Weg, welchen er nahm,	When the learned thinker presents himself with great and many series of knowledge quickly and successively, with distinctness and vivacity, he often experiences his striking appearance of his power of thought, that a thought passes like a lightning bolt through the rows which have been kept; Since there is enlightenment where it was dark before. The beam passes quickly, but the thinker knows how to find the way again; He strengthens all his powers, imagination, memory, reason, and reason, and now throws with all his strength the objects which the light beam had given him in a brighter light; He describes himself the way which he took, and the ranks which he passed through took

	und die Reihen, welche er durchstrich, nimmt die Feder zur Hand, und ordnet nun langsam in Worten, was vorhin so schnell vorüberging.	the pen in his hand, and now he slowly arranged in words what had happened so quickly before.
In der Seele des Denkers durchkreuzen sich öfters solche Blitzstrale, und es ist mehrentheils in derselben ein Schimmer, wie der Schimmer des Wetterleuchters; geht er dem Schimmer näher, so nähert er sich Blitzen.	In der Seele des Denkers durchkreuzen sich öfters solche Blitzstrahlen, und es ist mehren teils in derselben ein Schimmer, wie der Schimmer des Wetterleuchtens; geht er dem Schimmer näher, so nähert er sich Blitzen.	In the soul of the thinker, such flashes of light are often crossed, and there is in the latter a glimmer, as the glimmer of the light of the day; If he approaches the glimmer, he approaches lightning.
Aber auch da, wo noch kein Blitzstral die Gedanken der Seele durchfährt, wo noch kein Wetterleuchten den Horizont seiner Kentnisse erleuchtet, da weis er sich Fackeln anzuzünden, um die nächtliche Finsterniß in seinem Gesichtskreise zu erhellen. Er vermuthet, hier werde noch etwas verborgen liegen; dahin trägt er seine Fackel, und findet, was er suchte, oder findet nichts, wo nichts war; in diesem Falle geht er wenigstens denselben nicht wieder. So durchwandert er seine eigene Erkentniß-sphäre	Aber auch da, wo noch kein Blitzstrahl die Gedanken der Seele durchfährt, wo noch kein Wetterleuchten den Horizont seiner Kenntnisse erleuchtet, da weiß er sich Fackeln anzuzünden, um die nächtliche Finsternis in seinem Gesichtsstreifen zu erhellen. Er vermutet, hier werde noch etwas verborgen liegen; dahin trägt er seine Fackel,	But even when no flash of light passes through the thoughts of the soul, where no light of the day illuminates the horizon of his knowledge, he knows how to light torches to illuminate the darkness of the night in his face. He suspects there will be something hidden here; Whereupon he carries his torch, and finds what he sought, or

	und findet, was er suchte, oder findet nichts, wo nichts war; in diesem Falle geht er wenigstens denselben nicht wieder.	finds nothing where nothing was; in this case, he does not at least repeat it.
	So durchwandert er seine eigene Erkenntnissphäre	Thus he traverses his own sphere of knowledge
4. Ueber Selbſtdenker und Erfinder. 41 ſphäre beim Sonnenſcheine, oder bei der Fackel; und weil dieſe Sphäre mit der Sphäre eines andern Denkers oft zuſammenläuft, ſo trift ſichs, daß er in mancher Gegend ſchon bewandert iſt, wo der andere noch ſucht. Er kömt jenem in der Entdeckung zuvor, wenn dieſer, vielleicht früh oder ſpät, daſſelbe gefunden haben würde.	Sphäre beim Sonnenscheine, oder bei der Fackel; und weil diese Sphäre mit der Sphäre eines anderen Denkers oft zusammenläuft, so trifft es sich, dass er in mancher Gegend schon bewandert ist, wo der andere noch sucht. Er kommt jenem in der Entdeckung zuvor, wenn dieser, vielleicht früh oder spät, dasselbe gefunden haben würde.	by sunshine, or by the torch; And because this sphere often conflates with the sphere of another thinker, it is true that he is already versed in some parts of the world where the other is still seeking. He comes before the discovery, if the latter, perhaps early or late, would have found it.
Die Fackel dieſes Erfinders ſind ſeine Kentniſſe; er trägt ſie dahin, wo noch Kentniſſe zu fehlen ſcheinen, beleuchtet mit jeder Kentniß, oder mit allen zugleich dieſen Gegenſtand, und ſiehe da! es wird helle, er findet.	Die Fackel dieses Erfinders sind seine Kenntnisse; er trägt sie dahin, wo noch Kenntnisse zu fehlen scheinen, beleuchtet mit jeder Kenntnis, oder mit	The torch of this inventor is his knowledge; He carries them wherever knowledge still seems to be wanting, illuminates with every

	allen zugleich diesen Gegenstand, und siehe da! Es wird hell, er findet.	knowledge, or at the same time with all this object, and behold! It is bright, he finds.
 Solcher Erfinder hat die Welt schon manchen aufzuweisen; aber es sind ihrer nicht so viele, wie Sand am Meere. Ein Beispiel. Newton sahe einen Apfel vom Baume fallen — und seine Gedankenvolle Seele gründete darauf die Theorie der Schwerkraft, und der Bewegung der Himmelskörper. Solche Männer sind Erfinder erster Größe, wie Sterne erster Größe am Firmament. Der andern Art der Erfinder, die durch Experimente zu Erfindungen geleitet werden, sind schon mehrere; sie sind Sterne der zwoten Größe. Der Erfinder, deren Seele keinen Theil hat an der Erfindung, denen blos ein Zufall, ein Ohngefähr, wie das Glück dem Blinden eine Gabe in die Hand giebt, sind die mehresten, sie sind, — nicht Sterne, sind glückliche Sterbliche, die gerade an dem Orte standen, wo die wirksame Natur eben ein Geheimniß aufschloß; wie in einem zusammengerotteten Haufen Pöbels es sich trift, daß einer näher an einem unerwarteten Schauspiele ist, dieses erblickt, wo der entfernter stehende nichts zu sehen bekam.	Solcher Erfinder hat die Welt schon manchen aufzuweisen; aber es sind ihrer nicht so viele, wie Sand am Meer. Ein Beispiel. Newton sah einen Apfel vom Baum fallen- und seine Gedankenvolle Seele gründete darauf die Theorie der Schwerkraft, und der Bewegung der Himmelskörper.	Such an inventor the world has already shown too many, but there are not so many as sand at sea. An example. Newton saw an apple fall from the tree, and his thoughtful soul founded upon the theory of gravity and the movement of the heavenly bodies.
	Solche Männer sind Erfinder erster Größe, wie Sterne erster Größe am Firmament. Der anderen Art der Erfinder, die durch Experimente zu Erfindungen geleitet werden, sind schon mehrere; sie sind Sterne der zweiten Größe.	Such men are first-class inventors, such as stars of the first size on the firmament. The other kind of inventors, who are guided by experiments to inventions, are already several; They are stars of the second size.
	Der Erfinder, deren Seele seinen Teil hat an der Erfindung, denen bloß ein Zufall, ein	The inventor, whose soul has its part in the invention, to which merely a coincidence,

	Ungefähr, wie das Glück dem Blinden eine Gabe in die Hand gibt, sind die mehreren, sie sind,- nicht Sterne, sind glückliche Sterbliche, die gerade an dem Orte standen, wo die wirksame Natur eben ein Geheimnis aufschloss; wie in einem zusammengerotteten Haufen Pöbels es sich trifft, dass einer näher an einem unerwarteten Schauspiele ist, dieses erblickt, wo der entfernt Stehende nichts zu sehen bekam.	an approximation, as happiness gives the blind man a gift, are the several, they are, not stars, are happy mortals who are just beginning The place where the effective nature opened up a mystery; As in a crowded pile of mobs, that one is closer to an unexpected spectacle, one sees this, where the distant one has not seen anything.
 Beseke, Professor zu Mitau. 6 5 s. Ueber	Beseke, Professor zu Mitau _____	Beseke, Professor zu Mitau _____

Self-thinkers and inventors from Johann M. Beseke

When the soul has procured a store of knowledge in a science, or of individual matter, when this knowledge is conceived with the understanding, and by its natural connections are reasoned by reason; It is possible for the thinker to produce new knowledge from his abundance of knowledge, then it is possible, by means of reflection, to bring out such a combination of concepts and, consequently, also sentences and links of these propositions, which he now recognized for the first time, and, in so far as it is concerned, as new truths.

The new truths, recognized by such reflections, are, therefore, really new to the soul, which first recognizes such things by reflection, not by memory of a former sentiment or instruction; She would, therefore, regard herself as the inventor of such propositions, and would perhaps also have to be held in the great realm of truths for the discoverer of a new field, if no one had ever before discovered and made known to her before. However, she is also really the first inventor when really nobody has ever thought of her before.

From this it follows that every self-thinker, who is not merely concerned with the memory of the memory, is also an inventor; Constantly inventor in consideration of his faculty of knowledge; Not infrequently but also inventors, by the great mass of knowledge spread throughout the human world.

To be an inventor of this whole domain is a rare case; But when it arises, it is always the happy fall of the self-thinking head. He never walks over the truthfulness of truth, where he does not discover a still unknown plant, finds a new flower, tastes a fruit here, and see new care for a plant.

If indeed, the thinking head does not always increase the mass of the truths spread among all men, at least in its form, its correlation, its enlightenment, and its embellishment, it will always do something of its own. Yes, if he does this only he is a self-thinker; Insofar as he does, he carries the proud name of an inventor.

The self-thinker can easily become an inventor; For that is the first stage, the second. However, as little can be attained to the second stage, where the

first has not been entered before, no one can hope to become the inventor, where he has not previously laboured to self-thought.

Without being a thinker, a man might have succeeded in taking a new thought here and there, by chance, but then it was only the tapping of a blind man in darkness. I can not easily give a more fitting example of such fortunes, fortunate by mere coincidence, than the writings of the men who composed the twentieth book from a book is a compendium of a folio.

If such a man is at the helm, once a self-thinker dares to recite a new thought or a thought which does not stand in those ten books, he reproaches him an unbeliever or a rebel.

Self-thinkers are made by much trouble; One has to learn a lot, and also to forget a lot, to get rid of the slavery of the school, to escape from the despotism of the systems and compendia and to freeze in the founding of the founding of intellect, Where, however, one still may occur, and may teach a better one.

How in such a free state could one rise to the dignity of an inventor? There are no laws for that. However, I will describe what is going on with such a republican increase; Perhaps I will make many breaths of air, a transient.

When the learned thinker presents himself with great and many series of knowledge quickly and successively, with distinctness and vivacity, he often experiences his striking appearance of his power of thought, that a thought passes like a lightning bolt through the rows which have been kept; Since there is enlightenment where it was dark before. The beam passes quickly, but the thinker knows how to find the way again; He strengthens all his powers, imagination, memory, reason, and reason, and now throws with all his strength the objects which the light beam had given him in a brighter light; He describes himself the way which he took, and the ranks which he passed through took the pen in his hand, and now he slowly arranged in words what had happened so quickly before.

In the soul of the thinker, such flashes of light are often crossed, and there is in the latter a glimmer, as the glimmer of the light of the day; If he approaches the glimmer, he approaches lightning.

However, even when no flash of light passes through the thoughts of the soul, where no light of the day illuminates the horizon of his knowledge, he knows how to light torches to illuminate the darkness of the night in his face. He suspects there will be something hidden here; after that he carries his torch, and finds what he sought, or finds nothing where nothing was; in this case, he does not at least repeat it.

Thus he traverses his sphere of knowledge by sunshine, or by the torch; And because this sphere often conflates with the sphere of another thinker, it is true that he is already versed in some parts of the world where the other is still seeking. He comes before the discovery, if the latter, perhaps early or late, would have found it.

The torch of this inventor is his knowledge; He carries them wherever knowledge still seems to be wanting, illuminates with every knowledge, or at the same time with all this object, and behold! It is bright, he finds.

Such an inventor the world has already shown too many, But there are not so many as sand at sea. An example. Newton saw an apple fall from the tree, and his thoughtful soul founded upon the theory of gravity and the movement of the heavenly bodies. Such men are first-class inventors, such as stars of the first size on the firmament. The other kind of inventors, who are guided by experiments to inventions, are already several; They are stars of the second size.

The inventor, whose soul has its part in the invention, to which merely a coincidence, an approximation, as happiness gives the blind man a gift, are the several, they are, not stars, are happy mortals who are just beginning The place where the effective nature opened up a mystery; As in a crowded pile of mobs, that one is closer to an unexpected spectacle, one sees this, where the distant one has not seen anything.

Beseke, Professor of Mitau

Appendix III Extract of Images in Fieldnotes

See below the structure used for coding fieldnotes from the visited Maker Faires, events and experiences connected to the topics of invention and innovation.

(Photography) Interviews were supported by taking scribbled notes and additional photography to remind me of the situations the notes were taken. Some photography, later on, were gathered in the fieldnotes as well, depended on their coding relation.

(S) is the background about where this information was taken, what was the reason, location and time.

(IC) contains the initial coding after the fair or event was visited, generally within the next 24 hours.

(CC) contains the concept coding after a timeframe from standard four weeks and generally after other events have taken place.

(FL) further links often contain information if there is a relation to other faires, events OR other coding issues to be solved later on.

#	**Image**	**What it means**
X	**Photography**	**(S) source:: 'Title/ Reason', Location, Time** **(IC) Initial Coding::** **(CC) Concept Coding::** **(FL) Further Links::**

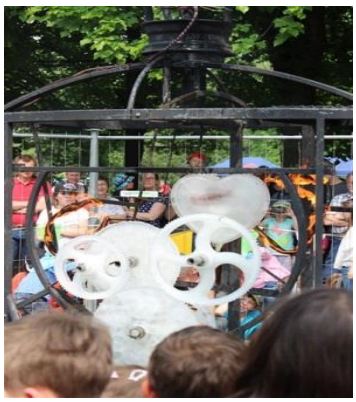
This extract of fieldnotes/ images is already grouped by topics mentioned in the tables and which connect to the topics in the findings sections of the thesis. Not all groups found here were part of the further, detailed analysis.

III-1 Art and Craft

#0001

S:: Maker Faire Cologne Nov 2016
IC:: something new with old books, artistic, paperwork, craft, patience, Mußе// leisure, beautiful, ironic, see letters saying books, vintage, reproduction instead recycling
CC:: sustainability
FL:: old rubber from bicycle tubes-handmade belt, 5 ¼’ disks, crown cap, Flott den Schrott, Repair Café, Dortmund Kunst aus Müll

#0002



S:: Maker Faire Hannover May 2016
IC:: art, mechanics, heart consists of ice, play with fire, perishable/ ice melt, crowd, interest, eye catcher, statue high about 5 meters, artist comes from the UK
CC:: art
FL:: Fish, Artists Hannover, Chemistry, Labor, Verkleidung, Entfremdung

#0003

S:: ‘Maker Faire’ Hannover Aug 2017
IC:: mantis, high tech hydraulic automotive, ant-/spider-like
CC:: art, movement, transport
FL::-

#0004

S:: ‘Maker Faire’ Hannover Aug 2017
IC:: Europeana, database of European art/ heritage, electronic formats, also 3d stl-files available, free-access
CC:: art, free access, heritage, sustainability
FL::-

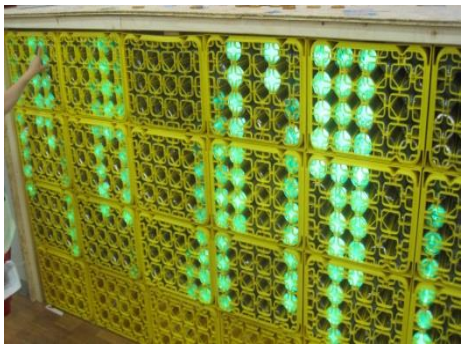
#0005

S:: ‘Maker Faire’ Hannover Aug 2017
IC:: tinkering, table work of children, involvement, share idea, low cost, city awareness (region Hannover)
CC:: involvement, share ideas, city activity
FL::-

#0006

S:: ‘Maker Faire’ Hannover Aug 2017
IC:: paper folding, colourful, lights, one designer, usefulness (light), impulse
CC:: art, paper, low cost
FL:: paper folding (cubes, Tetris like) at Cologne Mini Maker Faire 2016

#0007



S:: ‘Maker Faire’ Hannover Aug 2017
IC:: Matrix theme, reuse of bottles, and boxes, led control matrix, scalability, size
CC:: media, idea transfer/port
FL:: led matrix as face at Sindelfingen Mini Maker Faire 2017

#0008

S:: ‘Maker Faire’ Hannover Aug 2017
IC:: sustainability, reuse, new-use, becoming art object, design concept
CC:: new-use, sustainability, art
FL:: several, old book folding, keychains Dortmund 2017

#0009

S:: ‘Maker Faire’ Hannover Aug 2017
IC:: reuse, new-use, art, sellable, cheap material is input
CC:: new-use, re-use, re-waste
FL:: Dortmund, Make, Mach flott den Schrott

III-2 Fire Pitch Approach

#0010

S:: Maker Faire Cologne Nov 2016
IC:: programming robot moves for children, university, crowdfunding, Kickstarter, haptic approach, colourful, sitting together, parents as well, table in background
CC:: education, digital age
FL:: Dortmund, Ohbot(UK)

#0011

S:: Maker Faire Cologne Nov 2016

IC:: Funker// radio operator, own community, DARC, organised, analogue technique, electronics, soldering, traditional, age difference, communication style

CC:: roots, tradition, history, communication, electronics

FL: Wolfgang Back from WDR Computerclub as visitor at Cologne

#0012

S:: Shenzhen Apr 2017

IC:: un-organised, bastelbude// handicraft booth, 3D-printer on desk, wellpappe, far from engineering, skillset, low investment, big screen in middle, stuff to tinker with, light bulb

CC:: unstructured, not norm, non-conformity, work environment

FL:: Fablabs, Makerspaces, work environment

#0013

S:: Maker Faire Dortmund Mar 2017

IC:: empty table, low invest in tools and material, wire bending, free to own imagination, manufacturing, skillset

CC:: low invest, purity

FL:: starch pool in Cheltenham

#0014

S:: Maker Faire Dortmund Mar 2017

IC:: bicycle, high-wheel bicycle, some trials

CC:: movement, locomotion, shifting

FL:: work environments

#0015

S:: ‘Maker Faire’ Hannover Aug 2017

IC:: material mix, consumer articles

CC:: marble course, movement, teamwork

FL:: also seen at Dortmund, but with wooden sticks and glue pistol

#0016

S:: ‘Maker Faire’ Hannover Aug 2017

IC:: paper dishes as canvas to paint how city should look like

CC:: fire pitch approach, low invest

FL::-

#0017

S:: ‘Maker Faire’ Hannover Aug 2017

IC:: Lego car, reuse, play, children, colourful, easy to build, first idea, invention

CC:: simplicity, join lego and car, new-use

FL::-

III-3 Profession - Nurtured by Family

#0018

S:: ‘Schmiede//blacksmith’s shop’ Meinerzhagen Jun 2017

IC:: historical, fascination, hot steel, safety head, age, hammer, profession father, culture, iron age, industrialisation NRW

CC:: making, building, forming, rearrange, reorder

FL:: making ring Linus Dortmund 2016

III-4 Consumer - Producer

#0019

S:: ‘Brewery’ Ludwigsburg, May 2017

IC: cooking, household, experiment, forbidden, something special, unknown

CC: making, cooking, DIY-Bio

FL: fungi and germs, Dortmund 2017

#0020

S:: ‘Brewery’ Ludwigsburg, May 2017

IC: melting pod, sugar syrup from malt, household utilities, DIY beer

CC: food, nutrition

FL: 3D-printer making something

#0021

S:: ‘Brewery’ Ludwigsburg, May 2017
IC: malt, further use for bread, food for animals
CC: food, sustainability
FL: nitro coffee Hannover Maker Faire 2017

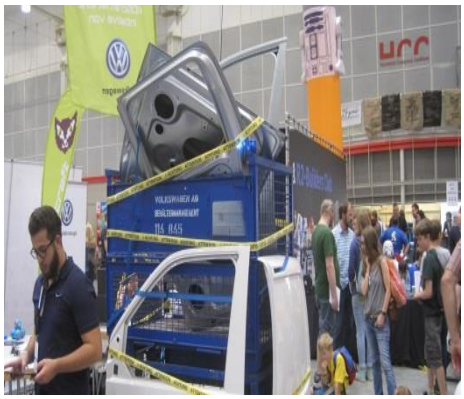
#0022

S:: ‘Brewery’ Ludwigsburg, May 2017
IC:: first beer, proud, DIY, like cooking, receipt, introductory course, insights, hidden skills, experience from others, historical human mankind, about enzymes, yeast, complex chemical process as we know today, equipment as kit
CC:: producer-consumer
FL:: Mannheim Bierausstellung, Reinheitsgebot, Ursachen

