Vanguard of the 3D printed future:

Peer production with use of 3D printing at hackerspaces

By

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Andreas is printing a 3D scanned object. Even though it was a test run, he did not have to alternate the scanned file. He just pressed 'scan' and then 'print'. "It works almost as good as the Replicator from Star Trek" - I thought. In the approximately same time the first fully 3D printed gun called "liberator" was proven functional. It was fabricated for the cost of less than 25\$ with an inexpensive desktop 3D printer similar to the one at metalab. It fired 9 rounds. (Forbes 2013)

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Introduction

we drift from block to block, from city to city, traversing continents and timezones. we live in cheap hostels, tiny flats and abandoned structures, scavenging the left-overs of a fallen industrial society.¹

Recently, there has been growing interest in the technology of three-dimensional printing. 3D printers are used to fabricate three dimensional material objects from previously prepared computer-aided designs (CAD), which contains set of instructions for the printer. Instead of subtraction, i.e. removal of redundant parts of the material by cutting, drilling or welding in order to shape an object, 3D printers use additive manufacturing process - fuse material to make an object. The key principle in this process is layerization (Ratto, Ree 2012). 3d printers work in relatively similar way to traditional printers, which however are only able to print in two dimensions on a sheet of paper, whereas additive manufacturing devices utilizes the movement of a print head in three dimensions – axis X,Y and Z. In the case of 3D printing the machine, instead of a single layer of ink, spreads out of its movable nozzle multiple horizontal layers of material, successively one layer on top of another. In this process the layers of material are binded together and as a result produce a solid structure. Depending on the model, machines use different raw materials (plastics, glass, steel, etc.) in form of filament, powder, liquid, rods or sheets, which then are distributed in layers, as small as 2-30 microns, and merged together by molding, laser sistering, an electron beam or liquid binder. (Rigi Nd.: 12)

Even though the technology is still mainly used in manufacturing industry for rapid prototyping, it has been rapidly gaining popularity and becoming more often used by general public for personal fabrication. According to Gershenfeld (2005) a variety of fabrication technologies, such as 3D printing, that were once the exclusive domain of large industry are now migrating from

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All the epigraphs in this work are taken from a poem the new by kewagi (2011). The author is one of the first members and a frequent visitor at metalab in Vienna.

factories to home desktops. As the technology becomes more accessible through popularization of 3D printing services or affordable digital desktop fabrication devices², an increasing number of people engage in experiments with computer-aided designing complex in shape objects, with less constrains about how to create their material form. Recent opinions suggests that ongoing digitalization of manufacturing can be interpreted as a third industrial revolution (Anderson 2012; Economist 2012), and even that popularization of the technology may result in a systemic change. (Ratto, Ree 2012; Rumpala 2012) As Rumpala aptly observes, the development of 3D printing technology can impact on the social system, and thus technical change can affect social change. Hence, the novel technology might be disruptive as it challenges power relations in the market society by reconfiguring relations of social production and the way how material goods are consumed.

My thesis research focuses on a particular use of the 3D printing technology in commons-based peer production, i.e. a collaborative production which results in creation of commons instead of commodities. By this peer production questions existing commodity relationships, and possibly attempts to change relationships in the current market society. Through an ethnographic study of metalab hackerspace community, I look on a group of hackers who are contributing to an emerging commons design economy (Moilanen 2012) and other forms of production of commons. I investigate their motivation for such activities and how do they contribute to the creation of the open content³. Reflecting on the open content movement, I analyze how the use of the technology to produce commons is realized in terms of individual motivations, social functions, meanings and ideologies, and whether is it potentially transformative to the organization of the society. I locate this practice in the context of the hacker ethic and the theory of peer production. This enables me to answer the question: how are participant's relations toward

² Personal 3D printers or other digital manufacturing machines for desktop use.

³ Open content is a term proposed by David Wiley (1998) which describes any form of a creative work, which can be legally copied and modified. It may involve open designs, open source software or open source hardware.

intellectual property and value, in case of commons-based peer production of computer-aided designs, constructed in relation to the dominant capitalist mode of production?