#0023

S:: ‘Maker Faire’ Hannover Aug 2017
IC:: Italian, kick starter project started in 2015, sellable product, ono printer
CC:: sellable products
FL:: (like 3D-printer earlier, still building hardware)

#0024



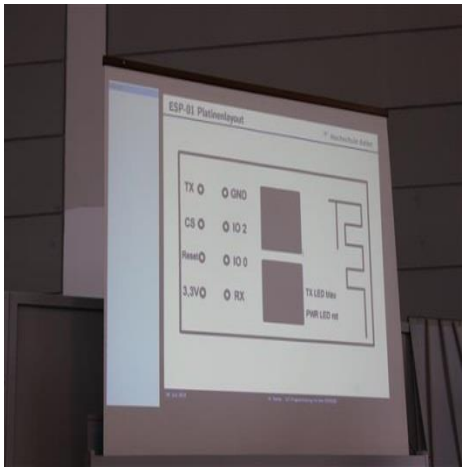
S:: ‘Maker Faire’ Hannover Aug 2017
IC:: Volkswagen, marketing activity, innovative art show of consumer goods, not making, in background star wars robot maker, r2 builder club
CC:: media, robots, club, company
FL:: Dortmund Star Wars Robot builders, different group

#0025

S:: ‘Maker Faire’ Hannover Aug 2017
IC:: met at maker conference, maker, family father, own PCB development
CC:: sellable product, support, scalability
FL:: also at Sindelfingen, compare with Fabscan

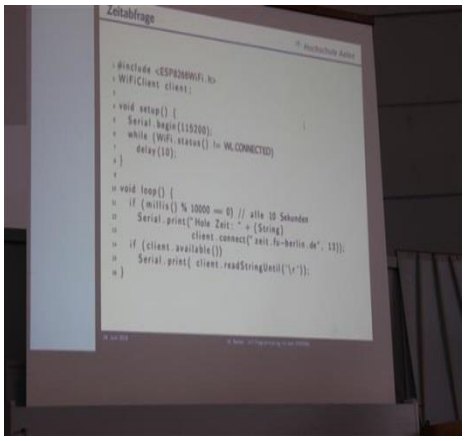
III-5 IoT - Programming Skills in the Digital Age

#0026



S:: Maker Faire Friedrichshafen Jun 2016
IC:: ESP-01, Wifi and programmable IC, low cost, training inside, first steps, help, learning, weitergeben, share, simplify, present to an audience,
CC:: education, sharing, new electronic, starting of nodeMCU
FL:: Cologne, buyable switch from China

#0027



S:: Maker Faire Friedrichshafen Jun 2016

IC:: programming, inside, easy?, logic, source code, cryptic, specific language, nerd, C-Source, excerpt of process

CC:: exemplify

FL:: Programming paradigm shift, like Scratch (MIT), Blockly (Google), NodeRed (IBM)

#0028

S:: ‘Maker Faire’ Hannover Aug 2017

IC:: analogue programming, understanding electronics, pre-packed solution/ DIY set, children ‘toy’,

CC:: DIY set, sellable product, access to electronics, logical understanding, education

FL::-

#0029

S:: ‘Maker Faire’ Hannover Aug 2017

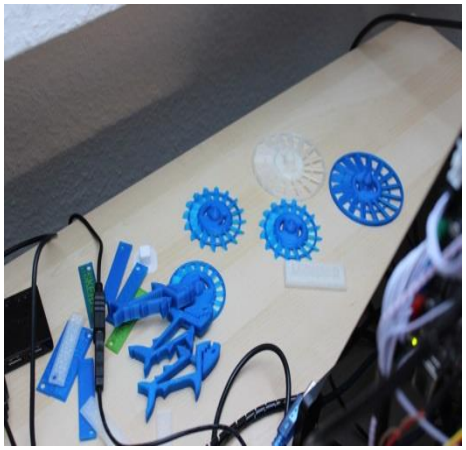
IC:: kits for building robots, movement, blinking, programming

CC:: DIY sets, construction kits, education tools for schools

FL:: Cologne as products within their fablab, Sindelfingen in school

III-6 Ideas - Children came up with

#0030



S:: ‘Beywheels’ Ludwigsburg, Jan 2017
IC:: Beyblades initially, Linus idea, 3D CAD software, fusion 360, easy-peasy, 3D-printer, fast-evolving structure, haptic, trials, modification, experience loop, fail and try, broken wings, beautiful, twist/ turn
CC:: trial and error, fast prototyping, haptic
FL:: 3D-printer Dortmund 2015

#0031

S:: ‘Spinner’ Ludwigsburg, May 2017
IC:: bearings, amazon buy, biggest producing company about 5 miles from residence, direct call, get rebate
CC: networking, anticipation, credit
FL:: -

#0032

S:: ‘Spinner’ Ludwigsburg, May 2017
IC:: turn, yin/yan, dragon, 3D print, own spinner, earn money, demand, school system, unsupportive, non-business orientation nor supportive
CC:: art, home production, small economy
FL:: -

#0033

S:: ‘Spinner’ Ludwigsburg, May 2017

IC:: mass production with 3D print, variations, not perfect, self-made, shortage

CC:: scaling to mass production

FL::-

#0034

S:: ‘Spinner’ Ludwigsburg, May 2017

IC:: self-earned money, 30 EUR one day, veto of school to sell goods

CC:: gatekeeper, economics, own purpose

FL:: -

#0035

S:: ‘Roller 3001’ Ludwigsburg, Apr 2017

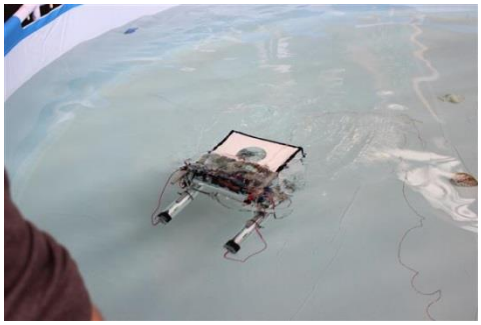
IC:: idea from buyable product, RC background, price of components higher than to buy, faster, another spec, availability of components, access to Conrad electronics

CC:: the ‘own’ project

FL:: Hannover Maker Faire 2017, VW showing similar

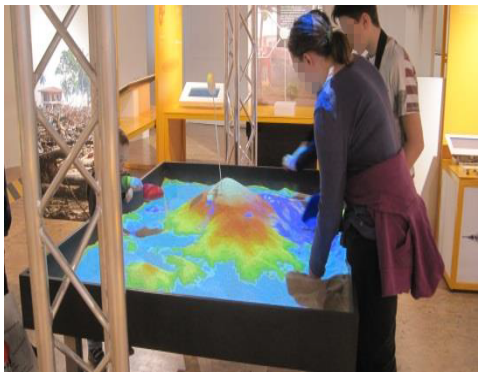
III-7 Ideas dependant on Localisation

#0036



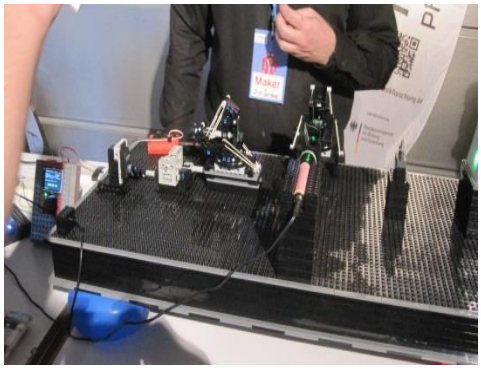
S:: Maker Faire Friedrichshafen Jun 2016
IC:: dive robot, Lake of Constance, Teufelstisch // devils table
CC:: localisation, tradition, storytelling, adventurous
FL:: link to story about

#0037



S:: Maker Faire Dortmund Mar 2017
IC:: flow of water, use of Kinect component, another kind of sandbox, water projected too high of sand piles
CC:: distribution of ideas and projects
FL:: example is seen in the UK 2017 and Hannover 2016

#0038



S:: Maker Faire Dortmund Mar 2017
IC:: laser spectrometer
CC:: low or high tech, professionalism
FL:: GCHQ because secure laser transmission lines, using quantum mechanics

#0039

S:: ‘Maker Faire’ Hannover Aug 2017
IC:: 3D printing in Africa, own research project, student at University of Hamburg, green approach/ solar energy
CC:: green approach/ solar energy, developing countries, educational, initial project, invention
FL::Project ‘One Dollar Glasses’ at Hannover and Stuttgart

#0040

S:: ‘Maker Faire’ Hannover Aug 2017
IC:: sharing experience, first-hand information, show and tell, trustworthy, experiential knowledge to share
CC:: sharing experience, first-hand information, show and tell, trust, experiential knowledge to share
FL::Project ‘One Dollar Glasses’ at Hannover and Stuttgart

III-8 Fungi - Upcoming Packing Material

#0041

S:: Maker Faire Dortmund Mar 2017
IC:: Fungi as packaging material, easy to grow, biology, explanation
CC:: packaging, sustainability
FL:: -

#0042

S:: Maker Faire Dortmund Mar 2017

IC:: Yuck!, smells like fresh fungi

CC:: food, household experiments

FL:: -

#0043

S:: Maker Faire Dortmund Mar 2017

IC:: biased by appearance of fungi

CC:: bias

FL:: -

III-9 Form, Function or just Modification - PC Modding

#0044

S:: Maker Faire Friedrichshafen Jun 2016

IC:: Modding of PCs, competition, win prize, form or function, art more important than function, specific to Friedrichshafen

CC:: art, modification/ change of existing, special hack, media connected, gaming

FL::-

#0045

S:: ‘Maker Faire’ Hannover Aug 2017
IC:: UK company, London based, idea of frame(laptop alike) for raspberry pi, called pi top, sellable, expensive
CC:: sellable product, raspberry pi, add-on, increase usability, lower access barriers, Minecraft, children
FL::-

#0046

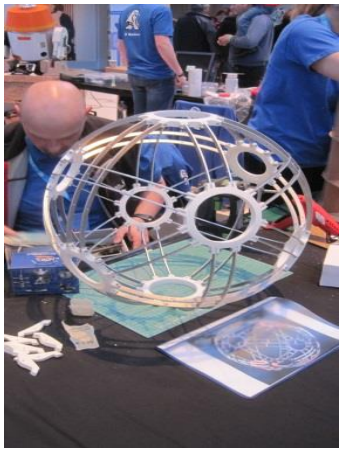
S:: ‘Maker Faire’ Hannover Aug 2017
IC:: Arduino, Lora, Atari games, remake, playing computer games
CC:: computer games, movement, colourful, tradition
FL:: Stuttgart 2016, old hardware

#0047

S:: ‘Maker Faire’ Hannover Aug 2017
IC:: computer game, sellable product, cd clock, light sculpture/ box, reuse, new-use,
CC:: sellable product, re-make, learning
FL:: Make Magazine, Make projects to follow/ to learn

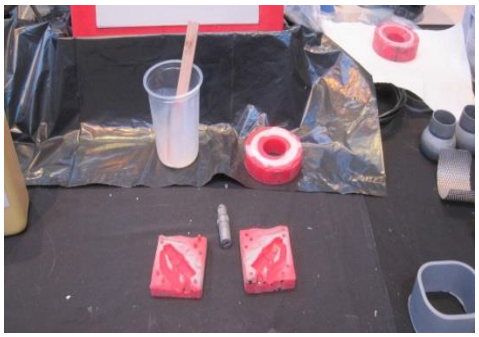
III-10 Ideas influenced by Mass Media

#0048



S:: Maker Faire Dortmund Mar 2017
IC:: Star Wars, mass media, professional structure, idea was given, how to make left open
CC:: star wars, media, copy/ new development
FL:: theme at all Maker Faires

#0049



S:: Maker Faire Dortmund Mar 2017
IC:: mould used for making robots, silicon used for moulds and parts, identic colouring, craft and skill
CC:: art, moulding skills
FL:: -

#0050

S:: 'Maker Faire' Hannover Aug 2017
IC:: Volkswagen, consumer product was shown, programming tool for schools, droid/ star wars
CC:: media, education, school
FL::-

III-11 Relicts from Digital History

#0051

S:: ‘Maker Faire’ Stuttgart Nov 2016

IC:: Apple I, the first homebrew computer ever, parts from Hewlett Packard

CC:: homebrew computing, tradition, museum artefacts

FL:: links to story of innovators, Steve Jobs bibliography

#0052

S:: ‘Maker Faire’ Stuttgart Nov 2016

IC:: Commodore, first industrial computers, collection of old computer as an association, not only collection of hardware they try to let them running

CC:: keep tradition alive

FL:: Friedrichshafen Maker Faire Textile machines

#0053

S:: ‘Maker Faire’ Hannover Aug 2017

IC:: old electronics, steampunk materials, radio era, selling, commercial, (waste)

CC:: reuse, electronics, tradition

FL:: Friedrichshafen

#0054

S:: ‘Maker Faire’ Hannover Aug 2017
IC:: old machines, typewriters, communication, historical, tradition
CC:: communication devices, traditional
FL::-

III-12 Relicts from Local Industry Background - Textile Industry

#0055

S:: Maker Faire Friedrichshafen Jun 2016
IC:: knitting machines and crochet machine, keep them running, own made wool, hobby for him and her
CC:: keep machines running, remain knowledge about machines and processes
FL::-

#0056

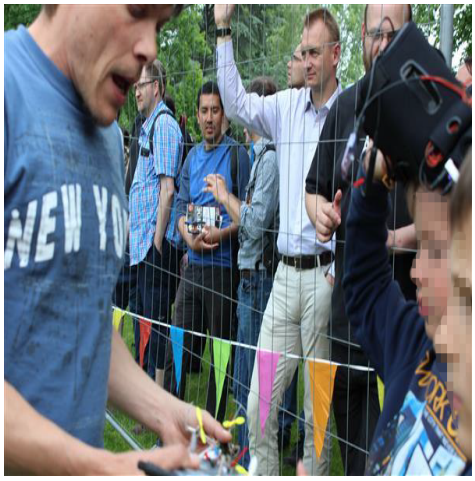
S:: Maker Faire Friedrichshafen Jun 2016
IC:: textile industry at south of Stuttgart famous in the 1970’s, fashion, Schiesser as an internationally known brand
CC:: traditional industry, localisation
FL::-

III-13 Share Knowledge and Skills, Learn and Improve Skills

#0057

S:: Maker Faire Hannover May 2016
IC:: own build 3D-printer, RepRap, proud
CC:: share, learn, improve skills
FL:: all Faires

#0058

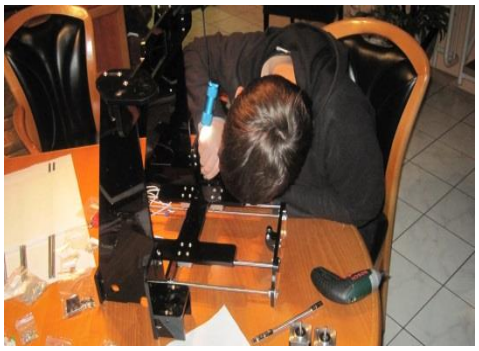


S:: Maker Faire Hannover May 2016
IC:: proud, interest, first-person view (FPV), drones, flying experience, RC development, model making, invention, special e-motors availability, controllers, attitude sensor, explanation, talk, wishes, fence to protect
CC:: explain, build curiosity
FL:: all Faires

#0059

S:: Maker Faire Dortmund Mar 2016
IC:: soldering, helping hand, explanation, share experience, programmable necklace, skillset, new capability, learning, interest, manufacturing
CC:: learning skills
FL:: all Faires

#0060



S:: ‘3D-printer’ Ludwigsburg, Jan 2017
IC:: building own 3D-printer from a configured kit, screwing, skill set development, reduce limits to start with
CC:: trust in skillset, start making
FL:: Dortmund Faire 2015

#0061

S:: Maker Faire Dortmund Mar 2016
IC:: making a ring from silver coin, craft, saw, adapt, fir, stake, deform, alienate, reproduction, new application, collection, Phoenix, destroy and create something new, support, interest, co-work
CC:: curiosity in making, tradition, professional
FL:: Dortmund, Friedrichshafen

#0062

S:: Maker Faire Hannover May 2016
IC:: Revell, commercial, attract, build from configured kits, co-work
CC:: joined working, teaming
FL:: -

#0063

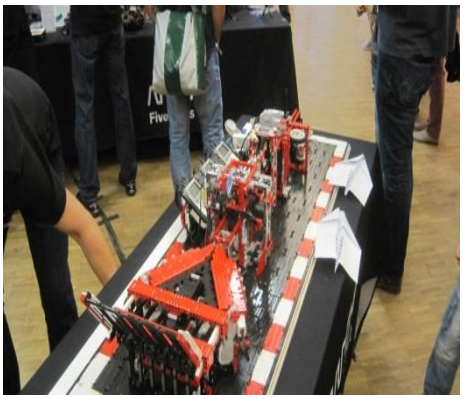
S:: Maker Faire Dortmund Mar 2017
IC:: age, interest, easy materials, school concept
CC:: low invest
FL:: -

#0064

S:: ‘Maker Faire’ Hannover Aug 2017
IC:: soldering, education, show and tell, try and fail
CC:: education, tinkering
FL:: Dortmund 2015, 2016, 2017, Hannover 2016, 2017, Friedrichshafen 2016

III-14 Fischer Technik Community

#0065



S:: ‘Maker Faire’ Hannover Aug 2017
IC:: paper plane folding machine from Fischer Technik, inventor of rawplugs, children's technical construction toy in 90ies
CC:: engineering oriented building kits, traditional, education tools for schools
FL:: Hannover 2016

#0066

S:: ‘Maker Faire’ Hannover Aug 2017
IC:: Community, Club, label/ brand, marketing activity?
CC:: commerce vs. hobby
FL::

#0067

S:: ‘Maker Faire’ Hannover Aug 2017
IC:: presenting artefacts, play instead building
CC:: presenting, building with kits
FL::-

#0068

S:: ‘Maker Faire’ Hannover Aug 2017
IC:: community event, different ages, children interested, technical objects crane, lighthouse, windmill
CC:: community
FL::-

III-15 Collaboration and Sharing Interests

#0069

S:: Maker Faire Hannover May 2016
IC:: marble lane, wood sticks, group work, interaction, communication, easy stuff, hot-melt gun, craft
CC:: teaming, share, easy objective
FL:: Dortmund

#0070

S:: Maker Faire Dortmund Mar 2017
IC:: to use old table upside down as a basis to start with, tougher than it looks like, continuous trial with the marble, speed, edges, trimming
CC:: trial and error, random approach, no planning
FL:: Hannover

#0071

S:: Maker Faire Friedrichshafen Jun 2016
IC:: computer games, interact, Minecraft, community, virtual, shops, islands, popcorn machine, leisure, camouflage net, support by parents, new media, consumer, skillset
CC:: media, teaming
FL:: -

#0072

S:: ‘Maker Faire’ Hannover Aug 2017
IC:: building together, children, tambourine as material, noise, different materials from household and natives like wood
CC:: teaming, do-it-together (DIT)
FL::Dortmund 2016, 2017

#0073

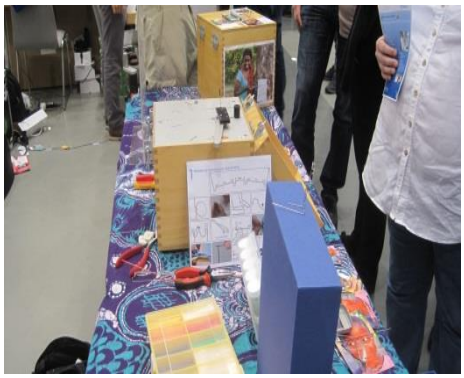
S:: ‘Maker Faire’ Hannover Aug 2017
IC:: robot wars in arena, teams preparing their robots, interested crowd/ visitors in background, tool boxes, destroy, money, sophisticated robots using co2 pressure driven weapons
CC:: NOT low invest
FL::-

III-16 Developing Countries

#0074

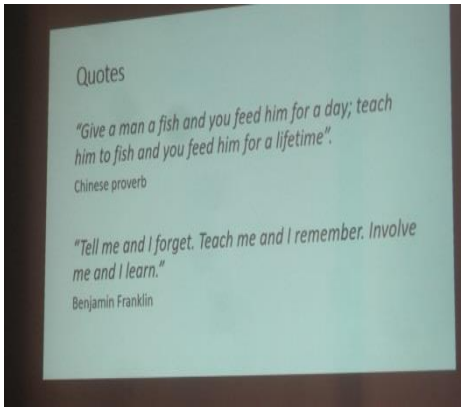
S:: ‘Maker Faire’ Hannover Aug 2017
IC:: One dollar glasses project, need for vision to work, learn, participate in life, earn money to live
CC:: low invest, developing countries, education, apprenticeship
FL::-

#0075



S:: ‘Maker Faire’ Hannover Aug 2017
IC:: self-build tool to make frames for the glasses, low-cost tooling, low-cost product, effective, first time at maker fair, profession of volunteers is often optician, 3 days earning for price for pair of glasses
CC:: passion for profession, helping developing countries/ people
FL::-

#0076



S:: ‘Maker Faire’ Hannover Aug 2017
IC:: 3D-printer with energy from solar panel, student project, make dependent versus making independent through teaching AND involvement
CC:: make dependent versus making independent through teaching AND involvement
FL::-

#0077

S:: ‘Maker Faire’ Hannover Aug 2017

IC:: show and tell, share experience

CC:: share, educate, train

FL::-

III-17 Decoration

#0078

S:: Maker Faire Friedrichshafen Jun 2016

IC:: competition, prizes, acknowledgement, age, press and local newspaper, school director, power, domain, institution

CC:: domain, reputation, competition, prizes

FL::-

III-18 Proof of Historical Concepts

#0079

S:: Maker Faire Dortmund Mar 2017

IC:: Leonardo ring, woodwork, historical, brought back to life, build from new parts, old design, costume, circus, play, theatre, interest

CC:: tradition, keep knowledge alive, reputation of historic inventions

FL::-

#0080

S:: Maker Faire Dortmund Mar 2017
IC:: explanation, Leonardo ring, old relationship to body dimensions, see picture,
CC:: reputation of people
FL::-

III-19 Commercialising

#0081

S:: ‘Maker Faire’ Stuttgart Nov 2016
IC:: commerce, sell old (and new) video games, history, collectors, collections, Zeitgeist, pocket money, addicted to collect, completion, no end
CC:: collecting goods, source for collectors, sustainability
FL:: all Faires

#0082

S:: Maker Faire Friedrichshafen Jun 2016
IC:: commerce, radio operator, origin of the fair, analogue, refitting, repair, spare parts, electric components
CC:: collecting goods, repair, make new things from old things, sourcing
FL:: Dortmund

#0083

S:: ‘Maker Faire’ Stuttgart Nov 2016
IC:: commerce, Nintendo selling game consoles, position to family games, Lego included as virtual games, growing markets, diversification, Batman, superman, heroes, mass media
CC:: consumer-producer products, economy, gain revenue
FL::-

#0084

S:: ‘Maker Faire’ Hannover Aug 2017
IC:: 3d glasses, immersion technology, video gaming, consume
CC:: consumer-producer products, economy, gain revenue
FL::-

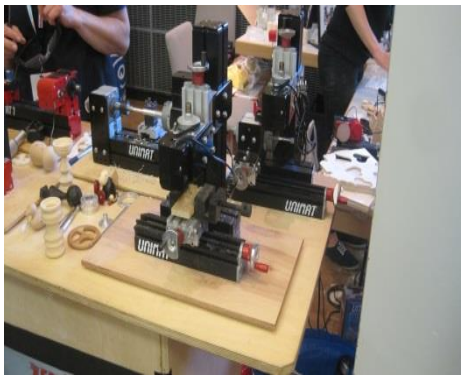
#0085

S:: ‘Maker Faire’ Hannover Aug 2017
IC:: high-end pc, expensive, sellable product
CC:: consumer-producer products, economy, gain revenue
FL::-

#0086

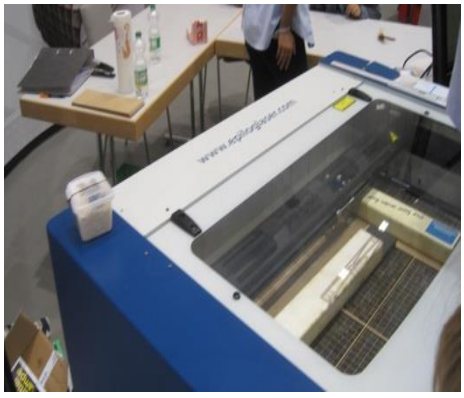
S:: ‘Maker Faire’ Hannover Aug 2017
IC:: small workshop machinery, niche for tool producers
CC:: producer products, machinery for making, economy, gain revenue
FL:: CNC project, Cologne 2016

#0087



S:: ‘Maker Faire’ Hannover Aug 2017
IC:: small workshop machinery
CC:: producer products, machinery for making, economy, gain revenue
FL:: project to build a large CNC machine from concrete (source video at hack-a-day.com)

#0088



S:: ‘Maker Faire’ Hannover Aug 2017
IC:: maker project, pick and place unit for small batches of PCB's
CC:: producer products, machinery for making, economy, gain revenue
FL:: laser cutter

#0089

S:: ‘Maker Faire’ Hannover Aug 2017
IC:: aluminium chassis from batch material
CC:: producer products, machinery for making, economy, gain revenue
FL::-

#0090

S:: ‘Maker Faire’ Hannover Aug 2017
IC:: small workshop machinery, next generation of 3D-printers and metal cutting machines
CC:: producer products, machinery for making, economy, gain revenue
FL::-

III-20 Repair - Sustainability

#0091

S:: ‘Maker Faire’ Hannover Aug 2017
IC:: ifixit, ‘never take broken for an answer’, open repair documentation of goods
CC:: sustainability, repair
FL::-

#0092

S:: ‘Maker Faire’ Hannover Aug 2017
IC:: ifixit, maintained by supporters and companies themselves
CC:: sustainability, repair
FL::

#0093

S:: ifixit.com, December 2017

IC:: manifest, if you cannot repair it, then it is not yours. Repair is better than recycling; repair educates engineering, repair save money, repair protects the environment, repair connects humans and things, repair is sustainability

CC:: sustainability, education/ learning, low invest and resource consumption

FL::-

Appendix IV - Primary Sources from the UK

#0094

S:: ‘Science Festival’ Cheltenham, Jun 2017

IC: crowded, line up at entrance, free entrance, no tickets needed, maker and science

CC:: colourful, tent atmosphere

FL::-

#0095

S:: ‘Science Festival’ Cheltenham, Jun 2017

IC: liquids, starch pool, different behaviours as water itself, children's play and test the behaviour

CC:: unexpected, low invest approach

FL::

#0096

S:: ‘Science Festival’ Cheltenham, Jun 2017

IC: earthquake, building houses, test against shaking

CC:: low invest shaker, prebuild parts

FL::-

#0097

S:: ‘Science Festival’ Cheltenham, Jun 2017

IC: clay modelling

CC:: modelling, making, forming, shaping

FL:: moulding for star wars components, Cologne

#0098

S:: ‘Science Festival’ Cheltenham, Jun 2017

IC: feathers, glitter, glue pistols, children play, support of crew/ parents

CC:: styling, designing, low invest

FL::-

#0099

S:: ‘Science Festival’ Cheltenham, Jun 2017

IC: crafting, basket maker

CC:: keep tradition alive

FL::-

#0100

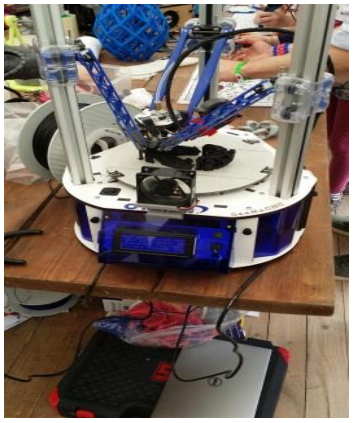
S:: ‘Science Festival’ Cheltenham, Jun 2017

IC: paper, table with resources, unordered/ crowded

CC:: low invest, two children trying out

FL::-

#0101



S:: ‘Science Festival’ Cheltenham, Jun 2017

IC: 3D-printer, distinct geometry - Kossel design, only one stand with 2-3 printers

CC:: niche 3D-printers

FL:: Dortmund 2015, 2016, 2017

#0102

S:: ‘Science Festival’ Cheltenham, Jun 2017

IC: cardboard, easy idea

CC:: low invest

FL::-

#0103

S:: ‘Science Festival’ Cheltenham, Jun 2017

IC: support, start without planning, tryouts

CC:: start and trial

FL::-

#0104

S:: ‘Science Festival’ Cheltenham, Jun 2017

IC: special tooling for children, safety

CC:: economy, toy vendors

FL::-

#0105

S:: ‘Science Festival’ Cheltenham, Jun 2017

IC: racing course with raspi cars, competition, play in focus, attraction

CC:: show and tell

FL:: Hackspace Cheltenham

#0106

S:: ‘Science Festival’ Cheltenham, Jun 2017

IC: explain, show, tell, share knowledge

CC:: share knowledge

FL:: Hackspace Cheltenham

#0107

S:: ‘Science Festival’ Cheltenham, Jun 2017

IC: Ohbot product, spaceflight, own fablab/ production in an old mill

CC:: sellable product Ohbot

FL:: Hannover 2017

#0108

S:: ‘Science Festival’ Cheltenham, Jun 2017

IC: fathers interest against hers

CC:: motivation

FL:: -

#0109

S:: Repair Café Cheltenham, Jun 2017

IC:: repair, capacitor defect, young and old, coffee mug, socialising

CC:: sustainability

FL:: Meinerzhagen Repair Café 2015

#0110

S:: Repair Café Cheltenham, Jun 2017

IC:: solutions, low invest, easy to copy, useful, screw holder magnetic

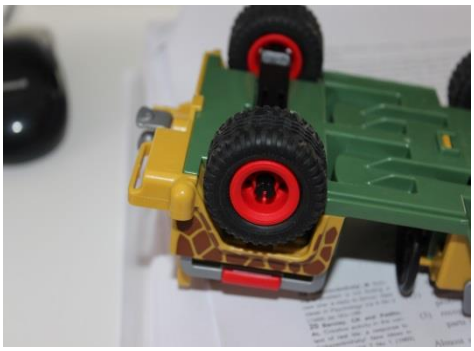
CC:: to easy to copy products

FL::-

Appendix V - Repair

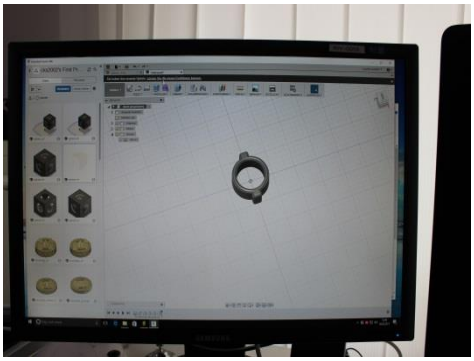
V-1 Repair - 3D Print Process in Detail

#0111



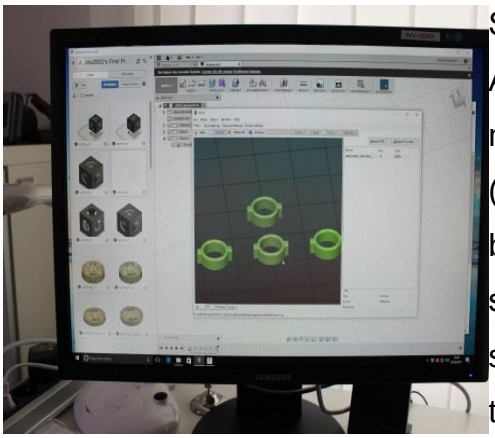
S:: ‘Repair’ Ludwigsburg, Feb 2017
This toy became useless as the wheel nut was missing, the spare part could be ordered from the toy vendor, but more postal charges would be more expensive than the piece worth itself.

#0112



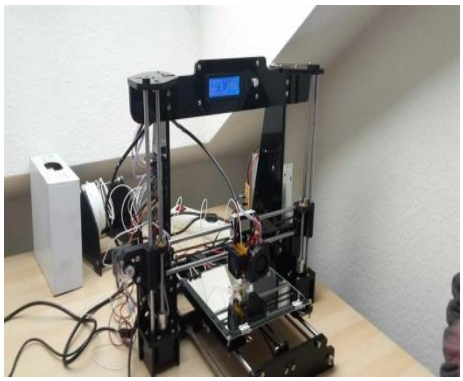
S:: ‘Repair’ Ludwigsburg, Feb 2017
After measuring an existing piece, creating the structure within Fusion 360 which is commercial, professional CAD software from Autodesk but is available for free for non-commercial usage. And it is relatively easy to learn.

#0113



S:: ‘Repair’ Ludwigsburg, Feb 2017
After the 3D structure has been modelled and exported as an STL (stereo-lithography) file, the data has to be prepared for the 3D-printer. The software ‘Slicer’ is exactly doing this, it slices the structure from the bottom to the top into thin layered slices and then generates a path for every layer to control the moulding unit of the 3D-printer. The control file for the printer is called gcode and is widely used also for NC (numeric controlled) machines.

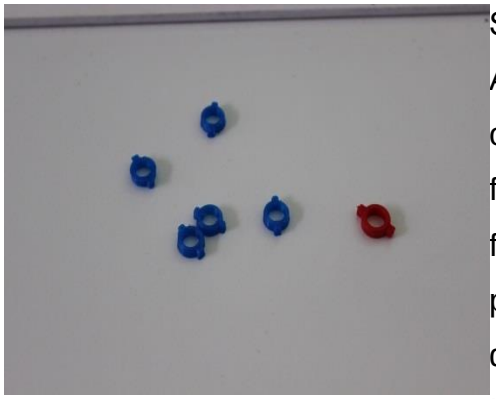
#0114



S:: ‘Repair’ Ludwigsburg, Feb 2017

One of the initial prints at our 3D-printer. - You feed the 3D-printer with the gcode data by using an SD card or directly via USB from another computer that runs Pronterface. Pronterface enables direct control of a 3D-printer, also during a print what could be useful (turn on/off of cooling fan, heat-bed temperature)

#0115



S:: ‘Repair’ Ludwigsburg, Feb 2017

After the parts had been printed it is often a question of tolerance and fitting; some trials may be needed to figure it out. As the price of such a piece is less than 1 cent, it is more a question of time.

In this case, an iteration may take 10 minutes, change geometry, generate STL and gcode, transfer to printer and get the printed part

#0116

S:: ‘Repair’ Ludwigsburg, Feb 2017

Done. This whole process might take 60 minutes if more experienced with the tools I would estimate less than 20 minutes from design to product.

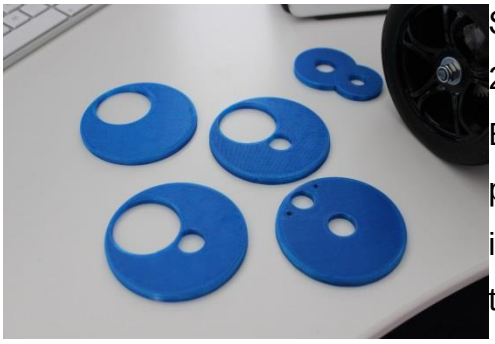
V-2 Exemplary Projects ‘Roller 3001’

#0117

S:: ‘Roller 3001’ Ludwigsburg, Apr 2017

A more sophisticated project initiated by Linus. Skillset is much higher for geometry, fitting of parts, like the gearbox, electronics like the RC controller, LiPo accumulator configuration and drivers to e-motor.

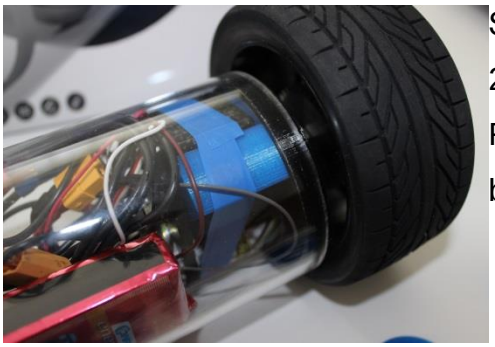
#0118



S:: ‘Roller 3001’ Ludwigsburg, Apr 2017

Evolutionary, iterative approach of parts for the gearbox, cycle time here is about one to two hours, as printing the part already take approx. 45 minutes. As you could see it is possible to print whole for screws as well.

#0119



S:: ‘Roller 3001’ Ludwigsburg, Apr 2017

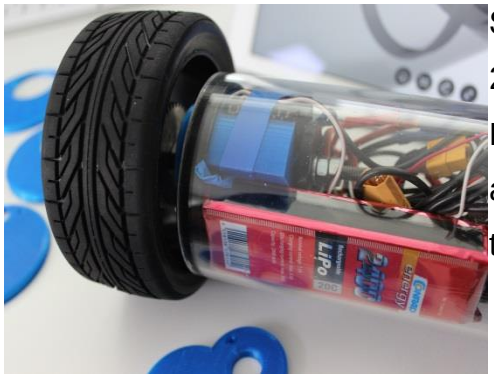
Fitting and fixing. Duck tape as your best friend.

#0120

S:: ‘Roller 3001’ Ludwigsburg, Apr 2017

Here the drive unit with the attached wheel, the hidden gearbox, the axle, e-motor and controller. The speed of this unit is calculated with 30 kilometres per hour. The specification was given by Linus - fast!