The research verifies claims about the transformative potential of the digital desktop fabrication to the capitalist mode of production by measuring a durability of the commons produced by the community and shared globally through the Internet, i.e. their ability to resists commodification attempts and to remain commons. In order to do so, I look for the limits of the social drive to create and share commonly produced goods by investigating community member's motivations to create commons. I look on how those values of the hackerspace community represented by open access to information can function within current systemic structures of law and power, and to potentially change them from within. My hypothesis is that there might be not only external but also internal commodification attempts on behalf of the market actors and community members themselves. The research analyzes the community's ability to resist those commodification attempts by exercising their ability to create, discuss and innovate through production of generally accessible commons.

Methodology

The data presented in this work was collected with use of three distinctive research methods. The primary source of information comes from a participant observation I have conducted at metalab hackerspace in Vienna, which is a place where people engage in both, experiments with 3D printers and collaborative production of commons, including open designs for 3D printing. Secondly, the participate observation was supported by series of semi-structured interviews with members of the space who use 3D printers and produce open 3D designs which they share with others over the Internet. Finally, I also conducted a content analysis of metalab's and hackerspaces.org on-line repositories, researching how the hackerspace and activities exercised within it are described to and by the Internet community.

In order to get acquainted with the technology, its capabilities, as well as with people who use it and contribute to the public pool of open designs, I have conducted an ethnographic fieldwork in metalab hackerspace, one of the oldest and largest hackerspaces in the world, which is located in the center of Vienna, Austria. Between April 10 and April 30, 2013 I engaged in a participate observation of the community by becoming one of its members. Similarly to other visitors, I worked on projects of my interests, participated in workshops, and socialized with the community. The participant observation allowed me to investigate attitudes and behaviors of the participants in their natural settings. Also it enabled me to investigate the social process of production over time, from collaboration in creating computer-aided designs, to manufacturing of the product. In the process I had interactions with approximately 80 members of the hackerspace, from which I chose 15 as my primary informants, who engage in experiments with 3D printing or are interested in the topic. Through informal and semi-structured interviews I gathered information about their life stories, their relation to the issue of intellect property and their opinions about the technology of 3D and its future. The interviews in average lasted between one and two hours.

In a process of data analysis, I have chosen four representative individuals that present four distinctive patterns of attitudes towards 3d printing, sharing culture and economy. Two of them (Wizzard, Jascha) are established members of metalab, whereas other two (Tom, Marcel) started to frequent the space recently. Secondly, Wizzard and Tom can be categorized as experienced creators and users of 3D printers, whereas Jascha and Marcel just started to experiment with open designs and 3D printers. Hence, the choice of these individuals reflects the typology of the members of metalab and their relation with 3D printing. Above all, it serves more focused, thick description of the profiles of participants engaging in creation of open designs for 3d printing. It also allows, to some extend, generalizations about patterns of social behaviors relevant to the case. Furthermore, it reflects a statistical data on an 'Average' member of hackerspaces community, described as a a highly educated, 26 - 31 years old male from Europe (39%) or North America (48%). (Moilanen

2012) To my knowledge, the most of the members of the space who engage in similar activity, to some extent can be associated with the characteristics visible in the presented four profiles. Hence, the most of the people at the space I have interviewed that engage in investigated activity, can be characterized by a pattern of attitudes of the profiles of the participants presented in the chapter 4.

Contribution

The paper contributes to study of peer production and extend it by focusing on use of 3D printers in the process of cation of commons. It will allow to verify transformative capabilities of the technology to the market society by measuring the social drive to create commons. Furthermore, my research about value in free and open content movements intend also to contribute to the broader study of value. By answering questions who are the commons creators and what is their system of value in relation to property, the research should lead to better comprehension of sociological questions of labor, esteem and power in organic hierarchy organizations in relation to value. In doing so, I seek to contribute not only to the ethnographic literature on free and open source movement, but to wider study of anthropological theory value and address issues regarding the relationships towards culture, morality, liberalism and technology in the counter capitalism movements working within and not outside of current world-system.