#0121



S:: ‘Roller 3001’ Ludwigsburg, Apr 2017

Here you could image the fitting issues as you could see the gear-wheel from the gearbox

Appendix VI Codebook

VI-1 Raw Concept Coding

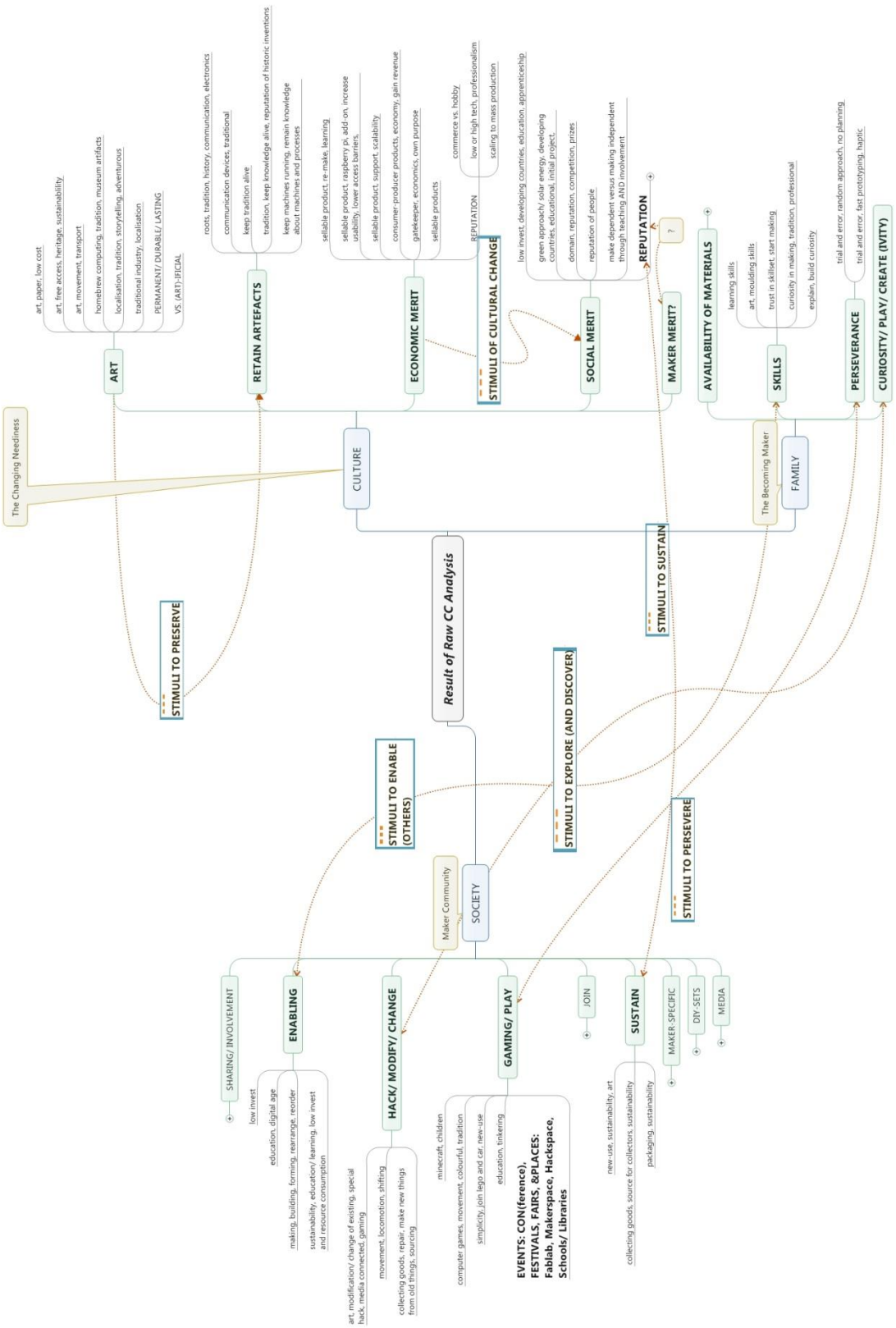
sustainability, art , education, digital age , roots, tradition, history, communication, electronics, unstructured, not norm, non-conformity, work environment, low invest, purity, movement, locomotion, shifting, making, building, forming, rearrange, reorder, making, cooking, DIY-Bio, food, nutrition, food, sustainability, producer - consumer, education, sharing, new electronic, starting of nodeMCU , exemplify, trial and error, fast prototyping, haptic, networking, anticipation, credit, art, home production, small economy, scaling to mass production, gatekeeper, economics, own purpose, the 'own' project, localisation, tradition, storytelling, adventurous, distribution of ideas and projects, low or high tech, professionalism, packaging, sustainability, food, household experiments, bias, art, modification/ change of existing, special hack, media connected, gaming, star wars, media, copy/ new development, art, moulding skills, low invest , teaming, share, easy objective, homebrew computing, tradition, museum artefacts, keep tradition alive, keep machines running, remain knowledge about machines and processes , traditional industry, localisation , share, learn, improve skills, explain, build curiosity , learning skills, trust in skillset, start making, curiosity in making, tradition, professional, joined working, teaming, trial and error, random approach, no planning, media, teaming, domain, reputation, competition, prizes, tradition, keep knowledge alive, reputation of historic inventions, reputation f people, collecting goods, source for collectors, sustainability, collecting goods, repair, make new things from old things, sourcing, consumer-producer products, economy, gain profit, art, movement, transport, art, free access, heritage, sustainability, involvement, share ideas, city activity, art, paper, low cost, media, idea transfer/port, new-use, sustainability, art, new-use, re-use, re-waste, marble course, movement, team work, fire pitch approach, low invest, simplicity, join lego and car, new-use, sellable products, media, robots, club, company, sellable product, support, scalability, DIY set, sellable product, access to electronics, logical understanding, education, DIY sets, construction kits, education tools for schools, green approach/ solar energy, developing countries, educational, initial project, invention, sharing experience, first-hand information, show and tell, trust, experiential knowledge to share, sellable product, raspberry pi, add-on, increase usability, lower access barriers, Minecraft, children, computer games, movement, colourful, tradition, sellable product, re-make, learning, media, education, school, reuse, electronics, tradition, communication devices, traditional, education, tinkering, engineering oriented building kits, traditional, education tools for schools, commerce vs. hobby, presenting, building with kits, community, teaming, do-it-together (DIT), NOT low invest, low invest, developing countries, education, apprenticeship , passion for profession, helping developing countries/ people, make dependent versus making independent through teaching AND involvement, share, educate, train, sustainability, education/ learning, low invest and resource consumption

UK Codings: colourful, tent atmosphere, unexpected, low invest approach, low invest shaker, prebuild parts, modelling, making, forming, shaping,

styling, designing, low invest, keep tradition alive, low invest, children try out, niche 3D-printers, low invest, start and trial, economy, toy vendors, show and tell, share knowledge, sellable product Ohbot

VI-2 Word Cloud on Raw Concept Codes using Nvivo Tool

VI-3 Clustering of Concept Codes into Pattern Codes



VI-4 Pattern Codes and Content Description

Compilation of the codes	Content description	Brief data example for reference
OVERVIEW & CODING HELP SHEET		
SO - SOCIETY - The Maker Community		
SO1 - ENABLING OTHERS		
SO2 - HACKING/ MODIFYING/ CHANGING THINGS		
SO3 - PLAY GAMES		
SO4 - SUSTAIN GOODS		
SOx - NEW OR MIXTURE RELATED TO SOCIETY		
-SO - NEGATIVE INFLUENCE		
FA - FAMILY - The Becoming Maker		
FA1 - LEARN AND SHARE SKILLS		
FA2 - PERSEVERE IN MAKING		
FA3 - FOSTER CURIOSITY/ PLAY/ CREATE (IVITY)		
FAx - NEW OR MIXTURE RELATED TO FAMILY		
-FA - NEGATIVE INFLUENCE		
CU - CULTURE - The Maker Movement		
CU1 - DEVELOP SOCIAL MERIT		
CU2 - (AVOID) ECONOMIC MERIT		
CU3 - DESIGN ART (WASTE)		
CU4 - RETAIN ART (EFACTS)		
CUx - NEW OR MIXTURE RELATED TO CULTURE		
-CU - NEGATIVE INFLUENCE		
!! NEW ASPECT IDENTIFIED (RESOLUTION IN CHAPTER 3.4)		

SOCIETY - The Maker Community **SO1 - ENABLING OTHERS** **SO2 - HACKING/ MODIFYING/ CHANGING THINGS** **SO3 - PLAY GAMES** **SO4 - SUSTAIN GOODS**		
SO1 - ENABLING OTHERS low invest (2x), education(2x), learning, digital age, making, building, forming, rearrange, reorder, sustainability, low invest and resource consumption	Situations and descriptions where the interviewee tells where he/she enabled others in doing something, the helping hand situation, this means also supportive tooling like building kits, writing blogs, maintain Wikipedia pages/ Wordpress, online Teamspeak support	#0010, #0018, #0026, #0059, #0061, #0064
SO2 - HACKING/ MODIFYING/ CHANGING THINGS art, modification/ change of existing, special hack, media connected, gaming, movement, locomotion, shifting, collecting goods, repair, make new things from old things, sourcing	Situations and descriptions where the interviewee tells that he/she opened things for the interest in knowing how something works or what its inside and how it function. There is no distinct if talking is about software or hardware issues. Another dimension is the modification, repair, use it for something that is not the intended use	#0002, #0008, #0012, #0044, #0052, #0053, #0056, #0091, #0111
SO3 - PLAY GAMES Minecraft, children,	Situations and descriptions where the interviewee tells	#0010, #0017,

computer games, movement, colourful, tradition, simplicity, join lego and car, new-use, education, tinkering	that he/she is in a playing situation plays with materials, software code, games, electronic equipment (Arduino, esp8266, Raspberry Pi, sensors) and data (temperature, humidity), objective might be unclear, unclear intent of doing in this situation, flow	#0028, #0045, #0046, #0069, #0070, #0071, #0085, #0095, #0100, #0103
SO4 - SUSTAIN GOODS new-use, sustainability, art, collecting goods, the source for collectors, sustainability, packaging, sustainability	Situations and descriptions where the interviewee tells that he/she do not like to throw things away like to keep things for later, for something not recognized at the moment. Repair and maintain things for himself/ herself or to help others.	#0001, #0008, #0009, #0041, #0051, #0052, #0053, #0054, #0055, #0091, #0093, #0116
FAMILY - The Becoming Maker **FA1 - LEARN AND SHARE SKILLS** **FA2 - PERSEVERE IN MAKING** **FA3 - FOSTER CURIOSITY/ PLAY/ CREATE (IVITY)**		
FA1 - LEARN AND SHARE SKILLS learning skills, art, moulding skills, trust in skillset, start	Situations and descriptions where the interviewee tells that he/she has learned something new, often from	#0001, #0010, #0011, #0027,

making, curiosity in the making, tradition, professional, explain, build curiosity	others (learning, support situation) and shared it later with others. On a skill level, might be a programming skill as well. Also using tools like Github, Wordpress, Web servers. Also, the situation, if in the family, friends, school, hackspace, club, Maker Faire, other fairs or workshops.	#0029, #0057, #0061, #0064, #0071, #0073, #0074, #0075, #0099
FA2 - PERSEVERE IN MAKING trial and error, random approach, no planning, trial and error, fast prototyping, haptic	Situations and descriptions where the interviewee tells that he/she failed in the intended outcome or in his/her expectation about the outcome. How to handle, making good for the bad, disappointment, retry, timing. Was there support from others? Help in this situation (needed)?	#0015, #0023, #0030, #0031, #0039, #0069, #0070, #0088
FA3 - FOSTER CURIOSITY/ PLAY/ CREATE (IVITY)	Situations and descriptions where the interviewee tells that he/she was fostered in doing something. Given play time, resources to follow and support his/her own curiosity. Special situations were	#0002, #0003, #0006, #0010, #0013, #0017, #0019, #0037,

	explicit space was given to be creative (cardboard boxes, liquids, computer games, hacking/destroy objects).	#0054, #0058, #0079, #0095, #0096, #0098, #0100
CULTURE - The Maker Movement **CU1 - DEVELOP SOCIAL MERIT** **CU2 - (AVOID) ECONOMIC MERIT** **CU3 - DESIGN ART (WASTE)** **CU4 - RETAIN ART (EFACTS)**		
CU1 - DEVELOP SOCIAL MERIT low invest, developing countries, education, apprenticeship, green approach/ solar energy, developing countries, educational, initial project, domain, reputation, competition, prizes, the reputation of people, make dependent versus making independent through teaching and involvement, **REPUTATION**	Situations and descriptions where the interviewee tells that he/she is 'making' because of reasons that are not economical driven.	#0004, #0005, #0039, #0074, #0075, #0078, #0080, #0095, #0109
CU2 - (AVOID) ECONOMIC MERIT sellable product(2x), re-make, learning, sellable product, raspberry pi, add-on, increase	Situations and descriptions where the interviewee tells that he/she does 'making' not only for fun but to earn some money to spend	#0001, #0008, #0009, #0023, #0025,

usability, lower access barriers, sellable product, support, scalability, consumer-producer products, economy, gain revenue, gatekeeper, economics, own purpose REPUTATION commerce vs hobby, low or high tech, professionalism, scaling to mass production	again for the hobby or for real profit background.	#0028, #0029, #0034, #0045, #0053, #0081, #0082, #0083, #0084, #0085, #0086, #0087, #0088, #0089, #0090, #0091, #0108
CU3 - DESIGN ART (WASTE) art, paper, low cost art, free access, heritage, sustainability, art, movement, transport, homebrew computing, tradition, museum artefacts, localisation, tradition, storytelling, adventurous, traditional industry, localisation, PERMANENT/ DURABLE/ LASTING VS. (ART)-IFICIAL	Situations and descriptions where the interviewee tells that he/she used a low amount of cost for materials, try to reduce these material costs by collecting from others, from donated materials, from scrap.	#0001, #0002, #0006, #0007, #0008, #0044, #0079, #0099
CU4 - RETAIN ART (EFACTS) roots, tradition, history, communication, electronics, communication devices, traditional, keep tradition alive	Situations and descriptions where the interviewee tells that he/she is interested in carrying on tradition and history. Maintain things	#0002, #0004, #0011, #0018, #0019,

tradition, keep knowledge alive, the reputation of historic inventions, keep machines running, remain knowledge about machines and processes	and objects that other later generation can see or use these goods like machines, skills, processes of manufacturing.	#0040, #0046, #0051, #0052, #0053, #0054, #0055, #0056, #0061, #0067, #0079, #0080, #0091, #0109

Appendix VII Contact Letter for Initial Contact

Hallo .....,

wir haben uns auf der Maker Faire in ... kurz in einem Gespräch kennengelernt. Ich fand deine Idee....

Daher meine Frage, hättest du Zeit und Musse, mir folgende Fragen zu beantworten (einfach wieder als Email zurück schicken). Deine Antworten werden anomymisiert, bevor ich sie weiter verwende. Es geht mir darum, ob ich in den letzten 1 1/2 Jahren die richtige Einschätzung zu manchem Maker-Thema gefunden habe. Hier die Fragen, du kannst die Anzahl der Zeilen zum Antworten sehr gerne erweitern, gerne können wir auch skypen und ich befrage dich persönlich, wenn dir das lieber ist.

Würdest du dich als Maker bezeichnen? Wenn Ja, was macht für dich den Maker aus? Wenn nicht, wie würdest du dich dann beschreiben?

Was machst du am Liebsten? Woher hast du die Fähigkeit, Fertigkeiten? Hast du auch schon in der Schule viel gebastelt? AGs, Projekte? Oder hast du mehr Zeit damit in der Freizeit verbracht? Beides?

Mit wem sprichst du darüber am meisten? Mit wem tauschst du dich darüber aus? Ist dir das wichtig? Was bringt es dir? Persönlich, anderen Personen, Gruppen? Ist es nur Hobby für dich, oder würdest du dich, wenn etwas besonders gut ankommt, damit selbstständig machen?

Was wäre aus deiner Sicht wichtig, wenn man sich Gedanken über die Maker macht?

Vielen Lieben Dank für Deine Antworten im Voraus. Ich plane auch zukünftig an den Maker Faires teilzunehmen, vielleicht können wir uns dort persönlich kennen lernen.

Liebe Grüße

Carsten Skerra

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Appendix VIII Questionnaire for Semi-Structured Interviews

TEIL A: KARRIERE UND PRIORITÄTEN IM LEBEN

TEIL B: BEZIEHUNGEN

TEIL C: ARBEITSGEBIET / INSIGHTS

TEIL D: AUFMERKSAMKEIT UND DYNAMIK

TEIL A: KARRIERE UND PRIORITÄTEN IM LEBEN

1. Auf welche Erlebnisse im Leben, bist du am meisten stolz?

2. Gab es ein besonderes Projekt oder Erlebnisse, die dich wesentlich bezüglich deines Werdegangs als Maker beeinflusst haben? Wenn ja, könntest Du ein wenig darüber erzählen?

    a. Wie hatte das Projekt/ Ereignis dein Interesse geweckt?

    b. Wie hat es sich im Laufe der Zeit entwickelt?

    c. Wie wichtig war dieses Projekt / Ereignis für deine kreative Leistung?

    d. Hattest du noch interessante, bewegende Erlebnisse?

3. Welche Tipps würdest du einem jungen Maker geben, der auch starten möchte?

    a. Wie würdest du aktuell jemanden über die Bedeutung der Maker Szene informieren?

        Sind wenige soziale Kontakte wichtig oder viele? Wie steht es mit Mentoren, Kollegen? Deine eigene Identität, stellte sich die eher früh oder eher spät auf? Welche Rolle hatte die Arbeit?

    d. Wie würdest du die Wichtigkeit deiner Motivation einschätzen?

        Intrinsische versus extrinsische Gründe? Bindung an persönliche Werte oder davon eher getrennt?

4. Wie würdest du einen jungen Menschen beraten, warum es wichtig ist, sich in dem Bereich zu engagieren?

    a. Ist das, warum es für dich wichtig war? Wenn nicht, wie ist deine aktuelle Perspektive?

5. Wie hast du dich zunächst engagiert oder interessiert? Was hat dich so lange beschäftigt/ eingebunden?

6. Gab es Zeitpunkte, in denen du weniger intensiv interessiert/ eingebunden warst - schien es weniger interessant oder wichtig für dich zu sein? Könnest du einen Zeitpunkt beschreiben, der herausragt?

TEIL B: BEZIEHUNGEN

1. Wenn es in deinem Leben eine bedeutende Person (oder Personen) gegeben hat, die dein Denken und deine Einstellung über deine Arbeit beeinflusst oder stimuliert hat ...

a. Wie hast du diese Person kennengelernt?

b. Wie/ warum hast du dich für diese Person interessiert?

c. Wie habt sie deine Arbeit und Einstellungen beeinflusst (z. B. Motivation, persönliche oder berufliche Werte)?

2. Ist es wichtig für dich, junge Leute zu unterrichten und mit ihnen zu arbeiten?

a. Warum?

b. Was habt dich daran interessiert, sie zu begeistern? Warum?

c. Wie machst du das?

3. Wenn du mit anderen Makern interagierst oder arbeitest, könntest du beurteilen, ob sie dabei bleiben, oder das Feld vielleicht wieder verlassen werden oder vielleicht auf dem Feld erfolgreich sein werden?

a. Erkennst du Menschen, die in ihrer zukünftigen Arbeit wahrscheinlich kreativ sind? Wie? Welche Eigenschaften haben sie?

4. Bemerkst du Unterschiede zwischen Männern und Frauen, Jugendlichen und männliche und weibliche Makern auf dem Gebiet? Wenn ja,

in den Interessen?

Den Fähigkeiten? Der Kreativität?

In der Art, wie sie Lernen?

In der Art, wie sie mit anderen Menschen / Kollegen interagieren?

Wie definierst du Erfolg und Leistung?

In ihren persönlichen Zielen und Werten?

In ihren beruflichen Zielen und Werten?

Andere Maker

5. Zu welcher Zeit in deinem Leben, waren andere Maker besonders einflussreich in der Gestaltung deiner persönlichen und beruflichen Identität?

Familie

6. In welcher Art und Weise war dein Familienhintergrund etwas Besonderes, um dir zu helfen, die Person zu werden, die du bist?

7. Wie hast du die meiste Zeit als Kind verbracht? Welche Aktivitäten hast du gerne gemacht? Mit Kollegen? Eltern? Geschwister? Allein?

8. In welcher Art und Weise haben dich dein Ehepartner und Kinder in den Zielen und der Karriere beeinflusst?

TEIL C: ARBEITSGEBIET / INSIGHTS

1. Woher kommen die Ideen für deine Arbeit?

    a. Lesen? Andere? Deine eigene vorherige Arbeit? Lebenserfahrungen?

    b. Was bestimmt (bzw. wie entscheidest du) welches Projekt oder Problem du als nächstes bearbeitest?

2. Wie wichtig ist die Rationalität gegenüber der Intuition in deiner Arbeit?

    a. Gibt es zwei verschiedene Stile in deiner Arbeit (z. B. die eine "rationale" und die andere "intuitive")?

    b. Glaubst du, es ist wichtig, "dem Bauchgefühl zu folgen" oder "deinen Instinkten zu vertrauen"? Oder ist das meist falsch und irreführend?

3. Wie gehst du über bei der Entwicklung einer Idee oder eines Projekts vor?

    a. Beginnst du mit dem Schreiben grober Entwürfe?

    b. Veröffentlichst du deine Arbeit sofort oder wartest du eine Weile?

4. Kannst du deine Arbeitsmethoden beschreiben?

    a. Möchtest du lieber alleine oder im Team arbeiten?

D: AUFMERKSAMKEIT UND DYNAMIK

1. Aktuell, welche Aufgabe oder Herausforderung siehst du als die wichtigste für dich?

    a. Ist es das, was die meiste Zeit und Energie in Anspruch nimmt? Wenn nicht, nimmt am meisten Zeit und Energie in Anspruch?

2. Was machst du dazu? [Testen nach Feld / Domäne / Reflexion]

3. Machst du das primär wegen eines Verantwortungsbewusstseins oder weil es Spaß macht? Beschreiben.

    a. Wie hat sich das im Laufe der Jahre verändert?

4. Möchtest du irgendwelche Veränderungen vornehmen, wie aktiv du in deinem Gebiet arbeitest?

Appendix IX Transcripts

IX-1 Interview Transcript - Fablab, anonymized

	Time	Content
1	6:18 - 7:54	ja wird sind gerade im fablab ~~HAUSEN~~ als ein Stadtteil des fablab ist vom ~~TRUDE~~ sie sind das grösste in ~~HAUSEN~~, oder? ja wird sin in ~~HAUSEN~~ sind eine offene entwicklungswerkstat in ~~HASUEN Mitte~~ und stellen Hightech Werkzeuge und entsprechende workshop für jedermann **(SO1)** zur verfügung und dein workshop beide ester ~~Frau TRUDE~~ besonderes Projekt das sie da machen ja wir haben heute das Projekt made for my reacher gestarrt das ist ein design Projekt mit rollstill Fahrern zusammen zu machen um add ons fr ihre Rollstühle die ndann ihr leben **(SO2, CU1)** erweitern sollen. und beinten sich noch in der findings-hase? diskutieren noch. genau wir haben heute eine ideation **(SO3)** gemacht und ganz viele Ideen entwickelt von denen werden wir später 3 aussuchen die technologisch umsetzben verfeinern und im Endeffekt ein Produkt auf den ... ein Produkt herausbringen **(CU2)**. vorzustellen, was gibt es denn da ein Sachen die man selbst mache kann und die Rollstuhlfahrer das leben erleichtern. ja wir hatten heute heute das Thema wetter rollstuhlfahrer habe oft da problem wenn es regnet keine richtige Lösung gibt hemm und wir haben zum Beispiel einen regenschutze **(SO2)** entwickelt der sich sich wi ein Zelt um das um den Rollstuhl rüber wirft. und das sieht dann auch schick aus oder ? wie bitte das suit dann auch schick aus oder? in diesem fall ist es eine ganz einfach Erlösung man hat ein Gestell und darüber stzieht man so eine haut. eine anderes Thema was das Thema transport und wir haben zum Beispiel so einen kleinen Koffer entwickelt der elektronisch weiss wo der Rollstuhl ist und der einem immer folgt. vorne rum fahren kann

		wo man gut dran kommt als Rollstuhl Fahrer und der immer mit am start heißt mein doc. ~~TRUDE~~ sie haben was ganz altes hergenommen eine alte Strickmaschine **(CU4, SO2)** was machen sie damit. es sind Maschinen die mit fünft rollen gehackt wurden da weis wir haben die alte hardware rausgenommen wir haben neuen hardware einen ardunio uno angeschlossen **(SO2)** und neue software für entwickelt so das das man jedes Bild was man im format 200 Pickel breit in png speichert stricken kann. und der stricken sie dann die se biene sind seh r haltbar sind dasquasi will gefärbt die kann man auch waschen ohne das da was raus geht von der färbe ja genau das ist ganz normale wolle wie sie auch für pullover verwendet und zum Arduino stand gehen wir später noch und ~~TRUDE~~ ist übergeben an sie.
2	5:04 - 6:00	ja jetzt gerade ist eine fahrende Skulptur auch vorbei gekommen die ein bisschen lärm gemacht hat mit knatterden Motoren auch das gehört dazu das hier so ein bisschen show **(FA3)** gemacht wird. sie haben eben ~~Herr TRUDE~~ angesprochen, die Rolle des 3D Druckers. also Drucker mit denen man, ja, Körper herstellen kann. Das hat die makerszene in der letzten zeit wirklich beflügelt diese Kunststoffdrucker **(SO1)**. Ja, ich meine das ist auch ein Projekt das aus der Szene raus kommt, die Technik ist ja schon 25 Jahre alt oder so. Viel grossen Firmen und Entwicklungs- ja eh Forschungsabteilungen vorbehalten **(SO1)**. die Maker haben vor 10 jaähren angefangen das können wir doch auch bauen, das schau mal, das ist doch nur x y z und da muss Elektronik hin hier muss ein Druck und so und sie haben das nachgebaut sie haben es als Gerät für den Privatanwender überhaupt erst möglich gemacht und auch 3d drucker so ein bisschen den Begriff geprägt und das wirkt natürlich nach. Und diese tools **(SO1)** sind auch die glaube ich, die Sachen sozusagen vom Basteln vom Bauen von vor 20 bis 30 Jahren

		unterscheiden.
3	3:15 - 5:04	Was sich geändert hat? Hallo. ja, Wir sehen das sich da etwas geändert hat. ich glaube so ein bisschen eine Synthese aus dem alten basteln das wurde ja so ein bisschen als der computer rauskam und das internet kam hatte man den Lötkolben weggelegt weil man dachte, ja altes zeug **(CU4)**, und heute sehen wir wie das halt zusammen fliesst weil diese neuen Bastler, diese maker die vernetzen sich ja da ist die community ja das wichtige ja die gemeinsacht **(FA1)** es sind nicht mehr mehr die Bastler im Keller sozusagen sondern sie treffen sich, sie tauschen sich aus sie lernen im internet von einander und natürlich hier vor Ort. Und welche Angebote werde nach gefragt von diesen Mauern, was interessiert hier alles? also löten ist auch immer noch in. also hier gehen glaube ich auch sehr viele Leute nach hause die das wieder oder erstmalig gelernt **(FA1)** das braucht man immer noch sie haben ja schon ein paar Sachen genannt arduino raspberry pi diese einplatinenkomputer. 3d druck ist ein Thema das werden wir auch noch hören das ist ja so ein bisschen verbunden mit der makerszene dieses Wundergerät was im wesentlichen aus digitalen Daten wieder unfassbare Sachen macht genau dieses verbinden von digitalen vom kreativen aber denn auch von zum dinglichen auch wieder Sachen mit der hand anfassen das kann auch das gute alte schrauben sägen **(CU4)** Sowas sein. das findet sozusagen seinen Ausdruck hier. Holzspielzeug **(CU3)** ist mittlerweile hier auch zu sehen was selbst gemacht wird oder die gute alte Seifenkiste kurvt hier auch rum ach so Sachen die maker interessieren oder in jedem fall wir versuchen das relativ breit aufzustellen und zusammen zu holen weil das befruchtet sich ja auch untereinander glaube ich wer hat das selber gebaut was kann ich mir daraus abgucken und unser ziel ist natürlich die ganzen Besucherinnen und Besucher hier zu

		Makern zu machen **(FA1, FA3)** unser credo ist so ein bisschen das kannst du halt auch und das ist halt nichts was ein Studium oder Ausbildung erfordert einfach mal anfangen und dann ergibt sich vielleicht ein neues hobby.
4	2:36 - 3:01	Reden wir jetzt über ein bisschen über Makers und die Makerszene über Menschen die dinge nicht nur einfach besitzen wollen sondern sie gerne selbst machen oder ja sie zumindestens genauestens unter die Lupe nehmen und begreifen wollen**(SO2)**.
5	3:00 - 3:15	~~TRUDE~~ selbster machen war ja lange zeit total out, basteln irgendwie wie letztes Jahrhundert, das hat sich in letzter zeit komplett geändert oder?
6	9:06 - 9:45	ja dann an ~~Achim~~ tatsächlich die ardunio die Einplatinen computer sind ein Thema was hier hier sehr sehr gepreit gestreut ist auch andere Plattformen kommen da zum Einsatz aber insgesamt geht es sehr in der maker Szene sehr stark um Elektronik um elektronikbastelnd eine Sache die ja lange zeit immer mal ein bisschen brach liegt lag jetzt wieder sher stark im kommen ist und das liegt auch daran das viele Leute etwas programmieren wollen**(FA1)** aber das hier auch etwas brauchen was es das Programm aufnimmt und umsetzt in Bewegung zum Beispiel neben mit steht ~~TRUDE~~ vom ~~Verein HAUSEN~~
7	9:46 - 12:45	~~TRUDE~~ wie kommt es das dieses ja selbst machen von Elektronik wieder so beliebt geworden ist und das so viele Leute sich dran setzen und wieder löten, Platinen herstellen, was treibt die an? ja es gibt viele gründe für einerseits sind die Komponenten **(CU3)** günstiger geworden die sind verfügbar geworden ich kann als Privatperson so etwas jetzt erwerben für kleines geld die Programmiersprachen und Umgebungen sind

		einfacher zu bedienen und dass man sagen kann die gesamte usability von so einem system ist einfach heute viel besser als noch vor 5 oder gar vor 10 jähren. sie haben einen verein gegründet**(FA1, CU1)** das heißt si e haben sich mit anderen Leuten vernetzt gibt es genügend Leute in Deutschland, die da dran interesse haben das zu machen und sich auszutauschen. die meine Chen gab es schon immer ich glaube durch das internet und dieses internet dieses soziale internet das wir jetzt haben diese web 2.0 und die ganze social media Sachen ist es einfacher geworden sich zu vernetzen die menschen gab es schon immer in Vereinen Funkamateure **(CU4)** und so weiter. jetzt ist es nur einfache geworden sich zu verabreden. ihr vereinen nennet sich freie maker, ahh hat das wort frei eine besondere Bedeutung? es ist ahem einfach irgendwie so vom Himmel gefallen, freie maker wir wollten unabhängig natürlich in unsrem ja wir sind ein gemeinnütziger verein der einfach unabhängig von ja sowohl von der Regierung als auch von kommerziellen Interessen ist und deswegen haben wir gedacht freie maker würde da ganz gut passen. wie muss man sich denn das verienleben vorstellen, was tun sie als verein was machen sie Kontakt siezen disci zusammen im Keller und löten fleissig mit mehr Leuten zusammen, oder ie muss man sich das genau vorstellen**(FA1)**. das eigentlich ziel ist die ja digitale Kultur vor allem bezogen auf hardware in Deutschland zu fördern das heisst den Leuten die Möglichkeit zu geben mit dieser Technik in Kontakt zu kommen und ihr wissen zu vertiefen**(FA1)** und dafür haben wir einseins naütich ganz anbende an denen wir löten bidmesweit aufgestellt so das wir halt ja es ist schwierig alle Leute in einen räum zu kriegen zur selben zeit und deswegen haben wir das ganz e auf das internet verteilt, weil ja, wollte hangout und Skype**(SO1)** und so etwa diese technologien verwenden wir für unsre Sitzungen, die wir da

		haben aber es geht noch weiter es ist also etwa ein offline Vereinsleben da das man etwas nachschlagen kann im wiki und so weiter. Man weiss ja von den Hackern **(SO2)**also von den guten Hackern das sie gerate nassen aufmachen reingucken um sie zu verstehen. haben sie auch diese n Anspruch selbst machen um zu verstehen weil ja mittlerweile ein samasrt phone zu kompliziert geworden ist ähm. so dass man wirklich untersuchen muss um es zu verstehen richtig das ist eigentlich genau das was wir machen wir interessieren uns wir hardware and software wir sind die guten hacker aber wir sind halt vor allem die offenen hacker das heisst bei uns muss man nicht wir sind kein geschlossener verein sonder wir sind gang ganz offen oder der das Interesse hat etwas gutes mit der Technik zu machen und neugierig ist ist bei uns willkommen**(SO2)**.
8	12:49-13:36	ist es denn auch so etwa was Erfindergeist**(FA3)** der der die Leute in den verein treibt? oder ist es nur ja nachmachen was andere Leute schon erdacht haben? das mit den Erfindern ist in Deutschland etwas schwierigen die wollen meistens ihre Sachen geheim halten und patentieren und irgendwie geld damit machen und was m´bestimmt auch seinen für manchen Leute sehr gut ist wir sind eher offen wir wollen alles wissen teilen, wir wollen unserer Designs teilen und wir wollen gemeinsam dann etwas grössere erschaffen was man Einzelt s o nicht schaffen**(FA2)** könnte als einzelner Erfinder aber natürlich kommen Erfinder bei uns rein. ~~TRUDE~~ herzlichen dank wir reden gleich noch ein bisschen weiter über das Thema aber jetzt wollen wir jetzt erst hören was schick killt griffen zum Thema 3d druck was ja sehr e´sehr gross repräsentiert ist.
9	13:36 - 16:19	die maker scene hatte such den 3d Drucker einen richtigen boom erfahren ~~TURDE~~ auch vom ~~fablab HAUSEN sie~~ haben einen ganz beordern d3 Drucker damit können sie nicht nur

		dinge machen sondern auch sie haben es ja auch selber gemacht ja der 3d Drucker ist aus verschiedenen Bausätzen **(CU2, SO1)** zusammen gesetzt und damit ein komplette neue Konstruktionäähm . und ist open source ja also wenn er einmal das level erreicht hat das er perfekt druckt dann werden die plane auch veröffentlicht und die Leute sind dazu eingeladen es nachzumachen und es weiter zu entwickeln und die Element die sie verwendet haben dsind auch open source. baute davon ja unterkomponeten sind auch von uns. und was drucken sie damit? also der drucker ist jetzt speziell dafür konstruiert Schuhe zu drucken**(CU2, CU3)**. Schuhe drucken, dass stelle ich mir recht kompliziert vor**(FA2)**. Schuhe drucken und Schuhe drucken da würde ich ja eigentlich lieber kaufen. als selber machen was ist der Vorteil, wenn man das selber macht es gibt grosse Vorteile also die Schuhe wie wir sie jetzt drucken sind komplett individuelle massgefertigte Schuhe quasi nicht als lderschuh wie man es kennt sondern als Sportschuh und wir haben halt ie möglichkeit durch 3d scan oder durch fussdruckmessungen ganz idi Daten in das design der Schuhe einfliessen zu lassen so dass sie eigentlich ein Komfort **(SO4)** kriegen können,,d er sonst kaum möglich ist. aber Schuhe bestehen daraus she runetrscheidlichen Materialien gibt es die Gummisohle dann gibt es Leder, Oberleder dann gibt es weiche Mittelsohle und dass drucken sie alles aus Plastik oder wie habe ich mir das vorzustellen also das ist due gröbster Herausforderung bei unserem Projekt das unser 3d pdrucker mit mehreren Materialien drucken **(SO2)** können soll die misten mteraielen sind schon Kunststoff aber als zum Beispiel fester Kunststoff mit flexiblem Kunststoff härter weicher und so gemischt. und wer hat dann das design die 3d Daten für die Schuhe entwickelt? also zur zeit mache ich das design für die Schuhe das könnte aber eigentlich jeder auch selber machen

		man könnte es auch automatisiert erstellen und dann würden diese Schuhe nicht drucken da hat man dann keine Probleme diesbezüglich das ist unsere Hoffnung. gerade würde ich sagen dann mache ich mich jetzt auf dies Schuhe respektive auf die suchen zum nächsten stand.

IX-1 Interview Translation

Semi-Structured, Open Questions and enhanced Answers (Grammar, Repetitions, Fillings)	**Translation from enhanced answers into English**
Was hat sich geändert? Ich sehe, daß sich da etwas geändert hat. Ich glaube, so ein bisschen eine Synthese aus dem alten Basteln, das war ja so ein bisschen als der Computer rauskam. Und als das Internet kam hatte man den Lötkolben weggelegt, weil man dachte, ja altes Zeug, und heute sehen wir, wie das zusammen fließt, weil diese neuen Bastler, diese Maker, die Vernetzen sich, ja, da ist die Community, ja das Wichtige, ja, die Gemeinschaft. Es sind nicht mehr mehr die Bastler im Keller sozusagen, sondern sie treffen sich, sie tauschen sich aus, sie Lernen im Internet voneinander und natürlich hier vor Ort.	**What has changed?** I see that something has changed. I think so a bit of a synthesis from the old tinkering, that was so a bit as the computer appeared. And when the Internet came, the soldering iron had been put away, because you thought, old stuff, and today we see how this flows together, because of these new hobbyists, the makers, the networking, yes, there is the community, yes Important, yes, the community. It is no longer the hobbyists in the cellar, so to speak, but they meet, they exchange, they learn from the Internet and of course here on the ground.

Semi-Structured, Open Questions and enhanced Answers (Grammar, Repetitions, Fillings)	Translation from enhanced answers into English
Und welche Angebote werden nachgefragt von diesen Makern, was interessiert hier alles?	**And what offers are demanded by these Maker, what interests here everything?**
Also Löten ist auch immer noch in. Also hier gehen, glaube ich, auch sehr viele Leute nach Hause, die das wieder oder erstmalig gelernt haben. Das braucht man immer noch, du hast ja schon ein paar Sachen genannt, Arduino, Raspberry Pi, diese Einplatinencomputer. 3D Druck ist ein Thema, das werden wir auch noch hören, das ist ja so ein bisschen verbunden mit der Makerszene, dieses Wundergerät, was im Wesentlichen aus digitalen Daten wieder unfassbare Sachen macht. Genau dieses Verbinden von Digitalem und vom Kreativen, aber dann auch zum Dinglichen, auch wieder Sachen mit der Hand anfassen. Das kann auch das gute alte Schrauben, oder Sägen, sowas sein. Das findet sozusagen seinen Ausdruck hier. Holzspielzeug ist mittlerweile hier auch zu sehen, was selbst gemacht wird oder die gute alte Seifenkiste kurvt hier auch rum, ach so Sachen, die Maker interessieren. Oder in jedem Fall, wir versuchen das	So soldering is still in. So here I go, I think, a lot of people home, who have learned this again or for the first time. You still need that; you already have a few things called Arduino, Raspberry Pi, these single-board computers. 3D printing is a topic that we will also hear, which is so a bit connected with the Maker scene, this miracle device, which essentially makes out of digital data again real things. It is precisely this combination of digital and the creative, but then also to the comprehensible, also to touch things by hand. This can also be the good old screwing or using saws. This is, so to speak, expressed here. Wooden toys are now also seen here, which is made itself or the good old soapbox car here, oh so things, the Maker's interest. Or in any case, we try to establish this relatively broadly and bring together, because that is also fertilised among themselves, I believe, who built that itself, what can I look at it and our

Semi-Structured, Open Questions and enhanced Answers (Grammar, Repetitions, Fillings)	Translation from enhanced answers into English
relativ breit aufzustellen und zusammen zu holen, weil das befruchtet sich ja auch untereinander, glaube ich, wer hat das selber gebaut, was kann ich mir daraus abgucken und unser Ziel ist natürlich die ganzen Besucherinnen und Besucher hier zu Makern zu machen. Unser Kredo ist so ein bisschen, dass kannst du halt auch und das ist halt nichts was ein Studium oder eine Ausbildung erfordert. Einfach mal anfangen und dann ergibt sich vielleicht ein neues Hobby.	goal is, of course, the visitors here become Maker. Our credo is so a bit that you can stop, and that is just nothing that requires a study or an education. Just start and then maybe a new hobby.
Die Rolle des 3D Druckers? Also Drucker mit denen man Körper herstellen kann. Das hat die Makerszene in der letzten Zeit wirklich beflügelt, oder? Ja, ich meine, das ist auch ein Projekt, das aus der Szene raus kommt, die Technik ist ja schon 25 Jahre alt, oder so. Die Technik war	**What is the role of the 3D-printer? So printers with which one can produce bodies. This has really aroused the Maker scene in recent times, right?** Yes, I mean, this is also a project that comes out of the scene, the technology is already 25 years old,

Semi-Structured, Open Questions and enhanced Answers (Grammar, Repetitions, Fillings)	**Translation from enhanced answers into English**
großen Firmen mit Entwicklungs- und Forschungsabteilungen vorbehalten. Die Maker haben vor 10 Jahren angefangen, das können wir doch auch bauen, da schau mal, das ist doch nur X-Y-Z und da muss Elektronik hin, hier muss ein Druckkopf hin und so haben sie das nachgebaut. Sie haben es als Gerät für den Privatanwender überhaupt erst möglich gemacht. Und auch 3D Drucker haben so ein bisschen den Begriff geprägt und das wirkt natürlich nach. Und diese Tools sind es auch, die glaube ich, die Sachen sozusagen vom Basteln vom Bauen von vor 20 bis 30 Jahren unterscheiden.	or so. The technology was reserved for large companies with development and research departments. The makers started 10 years ago, we can also build, since look, that is only X-Y-Z, and there must be electronics, here must have a print head and so they have replicated. As a device for the private user, they have made it possible at all. And also 3D-printers have shaped the concept, so a little bit and that works naturally. And these tools are. Also, I think, the things differ from the crafting of building from 20 to 30 years ago.
Was macht das fablab Stadt X, an welchen Projekten arbeitet ihr? Ja, wird sind in Stadt X. Eine offene Entwicklungswerkstatt in Stadt X und stellen Hightech Werkzeuge und entsprechende Workshops für jedermann zur Verfügung. Ja, wir haben heute das Projekt made for my reacher gestartet, das ist ein Design Projekt mit Rollstuhl Fahrern zusammen. Die Idee ist, zu machen, um add-ons für ihre Rollstühle zu	**What is the fablab city X, on which projects do you work?** Yes, will be in city X. An open development workshop in city X and provide high-tech tools and appropriate workshops for everyone. Yes, we started today the project made for my wheelchair, which is a design project with wheelchair users. The idea is to make to design add-ons for their wheelchairs, which should then extend their lives. We