The proposed research is furthermore particularly interesting not only to the scientific body but also to professionals working with the policy sector related to the intellectual property rights, because it address challenges for current methodological framework of capitalist production in this respect and therefore may be useful in answering policy questions related to the topic.

Chapter 1

Theoretical framework

In order to situate myself in the field, I analyze the gathered data through theory of commons-based peer production, i.e. collaborative production and ownership (Benkler 2006, Bauwens 2005, Gosh 2005, Rigi Nd.). The process of sharing resources and knowledge by the members of the hackerspaces is often described in the literature as commons-based peer production (Benkler 2006), i.e. collaborative production (and ownership), which results in creation of commons instead of commodities. It is a practice in which through collaboration of individuals volunteers create commons, that are usable and accessible by general public. It is also a popular practice that those commons are being constantly modified by others, who later return them improved to the same common pool. Unlike in the market economy, peer production is not regulated or planned by external agents who act as authorities standing above the communities of producers. Benkler (2006) argues that ongoing changes in the technologies, organization and social practices of production create new opportunities for both individual and cooperatives, in a way which increases the role non-market and non-property production. He notes that there is ongoing battle over "institutional ecology of the digital environment" (2) and a range of laws, institutions and property relations freeze spread of information and freedom enabled by information technologies. Benkler's concept of distribution of labor between a small circle of core developers, a numerous contributors and an audience of freeriders is adequate to the digital collaboration and refer to a popular Internet hypothesis of the "1% rule", proposed by Ben McConnell and Jackie Huba (2006). It states that the distribution of users who take part in the creation of Internet content, in regards to their level of participation can be estimated precisely through the 90-9-1 distribution; that is, in any given online community, only 1% of the users will create actual content, 9% will edit, modify or create

derivative content based on the original creation and 90% will consume it, having a very limited, "read-only", interaction with the community. Rigi (Nd.) further claims that there is a social link between peer production and anti-capitalist social movements. He claims that the "commons-based peer production, which, already, exists as a considerable economic niche, particularly in the realm of knowledge economy, has become the economic platform of the radical section of the protest movement. They aspire to transform the whole economy of society into common-based peer production."

Relevant here is a debate on public domain and intellectual property broadly popularized by Lawrence Lessig (2004) and recently developed by Michael Weinberg (2010) who included in the debate an issue of 3D printing. Lessig argues that we can observe constantly increasing commodification attempts on behalf of the intellectual property right holders, because it can be considered as a source for capitalist accumulation of capital based on immaterial labor. However the trend, as it diminishes the pool public domain, is a source of obstacles for human development rather than a productive force. Weinberg further indicates that there is growing tension between supporters of digital desktop fabrication and incumbents that try to limit the potential of 3D printing with introduction of restrictive intellectual property laws. The conflict arises around the more general issue of access and distribution of information. The current situation might be analogous to previous attempts to restrict access to knowledge. As gualities of the new technology have potential to reconfigure relation of production within society, the technology of 3D printing can be perceived as an opportunity to the public at large, but for industrial manufactures and property rights holders it might be a threat. Thus, those parties might attempt to restrict the use of the technology and in turn cripple its potential in order to protect their status quo. Emerging digital desktop fabrication is therefore a source of conflict which will escalate with increase of popularity of this technology and will lead to "the next digital war" (Weinberg 2010). This time it is the clash over replicating physical objects. The proposed research test community ability to resist commodification attempts

of intellectual property rights lobbies to restrict the use of the technology to production of printable commodities by exercising their ability to create, discuss and innovate through production of generally accessible commons.