Semi-Structured, Open Questions and enhanced Answers (Grammar, Repetitions, Fillings)	Translation from enhanced answers into English
entwerfen, die dann ihr Leben erweitern sollen. Wir sind noch in der Findungsphase und diskutieren noch. Wir haben heute eine Ideation gemacht und ganz viele Ideen entwickelt, von denen werden wir später drei aussuchen, die technologisch umsetzbar sind, verfeinern und im Endeffekt ein Produkt herausbringen.	are still in the investigation phase and still discuss. We have developed an idea today and developed a whole lot of ideas, of which we will later choose three, which are technologically feasible, refine and ultimately bring out a product.
Schwierig vorzustellen. Was gibt es denn da ein Sachen die man selbst mache kann und die Rollstuhlfahrer das Leben erleichtern? Ja, wir hatten heute das Thema Wetter. Rollstuhlfahrer haben oft da Probleme, wenn es regnet und es keine richtige Lösung gibt. Wir haben zum Beispiel einen Regenschutz entwickelt, der sich wie ein Zelt, auf den Rollstuhl drüber wirft. In diesem Fall ist es eine ganz einfache Lösung, man hat ein Gestell und darüber zieht man so eine Haut. Ein anderes Thema war Transport und wir haben zum Beispiel, so einen kleinen Koffer entwickelt der elektronisch weiß, wo der Rollstuhl ist und der einem immer	**Hard to imagine. What are the things you can do yourself and make life easier for wheelchair users?** Yes, we had the weather today. Wheelchair users often have problems when it rains, and there is no proper solution. For example, we have developed a rain cover that throws itself in the wheelchair like a tent. In this case, it is a straightforward solution, you have a frame, and you pull a skin like that. Another theme was transportation, and we have, for example, developed a small suitcase that electronically knows where the wheelchair is and which always follows you. Who can drive to where

Semi-Structured, Open Questions and enhanced Answers (Grammar, Repetitions, Fillings)	Translation from enhanced answers into English
folgt. Der dahin fahren kann, wo man gut dran kommt als Rollstuhlfahrer.	you can get as good as a wheelchair user.
Du hast etwas ganz altes hergenommen eine alte Strickmaschine. Was machst du damit? Es sind alte Strickmaschinen, die wir zu fünft ge-„hackt“ haben, das heißt, wir haben die alte Hardware rausgenommen, wir haben an die neue Hardware einen Ardunio Uno angeschlossen und neue Software dafür entwickelt, so dass man jedes Bild, was man im Format 200 Pixel breit in einem png-speichert, stricken kann. Und der strickt sie dann. Diese Bienen sind sehr haltbar, die sind quasi wie gefärbt, die kann man auch waschen, ohne dass da was raus geht. Das ist ganz normale Wolle wie sie auch für Pullover verwendet.	**You took something ancient, an old knitting machine. What do you do with it?** They are old knitting machines, which we have chopped to five, "that is, we took out the old hardware, we connected the new hardware to an Arduino Uno and developed new software so that you could see every picture In the format 200 pixels wide in a png-stores, can knit. And then he knits them. These bees are very durable, which are quasi like coloured, which one can also wash, without that something will bleach. This is quite natural wool as it is also used for sweaters.
Was macht so ein Arduino? Was macht ihr damit? Der Ardunio, ein Einplatinencomputer ist ein Thema, was hier sehr breit gestreut ist, denn auch andere Plattformen kommen zum Einsatz.	**What makes such an Arduino? What do you do with it?** The Arduino, a single-board computer is a topic, which is very broadly spread here, because other platforms are also used. But overall,

Semi-Structured, Open Questions and enhanced Answers (Grammar, Repetitions, Fillings)	Translation from enhanced answers into English
Aber insgesamt geht es sehr in der Maker Szene, sehr stark, um Elektronik. Um Elektronik-Basteln, eine Sache, die ja lange Zeit, immer mal ein bisschen brach lag, und jetzt wieder sehr stark im Kommen ist. Und das liegt daran, das viele Leute etwas programmieren wollen, aber das sie auch etwas brauchen, was es das Programm aufnimmt und umsetzt. In Bewegung zum Beispiel.	it is very much in the maker scene, extreme to electronics. To electronics tinkering, a thing, which for a long time, always lay a bit broke, and now again very strongly in the coming is. And that's because many people want to program something, but they also need something that the program takes and converts. In the motion, for example.
Wie kommt es, das „selbst machen“ von Elektronik wieder so beliebt geworden ist? Und das sich wieder so viele Leute dran setzen und wieder löten, Platinen herstellen? Was treibt die an? Ja, es gibt viele Gründe dafür, einerseits sind die Komponenten günstiger geworden, die sind jetzt verfügbar und ich kann als Privatperson so etwas jetzt Erwerben für kleines Geld. Die Programmiersprachen und Enticklungsumgebungen sind einfacher zu bedienen und das kann man sagen, die gesamte Usability von so einem System ist heute einfach viel besser, als noch vor fünf oder gar	**How is it that the "self-making" of electronics has become so popular again? And that again so many people turn and solder again, circuit boards? What drives them?** Yes, there are many reasons for this, on the one hand, the components have become cheaper, which are now available and I can as a private person now acquire something for small money. The programming languages and development environments are easier to use, and one can say that the whole usability of such a system is now much better than five or even

Semi-Structured, Open Questions and enhanced Answers (Grammar, Repetitions, Fillings)	**Translation from enhanced answers into English**
vor zehn Jahren.	ten years ago.
Du hast einen Verein gegründet, das heißt, du hast dich mit anderen Leuten vernetzt. Gibt es genügend Leute in Deutschland, die daran Interesse haben das zu machen und sich auszutauschen? Ich meine, die Chance gab es schon immer, ich glaube, durch das Internet und dieses soziale Internet, das wir jetzt haben, diese Web 2.0 und die ganzen Social-Media Sachen ist es einfacher geworden sich zu vernetzen. Die Menschen gab es schon immer in Vereinen, Funkamateure und so weiter. Jetzt ist es nur einfacher geworden, sich zu verabreden.	**You have founded a club, that is, you have linked with other people. Are there enough people in Germany who are interested in doing this and exchanging?** I mean, the chance has always existed, I believe through the Internet and this social Internet we now have, this web 2.0 and all the social media stuff has become easier to the network. People have always existed in clubs, radio amateurs and so on. Now it has only been easier to make an appointment.

Semi-Structured, Open Questions and enhanced Answers (Grammar, Repetitions, Fillings)	Translation from enhanced answers into English
Dein Verein nennet sich Freie Maker, hat das Wort „frei“ eine besondere Bedeutung? Wir sind ein gemeinnütziger Verein, der einfach unabhängig von, ja, sowohl von der Regierung als auch von kommerziellen Interessen ist und deswegen haben wir gedacht, Freie Maker würde da ganz gut passen.	**Your club is called Freie Maker; the word "free" has a special meaning?** We are a non-profit organization, which is simply independent, yes, of the government as well as of commercial interests and that is why we thought free makers would fit quite well there.
Wie muss man sich denn das Vereinsleben vorstellen, was tut ihr als Verein? Was macht ihr? Sitzt ihr dicht zusammen im Keller und lötet fleißig mit mehr Leuten zusammen, oder wie muss man sich das genau vorstellen? Das eigentliche Ziel ist ja die digitale Kultur, vor allem bezogen auf Hardware in Deutschland zu fördern. Das heißt den Leuten die Möglichkeit zu geben mit dieser Technik in Kontakt zu kommen und ihr Wissen zu vertiefen. Und dafür haben wir als Verein natürlich ganze Abende, an denen wir löten, bundesweit aufgestellt. Ja, es ist schwierig alle Leute in einen Raum zu kriegen, zur selben Zeit und deswegen haben wir das Ganze auf das Internet verteilt.	**How do you have to imagine club life, what do you do as a club? What are you doing? Are you sitting tightly together in the basement and soldering hard with more people, or how do you have to imagine that?** The real goal is yes to promote digital culture, especially on hardware in Germany. This means giving people the opportunity to get in touch with this technique and deepen their knowledge. And as a club, of course, we have set up whole evenings, at which we solder, nationwide. Yes, it 's hard to get all people to a room, at the same time, and that is why we distributed it all over the Internet. Skype and, like these technologies, we use for our

Semi-Structured, Open Questions and enhanced Answers (Grammar, Repetitions, Fillings)	**Translation from enhanced answers into English**
Skype und so etwa, wie diese Technologien, verwenden wir für unsre Sitzungen, die wir da haben. Aber es geht noch weiter, es ist also etwa ein offline Vereinsleben, das Besondere daran ist, das man etwas nachschlagen kann im Wiki und so weiter.	meetings that we have there. But it goes even further; it is about offline club life, the special thing is that you can look up something on the Wiki and so on.
Man weiß ja von den Hackern, also von den guten Hackern, daß sie gerne Sachen aufmachen und reingucken, um sie zu verstehen. Hast du auch diesen Anspruch selbst zu machen, um zu verstehen? Ja, mittlerweile ist ein Smartphone so kompliziert geworden, so dass man es wirklich untersuchen muss, um es zu verstehen. Richtig, das ist eigentlich genau das, was wir machen. Wir interessieren uns für Hardware und Software. Wir sind die guten Hacker, aber wir sind halt vor allem, die offenen Hacker. Das heißt, bei uns kann jeder mitmachen, wir	**You know of the hackers, so from the good hackers, that they just open things and re-engage to understand them. Do you have to make that claim yourself to understand?** Yes, now a smartphone has become so complicated so that you really need to examine it to understand it. Right, that's exactly what we're doing. We are interested in hardware and software. We are the good hackers, but we are just above all, the open hackers. This means that everyone can join us, we are not a closed club, but we are quite

Semi-Structured, Open Questions and enhanced Answers (Grammar, Repetitions, Fillings)	Translation from enhanced answers into English
sind kein geschlossener Verein, sondern wir sind ganz offen. Und jeder, der das Interesse hat, etwas Gutes mit der Technik zu machen und wer neugierig ist, der ist bei uns willkommen.	open. And anyone who is interested in doing something good with technology and who is curious is welcome to join us.
Gibt es denn auch so etwa was Erfindergeist der der die Leute in den Verein treibt? Oder ist es nachmachen was andere Leute schon erdacht haben? Das mit den Erfindern ist in Deutschland etwas schwierig. Die wollen meistens ihre Sachen geheim halten und patentieren und irgendwie Geld damit machen. Wir sind eher offen, wir wollen alles wissen, teilen, wir wollen unserer Designs teilen und wir wollen gemeinsam dann etwas Grösseres erschaffen. Was man einzeln so nicht schaffen könnte, als einzelner Erfinder, aber natürlich kommen Erfinder bei uns rein.	**Is there even something like the inventor spirit of the people who drive them into the club? Or is it imitating what other people have already thought?** This is somewhat difficult with the inventors in Germany. They mostly want to keep their things secret and patented and somehow make money with it. We are open. We want to know everything. And share, we want to share our designs, and we want to create something bigger together. What one could not create individually, as a single inventor, but of course, inventors come in with us.
Die 3D Drucker und Open Source das ist ja so eine Sache geworden. Wie seid ihr da vor gegangen? Wir haben den Drucker auch selber gemacht, ja der 3D Drucker ist aus	**The 3D-printer and open source this has become such a thing. How did you go there?** We have also made the printer

Semi-Structured, Open Questions and enhanced Answers (Grammar, Repetitions, Fillings)	Translation from enhanced answers into English
verschiedenen Bausätzen zusammen gesetzt und damit ein komplette neue Konstruktion. Und ist Open Source, ja also, wenn er einmal das Level erreicht hat, das er perfekt druckt, dann werden wir die Pläne auch veröffentlichen und die Leute sind dazu eingeladen es nachzumachen. Und ihn weiter zu entwickeln und die Elemente und Unterkomponenten, die wir verwendet haben, sind auch von uns, sind auch Open Source.	ourselves; yes the 3D-printer is composed of different kits and thus an entirely new design. And is open source, yes, once he has reached the level that he prints perfectly, then we will publish the plans, and the people are invited to imitate it. And to further develop it and the elements and subcomponents that we have used are also of us, are also open source.
Und was druckt ihr damit? Also der Drucker ist jetzt speziell dafür konstruiert Schuhe zu drucken.	**And what do you print?** So the printer is now specifically designed to print shoes.
Schuhe drucken, dass stelle ich mir recht kompliziert vor? Was ist der Vorteil, wenn man das selber macht? Es gibt große Vorteile, also die Schuhe, wie wir sie jetzt drucken sind komplett individuelle Maß gefertigte Schuhe, quasi nicht als Lederschuh, wie man es kennt, sondern als Sportschuh. Und wir haben halt die Möglichkeit durch eine 3D Scan oder durch Fussdruckmessungen ganz individuell die Daten in das Design	**Shoes print that I imagine quite complicated before? What is the advantage when you do it yourself?** There are significant advantages, so the shoes, as we now print them are completely own, custom-made shoes, quasi not as leather shoes, as one knows it, but as a sports shoe. And we have the possibility to let the data flow into the design of the shoes by a 3D scan or foot

Semi-Structured, Open Questions and enhanced Answers (Grammar, Repetitions, Fillings)	Translation from enhanced answers into English
der Schuhe einfließen zu lassen. So dass sie eigentlich einen Komfort kriegen können, der sonst kaum möglich ist.	pressure measurements. So they can actually get comfort that is otherwise hardly possible.
Aber Schuhe bestehen doch aus unterschiedlichen Materialien, da gibt es die Gummisohle, dann gibt es Leder, Oberleder, dann gibt es weiche Mittelsohle und das Drucken sie alles aus Plastik oder wie habe ich mir das vorzustellen? Also, das ist die größte Herausforderung. Bei unserem Projekt geht es darum, daß unser 3D Drucker mit mehreren Materialien drucken können soll. Die meisten Materialien sind schon Kunststoffe, aber zum Beispiel, fester Kunststoff mit flexiblem Kunststoff gemischt, härter und weicher.	**But shoes are made of different materials, there is the rubber sole, then there is leather, upper leather, then there is the soft middle sole and printing everything from plastic or how did I imagine that?** So, this is the biggest challenge. Our project is the fact that our 3D-printer can print with several materials. Most materials are already plastics, but for example, solid plastic mixed with flexible plastic, harder and softer.
Und wer hat dann das Design, die 3D Daten, für die Schuhe entwickelt? Also zur Zeit mache ich das Design für die Schuhe. Das könnte aber eigentlich jeder auch selber machen. Man könnte es auch automatisiert erstellen und dann würden diese	**And who developed the design, the 3D data, for the shoes?** So at the moment, I make the design for the shoes. But everyone could do it himself. You could also create it automatically, and then

Semi-Structured, Open Questions and enhanced Answers (Grammar, Repetitions, Fillings)	Translation from enhanced answers into English
Schuhe nicht drücken, da hat man dann keine Probleme diesbezüglich, das ist unsere Hoffnung.	these shoes would not press since then you have no problems in this regard, that is our hope.

IX-2 Interview Transcript - About Creativity Research, anonymized

	Time	Content
1	0:00 - 0:00	Forefront of Creativity ZigZag, understand techniques for creativity fascinated since a young age, jazz pianist ensembles improvisational nature of performance unpredictable flowing character playing with the group supercreative group transfer group activities qualitative interaction analysis moment by moment tied together how final product emerges process over time never a single solitary idea

		big flash of insight, no // decade ago
		it's about small ideas ability to tie these ideas together
		mastering that process and having these small ideas that drive the process
		its a combination of both called the bubble or balloon, lots of ideas, divergent thinking, more and more ideas
		and then the balloon gets smaller and get conversion idea thing
		much more iterative what is called today design thinking
		the process is flowing
		idea generation and then idea focusing every day or many times a day
		it is not linear, starts with divergent thinking and then ends with converging
		frequently and iteratively
		all group interaction is unpredictable
		emergent
		bottom-up sort of C
		members and the interaction generates some collectively
		the whole is greater the sum of the parts
		opposite than bottom-up like visionary CEO
		have creative insights and then distribute them
		that never generates successful innovation
		bottom-up
		improvisational flow

		variety
		open enough
		a wide range of responses
		flexibility
		emergence something new and great
		qualitative methodology
		focus on observation of
		natural occurring interaction
		when you go out the world and with successful interaction groups
		my belief is natural setting doing what they doing
		getting insights whats going on in really successful groups
		interaction analysis
		group flow state
		findings/ trends/ differences
		each individual takes action to provide for openness and future possibility
		so that the group collaboratively generates the new ideas
		block if members to constrain attempts to drive the group's flow
		writing the script in your head which they are training not to do
		taking action where you assume that the subsequent flow of the group will go in a certain path you are writing a script and then the flow of the interaction happens in another way and throws you off

		you have to be responsive to the unpredictability and then each of your action instead of driving the scene would which is another go you take action that allows for a broad variety of actions to unfold after your turn and all of the characterises of the individuals shift away from a person and shifting the C towards the ‘genius of the group.’ everyday C process over time, constantly have ideas, reject the notion to wait for, frustration, techniques and set of habits, trust that process even if it is unpredictable beliefe in the process and not wait for the brilliant flash of insight a small contribution to the process process over time build something great people everyday life ability to be creativity wait for a good question from the process not start with the problem the problem emerges in a surprising way were you not know how to ask the question yet - problem finding intuition where you have to go and what you need to do the type of question to ask emerges from the process pivot try to solve one problem users customers has another you miss the big opportunities

		creativity is important - incentive system
		not sending employees sending to workshops
		collaboration
		leadership important as establish culture (great risks expected, same respect, the person has to save wins more value and bigger incentive
		wild and crazy and is never successful
		expect risks
		WO GOAR, Delaware
		gate process a no go, that's top down, selection
		take a long time for leaders
		to get the nature if the process
		leadership and incentive aligned with the creative process
		that is unpredictable, iterative, and bottom up
		consciously introduce change to your routine
		include making an effort to meet people you normally would not encounter
		most important findings of Creativity
		distant combinations
		combing very varying conceptual materials or ideas or experiences together in your mind
		combination capabilities
		noticing thing you normally not do
		going for a broad range of material people perspectives

		concepts and idea a great forward creativity

IX-3 Interview Transcript - About Invention, anonymized

	Time	Content
1	25:59 - 30:11	Caffeine Level, sleep level, 120 hours, alcohol, drugs - difficult question. People perceive a benefit, but not an authentic benefit. Inhibit our judgement. We are not evaluating things in a realistic fashion. Domain-specific - music. Open-mindedness is a hidden or third variable.Mood disorders. Substance abuse. Taking walks is now a big thing which I love I take a walk every day. time away. creativity theory would say something like walk and sleep can change your perspective take advantage of your tactics I mentioned earlier take a walk it a time away from the problem you relax it goes into diverse directions instead of following the same old path the same old routine sleep can do the same thing these things can very well be beneficial I don't think we have good explanation for why. And I also pretty do not ensure if it depends on a little bit and quite a bit on the person there are people individual differences what we see as a support and an opportunity what comes to my mind is competition there are some people who are because of being in a competitor situation they think well I have to go in this direction there is a set goal I will be judged they are not creative at all. Competition inhibits creativity for some people, and at the other extreme, there are people who are only creative when there is competition. Individual differences. But I am very hesitant to offer any generalisations without recognising the individual difference.
2	24:30 - 24:30	Providing new diverse experiences travelled moved relocated these are very good, people should that the decision is trying new thing being around new people and

		other new experiences.
3	21:32 - 24:30	you do not work for a boss or company that doesn't think creativity is very usual you want to work at a place where there is an appreciation for it. that when you do this there go a be resources there gonna be creative people recreation for it, there will be tolerance for it because creativity means if you might be trying new things and there needs to be risk tolerance in the setting. and many of this is just making the right decisions to put yourself in the right place also decision how you behave how you think it is pretty easy to go through life and encounter problem, and you might do the same thing you already did following habit our routine. Take your time, to incubate, and to consider different alternatives, the distinction between sticky with assumption, with routine habit or tradition or going with something new experimenting taking a risk and postponing a tell you considered alternatives those are decisions I do not go making a decisions now I am gonna wait to consider other things I am gonna talk to other people I am gonna do my homework here is the oddest thing but I did this in the past I will try something new. Decision making is an enormous part being creative and exercising your creativity attitude is enormous it a good attitude its a value they will imitate to use the psychology term they will try the same attitude as well **attitude, decision making**, there are also particular **tactics and strategies that are good for problem-solving** and everything from questioning your assumption shift perspectives and dozens of these tactics. **They are trying work backwards**. You could try **problem-solving techniques**. Contribute immensely to creative behaviour.
4	0:00 - 0:29	Creativity Research Journal
5	1:00 -	interdisciplinary field genetic, org studies psych, education

	2:42	originality and effectiveness novelty unique wild crazy and useless solve problem effectiveness
6	2:45 - 5:06	aesthetic component culture, intentionality , luck, zeitgeist serendipity finding something when you looking for something else, cognitive Scientologist, creative thinking
7	5:08 - 6:47	artificial intelligence gatekeeper I see so much that is even not published because of peer review process
8	6:48 - 11:23	the brain and the creativity, booming area, exciting and fastest growing, neuroscience, networks and systems within the brain, some here some here, prefrontal cortex always included judgement decision making , put into the background during some phases of creativity, results for effectiveness, no specific localisation,
9	11:25 - 14:45	myths. people are forming a distinction between people. west east, genetic diff, men women, view of particular groups and domains. most pressing art bias. artistic to be creative. unfortunately is a educational system, correlate art with creativity , in the art it is the most obvious, odd bias, all creative, different range of potential/ genetics, inherit gen for creativity, range of possibilities, doesn't matter in which domain in which an individual is working, everyday creativity in a conversation, getting dresses, in coping with hassles and surprises, spontaneity, small little micro problems there we encounter from day to day life I think that is one of the most important impressions of creativity dealing with life and especially with everyday life.
10	14:46 - 15:56	sex differences. historical bias. who is who? there will be bias towards men. No longer with us, hurdles disadvantages, all creative, historical artefact. Education is missing 100 to 200 years ago.

11	15:57 - 17:54	the research in saying that in the debate of nurture versus nature the genes you born with versus the way you brought up the way you brought up and the way you nurtured seems to have more than an effect on the creative potential that you and up using it. I think that is accurate. as kind of a tangent there is genetic work out creativity there dopamine receptors, not go to behaviour. It is no one gene. Nurture part of it your effort and your resources and the support, your education your culture that these things all lead into and determine the likelihood that you invest in creativity and that behave your creative fashion.
12	17:58 - 21:22	improve my ability. what helps creativity and what actually hurts creativity. it's optimistic that is the efforts towards creative make a difference. I get this question regularly. educators organisational managers supervisors. there are very specific things an enormous part of it making the right decisions deciding to and you can't take a white span perspective here because different schools decision were to invest your time, doing research finding problems, give you practice at thinking creatively and you could make decision which puts you in an environment were creativity is appreciated
13	30:13 - 35:49	Last couples of years: bias in creative thinking and cognition, neuroscience, dialog to creative theory, divergent thinking, cognitive hyperspace, one chain of thought, remote associates, not changing directions, creative people do in think their thinking do attention, chain will change the problem, chain hyperspace new dimension n-dimensions, creativity change in pathway/ corridor, and originality I am fascinated by the work of cognitive hyperspace make all the turns and keep changing that seem to very be conducive to and helpful for originality. Hypofrontality. Work on cultures.

		Multiple language bilingualism, flexible system, pays off and is expressed as creativity. Hypofrontality, Flexible thought, bilingualism and the cognitive hyperspace.
14	35:50 - 40:16	Companies could do: Innovation does depend on creativity I am certainly not alone in business schools and businesses agreed that creativity is a necessity so not sufficient for innovation very practical there must be some implementation and so there is a difference, but I am comfortable that those people I know including in business would agree that Creativity is a prerequisite for innovation. And that is actually right helpful there it means to know about supporting creativity can be bought into or mapped onto business. About learning from education and the things a teacher can do is to support students creativity marvelling creativity appreciating it, providing time for it, practising tactics ensuring that there is a setting which signals work for creativity there are analogies in the business environment that work very well. It would be very good for example if there is a culture of creativity that is very clear that creativity is a good thing, even things like idea-boxes are good things because if a company wants ideas from employees there is an explicit message there that we value creative idea and new ideas and employee input it is helpful if the hierarchy is created so it is virtually possible to say well you know here you are at this level and we need you to be creative but if now one else in the hierachy is creative or appreciates creativity you gonna will have some problems. evaluation and judgement are known to a very frequently hinder creativity based on certain parts of the process and probably most of the process. But if employees don't think they can take risks if they think they gonna be overlook for bonuses and raises or be redirected by the boss there are less likely to think divergently and invest their time to the original

		problem solving , risk tolerance is very big in businesses in fact there almost two things to hear the recognition that is it ok to take risks but also tolerance even more broadly is very important tolerance for different perspectives different work styles tolerance we talked about rich diversed experience it could be creative individual really needs to take walks and take their time and study new fields and talks to people elsewhere in another culture or another business and that may be what is takes you need a boss a manager who understands thats ok to withdraw all differences I don't know where that headed but I know the creativity often requires that kind of experimentation and diverse approach and again I talking about tolerance is enormously important. Managers Educator and even more broadly. Tolerance and diversity.
15	40:17 - 41:43	Research education, brain, on organisations, social perspectives, historical perspective, political and philosophical perspective.

IX-4 Interview Transcript - About Maker Movement, anonymized

	Time	**Content**
1	0:08 - 1:47	In 2004 haben wir den ersten "Mach flott den Schrott" Wettbewerb angekündigt// Ich habe mich dann gewundert über diesen Titel, und habe erst etwas später verstanden, was die Mission dahinter ist, was das bedeutet, denn "Mach flott den Schrott" ist so für jemanden, der so ein bisschen von außen kommt, doch ein wenig ungewöhnlich, doch die Recycling Idee, und dieser open Gedanke**(CU1, CU3, CU4)** war schon da vertreten. Interessanterweise in 2005 als der erste Wettbewerb dann auch die ersten Gewinne ausgelobt hat, wurde das make Magazin in den USA gestartet. Wir hatten direkt gar nichts

		miteinander zu tun. In 2006 hatte Dale die erste Maker Faire gestartet in den USA. Und wir waren etwas später dran und wir haben in 2011 den "Mach flott den Schrott" Wettbewerb wiederholt. Der ~~TRUDE~~ hat ja gestern noch einmal über seinen Preis, den Toilettenpapier Drucker **(CU1)** berichtet, der in 2001 gebaut wurde und der damals auch einen Preis bekommen hat. Das war sozusagen die 2 Variante. Und das war für uns der Startzeitpunkt, mit ct'hacks zu starten, also einem Sonderheft aus der ct, wo wir gesagt haben, lass uns dieses Thema DIY doch mal beleuchten und daraus ein Magazin machen**(FA1, CU2)**. Und wir haben da erst so gesehen was in den USA stattfindet. Ich persönlich war 2012 dann auf der ersten Maker Faire in Amerika, war total begeistert, und habe gesagt, Mensch hättest du ja früher mal drauf kommen können, diese Welten haben irgendetwas miteinander zu tun, und das war auch der Zeitpunkt, wo wir ins Gespräch gekommen sind und über eine intensive Zusammenarbeit geredet haben.
2	1:49 - 3:04	Was mich an Dale immer wieder begeistert hat, ist einerseits, es ist ein demokratischer Gedanke**(CU1)**, der dahinter steht, Wissen für alle, das Thema open source ist ein ganz wichtiger Gedanke und was er hat! Er ist wirklich ein Missionar, er hat Passion, er redet mit jedem Maker, in bin immer wieder erstaunt auf der Maker Faire, egal ob das in Stadt X ist oder ob das in San Francisco ist. Er spricht mit jedem dieser Maker und möchte die Geschichte hören, die dahinter steht. Und man merkt einfach das ist derjenige, der als Evangelist**(CU1)** diese Bewegung auch voran treibt. Er ist der Gründer der Make und er hat diese ganze Bewegung auch vorangetrieben. Das ging sogar so weit, mittlerweile gibt es heute maker faires in sehnen in china es gibt maker faires sogar Ägypten **(FA3, SO1)**was auch interessant ist ein Amerikaner startet in Kairo mit Hilfe der lokalen maker eine maker faire und er hat es auch geschafft ins

		weisse haus zu kommen, also wen es interessiert kann es sich auf you tube angucken. Obama **(CU1)** hat seinerzeit die Maker Faire eröffnet, weil die Amerikaner dann auch gemerkt haben, welchen Impact diese Bewegung, die von unten heraus kommt, die so "open" ist, vielleicht auch für die ganze Gesellschaft haben kann.
3	3:04 - 3:27	Also mich freut es total, der Dale ist extra aus San Francisco hierher gekommen, um auch mit euch in Kontakt zu treten und um auch an diesem Format ein bisschen Teil zu haben. Und insofern lassen sie mich ganz herzlich begrüssen, den Dale Dougherty, Founder and CEO of Make Magazine and Maker Faire and he is the founder of the Maker Movement. Dale, thank you.
4	3:36 - 6:40	Guten Tag, that is the extent to my German unfortunately so I will speak in Englisch. But it is great to be here great to meet so many of you in a day and a half. My talk today is really I think trying to explore how we can understand making in terms of innovation**(SO2)**. And I think it is a story we need to tell a little bit more, but I think it is more than that. Is going to define the Maker Movement into the future. But I want to start by telling a story by a specific maker. It is Dammond Mc Mallan. Dammond and the idea about building a boat and he wanted to, you know like many makers, sketch it out and come abroad he had some ideas of what he is trying to do**(FA1),** and it would be about an 8-foot boat, 8-foot long boat. And it would have solar panels on it and it, you know, and sorry I run out of words. He built it in his garage, and it started out, and this is kind of what I like about Dammonds story. He said, oh,yeah I didn't really do this for money or for some competition it did it because is a personal challenge**(CU1)** it was the idea I had the idea. And I think it is a fundamental level making is all about having that idea and

		making it real**(CU3)**. Doing some of that idea acting on this idea. Mic falling apart//. But it is this opportunity to act on an idea lots of us have ideas not everyone can act on them; not everybody can say I will build a boat and actually build that boat and so // how are we doing? Tech problems// You know, here is, here is a parts list, a rough diagram, and you know there are famous things you know like adafriut gps and a seeduino mega board**(SO2, SO1)**. He is using a kind of common maker components this is homemade as I said in his garage. He might think it would take him a year and it takes him 30 months. He says you know that is a project that was full of mistakes, compromises and do-overs. You know that's a reality that's what its like to do something it doesn't just come out instantly the way you might have thought it as.
5	6:40 - 9:49	Dammonds brought his sea charger as he called it to maker faire in the bay area last may and he was on display there he got to talk to other people he said you know engineers had come up and asked him and argued with him what you try to do**(FA1)**. you see it is a solar powered boat but its also autonomous so he wanted to build a boat that could pilot itself. and to some degree after 30 month he had accomplished that he talked it over with others and then having a team of people **(FA1, SO1)** working on it and the weak after maker faire he put, he went to half moon bay which is near San Francisco, and he put the sea charger in the ocean and he had programmed it to go to Hawaii. **(SO3)** Pause. You know, so he had done not only build something, but he had a mission for it, he figured out that he was gonna see if this boat a homemade boat got in the garage could get all the way to Hawaii. And he programmed it so like almost like a Mars mission.You know it is reported in every two hours and said here is where I am, here is where I am. He could see that is was drifting south with the winds were

		moving along. And then it went dead silent, and for a day he didn't hear from it at all **(FA2)**. And he writes, and he thought maybe a whale had swallowed it **(CU1)**. Because you know you can't really see what is up against it just kind of charting a course and it's going somewhere, and it could hit something extensively. But 41 days later he said I am standing on the shore of the big island in Hawaii with my wife, my parents, a brother and a reporter and I touch the first glimpse of the solar panels in the sun, so here is the boat makes it 2400 some miles across the Pacific into the harbour that he specified and here is there with his family to receive it**(CU1)**. And that seems to me like almost the quit essential maker project. you know. adventurer is doing something you don't know it's gonna work out. And if you read the story he talks there all about a feeling like, there is no way it would work. I would try to do put these electronic components and seal them up, and I don't know if I got it all right. But he gets it there. There is him this family **(CU1)**with the boat just picking it up from the harbour. Now, it doesn't end here; it doesn't end here in Hawaii. Because being a Maker, he's kind a cheap. And he doesn't want to pay a cent to send his boat back in a container, a crape. So he takes a day he reprograms it puts it back in the water heading for New Zealand. (Laughing).
6	9:49 - 11:54	And he writes after 155 days at sea the rover stopped responding this time the sea charger is really dead **(FA2)**but not before it travelled an impressive 6480 nautical miles. so it comes about almost 400 miles shore of New Zealand, and there were people really disappointed that a fan because there were gonna hit people lined up waiting to greet it as it went into Neuseeland **(CU1)**. So we heard about this, and he wrote this story and it in the current issues of Make and called the little boat that could. But you know he wrote his own story about this

		and talked how he built it and gave us lots of great details here**(FA1)**. So that issues came out about in January and first to subscribers and we got this great email from that. Hey, I am subscribing I just finished reading the bottom referenced article it was outstanding I create more information especially regarding some of the details, so the satellite modem controls the information channel that is magnetically coupled main propulsion motor. You know that's a Maker reader right, you know just saying, I want more detail more technical details just burping. So we send that to Dammond it was from Bruce McCandless, and Dammonds replies, first of all, are you the Bruce McCandless, the astronaut. (Laughing) **(CU1!)** So American astronauts are reading Make magazine reads about this project and wants to connect with them and talk to them how did you talk to the satellite and how you did you do the magnetic coupling. And Dammond replied hey into just yesterday the boat was picked up by a container ship of the later Neuseeland**(FA2)**. so it is not completely lost, and then later now it is in the New Zealand maritime museum on display. These are the guys that are setting it up there. so the container ship brought it New Zealand set it up.
7	11:54 - 12:00	This all initiates from a guy with the idea that starts at a chalkboard does something in his garage and puts together a lot of components that he is you know where meant to be cheap he said if he spends too much he will jeopardise his marriage (laughing). And you know he goes to places that he never expects to **(FA1)**. you know and I just think this is really about the adventure of making. that because you are acting on that idea, you don't know where it goes whom you meet who you connect to and you know I think this is the best side really to innovation. of doing something new. of creating change. and to some degree connecting with other people because of it. he is

		not starting a business here as far as I know. He works in business as job mechanical engineer, but this was his passion this was his side project that he accomplished. And again I think the context for this that I had been thinking about lately as for how makers have a mission that is not just to build something in a taxi the mission comprises the whole adventure. that you know this idea actually came to these during plane coming back from a maker faire at China knows I was watching star treck I think beyond and how wonderful is it to go Starfleet academy get assigned to a mission you know you gone into the future not exactly knowing were you are heading what gonna happen but you have problems solved and usually all hell breaks loose**(FA3)**. But I think Makers have missions they some of them come to define that mission for themselves and sometimes the mission finds them.

IX-5 Contemporary Research about Creativity

All names are pseudonyms.

Analysis of Interview with Janet (anonymized)

This information is a first phase concept-coded transcript I generated from the audiotaped interview. Janet mentioned, in general finding, a new idea is a process over time (FA2) that ties little ideas together. It is not linear as it would start with divergent thinking and ends with converging (FA3,SO3,SO2). It is much iterative what is called today Design Thinking. Janet mentioned waiting for good questions from the process(SO3, FA2) instead of to start with the problem, trust that the process even if it is unpredictable is successful. The problem often emerges surprisingly (SO3), especially were you not know to ask the question yet - problem finding. As Janet is fascinated by Jazz and its improvisational nature of performance she tried to transfer this unpredictable flowing experiences onto group activities(SO1, FA3). Findings for the positive and creative experience she identified were if each takes action to provide for openness and future possibilities(SO3, SO2) so that the group collaboratively generates new ideas (FA3). On the other hand, findings were if members were too constrained and attempted to drive the group flow in a certain path which they are trained not to do, called writing a script in the head, and then the flow of the interactions happens in another way it throws them off. Important is that each has to be responsive to the unpredictability (SO1) and take action that allows for a broad variety of activities to unfold (SO1, SO2, SO3). It is a bottom-up improvisational flow (SO1, SO3), flexible to a wide range of responses(SO1) that opens up for something new and great to emerge, something that is greater the sum of the parts. *Finally, Janet mentioned that continuously introduce change to your routine (!!) include to make an effort to meet people you normally would not encounter (!!) is one of the most significant findings of Creativity*. Key are these combination capabilities(SO2, FA1) that are varying distant combinations(FA1), as a broad range of material from people perspectives, concepts, ideas and experiences(SO1, FA1, FA3). Moreover, that is great forward to creativity.

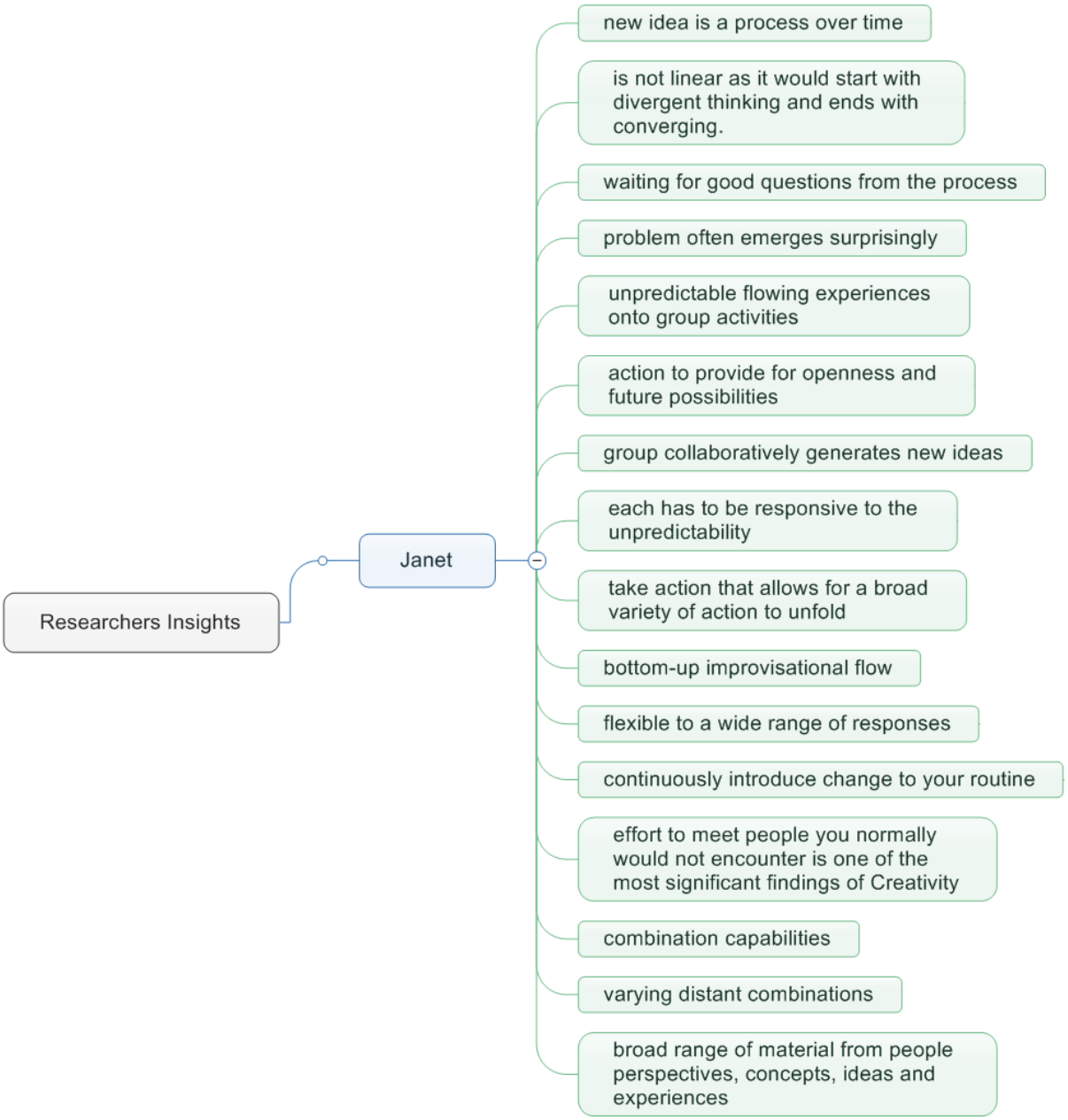

Figure 65. Researcher Insights from Janet

Preconception Stimuli of Invention (PSI)	
Positive:	**Negative:**
TAKE ACTION, PROVISION INTERWORKING, ITERATIVE AND FLOW PROCESS, TECHNIQUE AND METHODS, BOTTOM-UP	NOT BRILLIANT FLASH INSIGHT, NOT VISIONARY CEO, NOT GATE PROCESS/ SELECT BEST, CRITICAL JOBS INTERPRET NEW

IX-6 Contemporary Research about Creativity

Analysis of Interview with Karen (anonymized)

Karen is editor of a famous Creativity Research Journal, and she hosts the encyclopaedia on creativity. And she just recently published a book called Creativity: Theories and Themes, Development and Practice. This information is also a first phase concept-coded transcript I generated from the audiotaped interview.