In the research of motivations to produce commons shared by communities the study of Colman and Golub (2008) examine hacker practices in their hacker ethics is relevant. heterogeneous nature of hacker sociality and portray the topography of hacker morality and cultural articulation of liberalism. Similarly Söderberg (2008) investigate morality within hacker movements with even greater emphasis on community practices of opposing commodification of information in the free and open source software movement. His opinion on hacking as a labour struggle against capitalism provides an insight on relation between hackers and capitalism. I verify his theory that hackers "play struggle" is in fact an anti capitalist labor struggle. Gosh (2005) frames collaborative ownership through peer production in the sphere of digital economy and reveals relevant issues of property and ownership of commons. The important to my work is Levy's (2001) study of the hacker ethic which is based on principles of sharing, openness, decentralization, free access to the information and world improvement. Those notions will be investigated by me in the chapter 2, where I present in detail characteristics of a hacker and hackerspaces. Further, I refer to Molinanen (2012), who discuss a motivation model of hackerspace communities which is characteristic for a "strong social motivation factor". He categorizes motivations of members into four categories:

- 1. Knowledge-enriching motivation for improvement of personal assets, software and hardware skills
- 2. socially-enriching motivation, that is related to development of phisical space, real life events, care for the community and the space.
- 3. Group-enriching motivation for knowledge sharing, enjoyment, altruism and "respect".
- 4. Self-enriching motivation, which can be related to personal gains such as monetary rewards,

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or future opportunities.

In the chapter 4 I discuss this devision of motivations comparing it with the data gathered at metalab on motivations of informants participating in the production of printable digital commons and propose author's own division.

In order to establish relation to larger structures – state, power and legal apparatus I rationalize my experience through framework of a classical Marxism (Marx 1976) as well as with heterodox Marxism, in particular Holloway's theory of counter power (2002) and notion of "everyday communism" proposed by the authors of Human Economy. (Hart et al. 2011) As the digital designs of 3d objects are shared within the community and copied without limitations they do not posses exchange values. It is in opposition to the capitalist mode of production described by Marx. Marx starts Capital (1973) with distinguishing two features of commodities: use-value and value. Capitalism has its foundation in using labor time as measure of value. In capitalist society value (understood as socially necessary labor time objectified in commodities) is source and measure of wealth (Marx 1973: 705). On the other hand material wealth express itself in use-values. All the useful objects possessed by a person constitute their material wealth. In this sense even clean air can be taken into consideration as part of material wealth. But in capitalist society commodities are characteristic form of wealth. Their value is determined by labor-time embodied in them. Amount of material wealth is equal to sum of use-values possessed, where relation is proportional. However value of this wealth is not measured by its usefulness but by quantity of labor-time socially necessary to produce those use-values. Paradoxically, in capitalist society it can happen that even though material wealth grow in its amount, its value of single use-value can simultaneously decrease. It happens because with rise of productivity of production, commodities can be produced faster, i.e. less labor-time is objectified in them, therefore less value they have. Using value, understand as socially necessary labor-time objectified in commodities, as a measure (exchange-value) of wealth is therefore a foundation of capitalism.

My hypothesis that digital commons posses no exchange-value suggests, that capitalist system of value do not apply in the case of peer production of commons. Those might stand in the contrary, because as Marx described capital has life of it own, whose mission is centralization through capital accumulation, whereas the principle of peer production is decentralization. In the process of accumulation capital changes its magnitude, grows, replicates itself in the process of self valorization. Capital becomes a living organism, an "animated monster". It acts as independent agent which with change in its form, from money to commodities, perform self valorization. Capital has therefore anability to act itself as a self valorizing value. (Marx 1976: 255). However in the case of peer production, as it is functioning outside the capitalist framework and results in produce of commons instead of commodities, capital losses its ability to function as a self valorizing value. As the pursuit in increase of surplus value is an immanent drive of capital, this drive is undermined by the alternative mode of production.