Karen recognises herself, being the editor of the Creativity Research Journal, as a gatekeeper as there is much information about creativity that is even not published because of the time-consuming peer review process (CU4). So some insights of this interview are based on new but maybe not reviewed information from the research community. *Karen noticed that the brain and the creativity is a booming area, the exciting and fastest growing field of neuroscience. As insight creativity is supported by a network of distributed systems and that the prefrontal cortex is always included in judicial decision making (!!).* However, the prefrontal cortex put into the background during some phases of creativity (SO3) where there is no specific localisation of involved systems (SO2,SO3,FA1). Today the prefrontal cortex is seen as it filters the results for effectiveness (SO4,CU4). As a consequence of this insight, Karen stresses the decision making aspects of creative processes. *Asked about the hereditary of creativity, the debate of nurture versus nature, Karen answered that the way someone is nurtured seems to have more than an effect on the creative potential (!!, FAx) that you have and the up using it.* Karen followed on as kind of a tangent there is genetic work about creativity and the existence of dopamine receptors, but not to go too far into behaviour. Moreover, it is not one gene. *So, the nurture part which is the effort, resources, and the support, the education, the culture are all things lead into and determine the likelihood that someone invests in creativity, and that behave creatively (!!,Fax, CUx).* However, this leaves open the answer what helps creativity and what hurts creativity. Karen explains that it is optimistic that the efforts towards creativity make a difference; as she gets this question regularly from educators, organisational managers, and supervisors. There is an enormous part of making the right decisions in a full

span perspective, the decision for different schools, the decision was to invest your time (CU1, CU2), doing research finding problems that give practice to thinking creatively (FA1, SO3, FA3), and decide which puts someone in an environment where creativity is appreciated (CU1). Karen mentioned you do not work for a boss or company that does think creativity is very usual. Karen expressed that you want to work at a place where there is an appreciation for it. In her words that when you do creative work, there have to be resources (FA3). There have to be other creative people (SO1, CU1). There is recreation for original work. Moreover, there will be tolerance for it because creativity means if you might be trying new things they fail (SO3, !!). Therefore, there needs to be risk tolerance in the setting (SO3). Karen said many of this is just making the right decisions to put yourself in the right place. Also decisions about how you behave. How you think. To incubate in a creative setting takes time (FA2). It is about considering different alternatives (FA, SO2), the distinction between sticky with the assumption, a routine, a habit or the tradition. Alternatively, go with something new, experimenting taking a risk (SO2, SO3) and postponing. *You considered alternatives those are decisions as I do not go making decisions (!!). Now I am going to discuss other things and talking to other people (!!, SOx, FA1).* I am going to do my homework. These are the oddest things but I did this in the past, and now I will try something new (SO2, SO3). Karen concludes that decision making is an enormous part of being creative and for exercising creativity in a context (CUx, SO1, SO2, SO3) of an organisation or together with students, your creativity attitude is enormous (FA1, FA3). You have to express that this is a good attitude; it is a value, they will imitate (FA1, SO1) to use the psychology term. They will try the same attitude as well the attitude on decision-making. *Karen added that there are also special tactics and strategies that are useful for problem-solving; like everything from questioning your assumption, shift perspectives, and dozens of these tactics (FAx). They are trying work backwards(!!).* You could try problem-solving techniques. All these, contribute immensely to creative behaviour, as they are providing new diverse experiences. *People should make decisions in trying new things, being around new people, and search for other new experiences (!!).*

Karen questioned about caffeine levels, sleep levels, 120 working hours a week, alcohol, drugs, she answered that these people perceive a benefit, but not an authentic benefit. It inhibits their judgement, and they are not realistically evaluating things (!!). Also, a lot of this might lead to mood disorders or substance abuse. Karen explained that taking walks is something she loves. The creativity theory would say something like walk and sleep can change your perspective. It goes into diverse directions instead of following the same old path the same old routine. Another important aspect, Karen distinct on people individual differences what people see as a support and an opportunity (FAx). Karen gave an example of the role of competition. *There are some people who are because of being in a competitor situation think, well I have to go in this direction, there is a set goal, I will be judged, and they are not creative at all (-FA1, -SO1).* Competition inhibits creativity for some people, and at the other extreme, there are people who are only creative when there is competition (FA2). These are individual differences taken into account. Karen closes that she become very hesitant to offer any generalisations without recognising these individual difference (FAx).

As there is always the question about what companies could do, Karen answers, innovation does depend on creativity. Business schools and businesses agreed that creativity is a necessity, as so it is not sufficient for innovation. Very practical there must be some implementation, and so there is a difference. But Karen feels comfortable that those people I know including in business would agree that creativity is a prerequisite for innovation (SO2, SO3). And that is actually right helpful there it means to know about supporting creativity can be bought into or mapped onto business (SO1). About learning from education and the things, a teacher can do. It is to support students creativity, by marvelling their creativity, appreciating it (CU1), providing time for itCU2), practising the tactics (FA1, FA2) mentioned earlier; ensuring a setting which signals for creativity (FA3). There are analogies in the business environment that work very well. If a company wants ideas from employees, there should be an explicit message

that they value creative idea (CU1, FA3), and the employee's input is helpful. If the hierarchy is creative, so it is virtually everything possible.

Karen asked to about evaluation and judgement, she answered; these are known to hinder certain parts of the creative process (CU2). *If employees don't think they can take risks (!!, SO3).* If they think they will be overlooked for bonuses and raises (CU2), or if they have been *redirected by the boss (-SO1,-CU1); there are less likely to think divergently and to invest time in the original problem-solving (-FA1). Risk tolerance(-SO3)* is a very big topic in this context. In businesses in fact there almost two things to hear, firstly the recognition that is it ok to take risks, secondly *tolerance for different perspectives and different work styles (FA1,!!).* This is the tolerance Karen talked about this rich diverse experience (FA1, SO1, SO2, SO3). *It could be that creative individuals really need to take walks, take their time, study new fields, and talk to people elsewhere in another culture or another business (!!).* And that may be what it takes, a boss or a manager who understands that's ok and to withdraw all differences. Karen mentioned; I don't know where that headed but I know the creativity often requires that kind of experimentation (SO3) and diverse approach (FA1). *And again I talking about tolerance is enormously important (!!). Managers and Educator and even more broadly, it is about tolerance and diversity (!!).*

Preconception Stimuli of Invention (PSI)	
Positive:	**Negative:**
DECISION MAKING, CREATIVE POTENTIAL, ENVIRONMENT WERE CREATIVITY IS APPRECIATED, RISK TOLERANCE	NO RECREATION FOR CREATIVE PHASES (PROVIDING TIME)
Decision-making aspects	
nurture part which is the effort, resources, and the support, the education, the culture	

IX-7 Preconception of Stimuli of Invention (PSI) from research perspective

#	Interviewee / Description of Stimuli of Invention (SI)	SI Type	SMoC	+	-
	Janet				
	Waiting for good questions from the process instead of to start with the problem. The problem often emerges surprisingly, especially were you not know to ask the question yet - problem finding	Process	Indiv.	+	
	If each group member takes action to provide for openness and future possibilities so that the group collaboratively generates new ideas	Behaviour	Field	+	
	Members too constrained and attempted to drive the group flow in a certain path, called writing a script in the head, and then the flow of the interactions happens in another way it throws them off.	Behaviour	Field		-
	To be responsive to the unpredictability and take action that allows for a broad variety of activities to unfold	Skill	Indiv.	+	
	Bottom-up improvisational flow	Process	Field	+	
	Continuously introduce change to your routine include to make an effort to meet people you normally would not encounter	Tactics	Indiv.	+	
	Varying distant combinations, as a broad range of material from people perspectives, concepts, ideas and experiences	Tactics	Field	+	

	Opposite than bottom-up like visionary CEO have creative insights and then distribute them that never generates successful innovation	Tactics	Domain		-
	Reject the notion to wait for, builds frustration, not wait for the brilliant flash of insight	Behaviour	Domain		-
	Gate process a no go, that's top-down, selection, take a long time for leaders	Process	Field		-

IX-8 Fieldnotes ‚Mini Maker Faire', Cologne, Staturday, 05.11.2016

Gratis Eintritt in der Stadtbibliothek Köln
Sonstige Beobachtung:
Hoher Familienanteil, Kinder, Stände teils eher professionell, VR Brille oben Konsum, eigener Makerspace der Bibliothek (rudimentär), Fressbuden, Make Magazin(PUBLIKATION), dingfabrik köln (CNC Fräse(big picture, SOCIAL), workshops, engagement Gruppe vs. Einzel), ESP (Rolle des OPEN, ENERGIE MESSEN, Energiewirtschaft und Sensoren), repair cafe, universitäten, rwth aachen, 1 sehbehinderten Weste(PROTESEN), Pflanzen (Tanzen, 2xBewässerung, Kinderprojekt), Lego Wettbewerb international, 3D drucker (ca 3x), funkamateure(!, auch in Friedrichshafen), hacklace wieder da, auch in Dortmund, Kinder programmieren(TREND), fabscan projekt von mario Finanzierung, Skalierung), Besuch Back WDR-Computerclub, 3 stockwerke (teilweise belegt), Luftqualität Projekt in Stuttgart gestartet/ Feinstaubmessung durch Bürger Citizen Science(SUPPORT, TRANSPARENZ), Origamie (TEILEN, TEILHABEN LASSEN)
Bilder Handy
Stand Dingfabrik Köln e.V.
Origami Falten, älterer Herr
Cnc14 Fräse, www.cnc14.de
Workshops 1400 EUR / ca 800 EUR Material
Buch? Welches?
Interessiert an Interview

Link zu www.Anstiftung.de (München)
War auch in Friedrichshafen
www.glaskugelsehen.de
ESP Beispiele
Link zu Sonoff (ESP-Schalter), Firmware Austausch, eigener Blog

Eher technisch orientiert (Frau mit Nähmaschine, sticken)
Plakat mit Ideen für IoT! Ergebnis ?
www.4makers.de
Verkauf von Druckern und Filamente
Prüfung von Filament mit Hochschule (DACSA GmbH?)
Jung, dynamisch, versiert, informiert
Voxel8, MIT Entwicklung
Mit Ursprungs MAkerbot anwesend und gedrucketem Drohnen Chasis
Aus Hannover
Fusion
www.FabScan.org
Plaziert bei Watterott, Skalierung als Problem (Stückzahl), Finanzierung
CE Zeichen
Rolle Kickstarter und andere/ Gebühren/ openness
Aachen / Student RWTH

Köln www.lochraster.org
bisschen komisch

www.makerwissen.de
Nürnberg
Engagiert, jobsuche?

Prima spielzeug, programmieren unter 6 Jahren, Kinder
www.Schuelerlabor.informatik.rwth-aachen.de
Roboter

Beobachtungen
Visitenkarten
Finanz/ Finanzierung
Sensebox

FabLab in Stadtbibliothek, eher übersichtlich, resonanz?
Feinstaubprojekt in Köln (auch in Stuttgart http://feinstaub.messen.click/
Hacklace auch dabei
Teilnehmer aus gesamten Bundesgebiet
TED Spielzeug (rudimentär)

IX-9 Excerpts from Units of Analysis (UA), Linkage UA and TD

Unit of Analysis	Numbering Schema between Unit of Analysis (UA) and Transcript Detail (TD)
UA1	‚We are the second time here at Dortmund; my friend is the driving force. He is responsible for the technique of the printers. He also bought these 3D pens from a Kickstarter to test them together with others at the table,' TD01. 'If we could make a creeper? First, we have to look for the stl. File, then it isn't a problem. About 15 minutes,' TD01. 'My friend is extremely important to me because he tries the new things,' TD01. 'We are students. Mechanical Engineering,' TD01. 'Look here. How the kids work with these 3D pens, nobody told them, he or she just start making,' TD01. 'That's a tower,' TD01. 'That's a face,' TD01. 'People are asking, what or if we could do something with these printers. Like this men asked for a broken part of his Märklin railway,' TD01. 'Here is a creeper!' TD01.
UA2	'I gathered coins than I started in making rings out of these. It not that easy to find silver coins, but if you know where to search for, it's ok,' TD02. 'I like to work with others. But everyone has his own piece he's working on. I help, I show, and if a special skill is needed, I do. See here this drilling in the coin is the difficult part,' TD02. 'It's not for earning money. The 20 EURO is more or less the material and some money for tools. I like to share the craftsmanship with next generations,' TD02. 'Normally we are at medieval festivals, but Dortmund was close to home. And it's nice, here the working atmosphere. The blast furnace. Or, that guy on his high-wheel bike!' TD02.
UA3	'Yes. You are printing all the parts by yourself. And some metal sticks from the Baumarkt. And the Arduino with the controllers and the motors,' TD03. 'We have our makerspace. We are about eight people, the same as here on the fair,' TD03. 'I am here for the first time,' TD03. 'I got help from the others to build this 3D-printer, a rep rap design,' TD03. 'Next, I build a larger one. But this was a start,' TD03. 'I always tinkered. I am an engineer,' TD03.
UA4	'I start with comics. I look at the characters, and then we discuss it

	and how we could make this helmet, this cape, this weapon, and so on,' TD04. 'I make my drawings first. Sometimes I play with the material, especially for capes,' TD04. 'We use paper mâché. Others make moulds,' TD04. 'It depends, some of these costumes are over 300 EURO. But much more time. About a year until it is finished,' TD04. 'I like to make them,' TD04. 'I make my costumes. Here in this area are not that many making cosplay,' TD04.
UA5	'This is only a small CNC I bring to the fairs. Normally I do workshops for larger CNC machines. This large that people can build bodies for their guitars,' TD05. 'I make four to five workshops a year with up to 10 participants. I support in doing this; the participants bring their materials, it's their project,' TD05. 'It's my skill to share with them,' TD05. 'Currently, I am participating in a book [Die Welt reparieren/ Repair the world - Open source and DIY as post-capitalistic practice] ,' TD05. 'The workshop is 360 EURO, and the material depends, about 600 EURO it starts,' TD05. 'I started at a hackspace. I wrote an article for ct'hacks. People are building this CNC machine on their own now,' TD05.
UA6	'We like to share, that there products that could be repaired and such designs that could not be repaired,' TD06. 'Sometimes only on part fails, often capacitors, a part 1 EURO worth,' TD06. 'Once a month. People know that date and are prepared. For us, it's always new,' TD06. 'Now we also work on textiles. Here she made up my trousers again,' TD06. 'All people, young and old come. Here is a boy with a scooter, plastic is broken so we cannot fix it. But there are others we could fix,' TD06. 'I worked in a company,' TD06. 'I am retired,' TD06. 'I have my tools I bring with me, but now we have a coffee machine,' TD06. 'We use community facilities,' TD06. 'We look at the internet for help, but mostly it is our experience. When someone comes with an old record player nearly always the rubber rings are dissolved,' TD06.

	‘Often capacitors. Things after nearly two years of use,’ TD06. ‘The group we come together. It’s a sit-in, sometimes there is a lot to do, sometimes not. Then we talk,’ TD06. ‘There are only a few young people joining us. But some,’ TD06. ‘Smartphones are complex. We change screens,’ TD06.
UA7	‘This is book fold. You could do nearly every silhouette. In the beginning, there are templates available,’ TD07. ‘Some only fold and some cut. Folding is more original but also more effort,’ TD07. ‘You need only an old book to start,’ TD07. ‘There are charts available with all the measures. Or black and white prints as a template to use,’ TD07. ‘It is not difficult, but folding 400 to 800 pages takes your time. But you could stop and take it with you,’ TD07. ‘It’s a little like knitting,’ TD07.
UA8	‘This first conference is to connect business with the Maker Movement,’ TD08. ‘I was not aware of this movement until I began to travel to all the maker fairs in the world,’ TD08. ‘It is more about education, learning, enabling people here in Germany,’ TD08. ‘I like to talk to people about their projects. To talk about their vision and mission,’ TD08. ‘It is sharing and the democratisation of things. It enables people to do things they did not believe in before,’ TD08. ‘Yes, of course, take a picture,’ TD08. ‘My vision is a Maker city,’ TD08.
UA9	‘First I wash the pieces in the washing machine,’ TD09. ‘People bring me stuff, like these old bicycle tubes. I make waist belts of it,’ TD09. ‘I do not need many tools, sometimes only a glue pistol. Sometimes a drill, some wire and a gripper, often superglue,’ TD09. ‘I play with the material. Test some things, show others, speak with others,’ TD09. ‘I have my studio,’ TD09. ‘It is still more hobby,’ TD09.
UA10	‘I have built this scooter for my friend after he has fallen from a gantry,’ TD10. ‘I have a patent for this, see,’ TD10. ‘I have spoken to a manufacturer of medical devices. They said my invention would substitute too much of their products at once. So they are not interested,’ TD10.

	‘One company donated this belt for my friend. It costs 2000 EURO. This belt!’ TD10. ‘Look here at the wheels. I could switch them that the scooter gets into the bus. But for higher speed, it is better if they are outside,’ TD10. ‘This mechanism took me a while. Now it is easy; it works to relieve and control the pressure to his legs,’ TD10. ‘It gave me new vitality,’ TD10.
UA11	‘Simple resources, large effects,’ TD11. ‘150 million people are ametropic. It would take 500 years with the current number of opticians,’ TD11. ‘Idea is the primary health care. To see again. The ability to learn and work. To get the ability,’ TD11. ‘I am a precision engineer. I work on the bending machine,’ TD11. ‘I am an optician. Last year I sold my two shops,’ TD11. ‘In Africans is no word for spectacles/ glasses,’ TD11. ‘It creates workplaces and income for 25 people. As they have learned to make glasses from the beginning, they maintain the glasses as well,’ TD11. ‘Martin got the Empowering People Award from the Siemens Foundation in 2013,’ TD11. ‘We look for volunteers, that after a while support our projects offsite,’ TD11. ‘We look for different skills, also clerks, and finance people. It is like social business, social entrepreneurship; we are doing,’ TD11. ‘We conduct interviews with all participants of the workshops,’ TD11. ‘This summer we did marketing for the first time. There was a one-page article in the newspaper about us,’ TD11. ‘People are amazed, but they recognised our project for the first time,’ TD11.
UA12	‘I like to work outside. Here under the trees,’ TD12. ‘After a while, you get used to,’ TD12. ‘I like to see something from my work. Made by my hands and easy tools,’ TD12.
UA13	‘I am doing this for 20 years. I think it was not even called cosplay,’ TD13. ‘I am a teacher for mathematics,’ TD13. ‘I also presented my costumes in shows for Channel,’ TD13. ‘Over the years this fair becomes more commercialised,’ TD13. ‘Most of the people want to take pictures with me. Some steal my feathers,’ TD13. ‘I travel from south of Germany to Hannover,’ TD13.

	‘There is always a discussion about the first day, the school day. In Berlin, it was skipped. Some pupils are interested some not. If there are not interested, they make nonsense. The teachers should give same free,’ TD13. ‘The last project was this box. I could move my wings now,’ TD13.
UA14	‘It's a great mood. The people are great. I come from the beginning,’ TD14. ‘It has grown steadily over the years,’ TD14. ‘Makey is cool,’ TD14. ‘I have never seen that,’ TD14. ‘Some Makers come regularly,’ TD14. ‘We are only the organiser, the platform. The fair is you makers,’ TD14. ‘I am a sociologist,’ TD14. ‘I come here with my son and my wife. And I help here at the lego car,’ TD14. ‘The children are not afraid. Yesterday I had to pick someone from under the car,’ TD14. ‘The van is cool. Have you tried it?’ TD14. ‘I got into the submarine boat,’ TD14. ‘Let’s stay in contact,’ TD14.
UA15	‘We come together once a month,’ TD15. ‘It is to show people how some things work,’ TD15. ‘It is not only to repair. It is to talk about things that could be repaired,’ TD15. ‘Maybe next time they buy something different because it could be repaired,’ TD15. ‘We always look for volunteers,’ TD15. ‘The sustainability of products is important,’ TD15.