The investigated hacker practice, which is firmly based in pragmatism and focus on doing, can be also interpreted in the terms used by Holloway (2002). He defines the activity of doing as a "scream of an active refusal" (15) which has to be inherently plural, collective. The power in Holloway understanding is related to agency, and can be understood as "can-ness", a capacity to do. The social power of the hackerspace movement is analogically exercised by collective actions, where in the environment of a hackerspace the movement aggregates its power, capacity to do, to collaborate, to hack. Instead of selling their capacity to do, hackers devotes their time and energy to work on their own projects, to develop themselves personally, and in many cases contribute to the pool of public knowledge. By doing so, members of hackerspaces liberate their power-to, and oppose commodity fetishism which is "a relentless rupture of the collective flow of doing". (30)

Furthermore, corresponding to my work is the research done by the authors engaged in The Human Economy project (2011), who explore the notion of 'everyday communism', i.e. "a common human propensity for sociability that, with some redirection of emphasis, might serve as ground for

non-capitalist economic organization" (Hart et al. 2011:15). Their description of human economy is particularly accurate to the organization of the investigated hackerspace community and to ongoing practice of peer production. As it functions through collaboration rather than competition, instead of individual egoisms it serves the needs of communities and even humanity in general, and yet at the same time is based on individualism.

Chapter 2

Case Description

we speak many tongues, but one language. we smell riots long before they happen, and sense wireless hotspots. we distrust all that claim to lead us, and fear those who pretend to protect us.

In this chapter I firstly describe what are the 3D printers and how they are used in open design economy. Secondly, I investigate the notion of a hacker and its specificity. Finally, I describe the metalab hackerspace and community relations within it.

3D Printers

3D printing has its roots in industrial manufacturing, where for over twenty years is used for rapid prototyping. However popularization of the technology and its slow migration from factories to home desktops is a result of grass root initiatives of makers and open content movements rather than a result of commercial development of a product by manufacturing corporations. Initiatives such as RepRap⁴ are the reason for growing popularity and affordable price of basic 3D printers. Those initiatives aim towards widespread adoption of the 3D printing technology by sharing idea to build affordable printer and organize around it community of makers. It resulted in directing an attention to appropriating the hardware and engagement in experiments with self-assembled devices. Nonetheless the trend is also recognized and further stimulated by major professional producers such as 3D Systems, a company that is on the market for over 20 years selling both professional 3d printers for industrial manufacturing and providing content-to-print solutions, for example printing elements for hi-tech drone aircrafts. More recently the company started to provide services for private consumers selling affordable home purpose 3D printers (Cube 3D starts at

⁴ According to <u>http://reprap.org/</u> "RepRap is humanity's first general-purpose self-replicating manufacturing machine."

around 1300\$) and lunched Cubify, an on-line service, which is a sharing platform and a marketplace. It also provides modeling and customization tools for 3d printing.

What is peculiar about machines which print in three dimensions is their ability to transform information into material form. Rumpala (2012) argues that they incorporate two types of factors: mechanical and digital. As "both material and data are used by these machines: they are combined to assemble hybrid artifacts, which are taken from virtuality and are given materiality". (Rumpala 2012: 2) Even though computers were supporting industrial manufacturing process since the 1960s, and digital instructions in form of CAD files were used to guide machines in the process of fabrication, it is only recently that machines such as 3D printers are affordable to wider public as they are becoming less expensive and more compact in size. (Retto, Ree 2012) This trend facilitates the expansion of the technology by making it 'personal' similarly in a way computers were popularized previously. Because of this, it will allow in broader spatial distribution production of material goods, eventually transforming households or small workshops into micro-factories.

3D printing can be considered as a socio-technical invention that carries a potential not only to change the work in manufacturing and creative industries, but with democratization in access to the technology it challenges social relations of how material goods are produced and consumed. Chris Anderson (2012) argues that we are now encountering "the third wave of digital revolution". The first was popularization of personal desktop computers; second was related to ability to broadcast globally through the Internet, which led to increase in production of written culture and digital visual arts. With "Web 2.0"⁵, which encourages active participation in creation of digital content. Popularization of the 3d printing technology is the third stage of digital revolution that now makes it available for general public not only to design and share digital objects through the Internet, but push it one step further surpassing the borders of digital reality, making it possible for

⁵ Web 2.0 is a popular term describing non-static, social media web sites which allow their users to participate in creation of the website by generating their own content, interacting and collaborating with each other. It is opposite to web 1.0 form of website which only allow to view the web site but do not allow public to generate its content.

those objects to acquire physical form.

The Internet is a natural medium through witch culture a in form of printable files containing 3D designs are exchanged and shared. There are emerging on-line sharing platforms, which specialize in mediating in process of cultural display and distribution of printable objects. Websites such as Thingiverse (thingiverse.com) function as a community repository, allowing free and open access to its resources, and thus to the culture. As those files are provided without any charge they do not function as commodities but as commons that can be replicated infinitely. Members of the Thingiverse community therefore engage in a process of commons-based peer production, collaborating together though discussion and remixing of the designs, and sharing results with each other. By doing so they propagate an alternative to capitalist culture. Rumpala argues that "these values contribute to emphasizing creativity and the capacity to make something oneself. These new tools seem to bring about new modes of production and consumption, and therefore potentially different relationships to goods." (Rumpala 2012: 14) This opinion is shared by Jacob Rigi, who also observes that facilitating this process technology of 3D printing allows to transcended technical and social divisions of labor. Furthermore he claims that generalized digital desktop fabrication has even potential to abolish the market. (Rigi Nd.) Hence, with an intersection of peer production of digital commons the 3D printing technology reveals its the most revolutionary characteristic and ability to reconfigure not only cultural production but the whole organization of society.

Marx (1976) argues that, through capitalist production, the worker is alienated from their labor. Furthermore by devision of labor the worker loses ability perform the whole craft. Makers, tinkers or hackers in hackerspace communities oppose this trends by presenting "do it yourself" (DIY) attitude towards fabrication of goods, that results in self sustainability. By this it diminishes the notion of commodity fetishism. The process of personal production is greatly facilitated by 3D printers; the machines handle the manual labor. Thus the manual fabrication skills are redundant or at least limited. The technology allows to freely modulate and change shape of objects in form of digital design and then simply print them without using any physical work. It opens new possibilities for makers to fabricate objects, while remaining unconstrained by complexity of their shapes. As the machine does the physical labor, manual skills are not necessary. No tooling nor molding is required. The shape of an object is limited only by author's imagination and possession of new set of skills necessary to create digital design of the object. With use of 3D printing technology the process of actual object creation is transferred to virtual space where the digital designs are made. This gives rise to a new way how the physical aspects of culture are created and consumed. With use of the Internet the novel mode of production can replace the capitalist division of labor with global scale distribution of labor (Rigi Nd.) As digital desktop fabrication is being used as a tool, which facilitates process of personal production, it enables in people what Holloway calls power-to, and by it reduces the centralization of power by creating counter power. (Holloway 2002)

My analysis of the issue showed that the most important element of the emerging technology of 3D printing is a digitalization of the process of manufacturing. As it was emphasized by my informants, and as I could later verify through participation in the fabrication process, the most important characteristic of a 3D printer is that it is able to "materialize information", i.e. in order to print an object it uses sets of instruction from computer-aided designs. A preparation of the design is hence where all the human intellectual labor is focused. The rest is to connect the printer, load filament to the printer's extruder and set desired parameters for print. The printing itself is automatized and should not require human involvement. "In some cases it is not even necessary to print the object for yourself", one of the creators told me. "If you share it on thingiverse or other services, someone else can print it, test it and give you a feedback, or just simply make a use of it." This verifies my hypothesis that the cation of the digital designs for 3d printable objects is the most essential part of the digitalized manufacturing on which I focus in this work. Furthermore, according to one of my informants, Michael (30 years) "it's a tendency of technical people to overemphasize the ability of the technology to transform the society. It's cool to have all types of tools like 3d printers or laser cutters but they are not social by default, so you need collaboration to change the world." Unlike the Internet, which as a mean of communication (hence is social by default) 3d printing is not a social technology by itself, and can be used in various of ways and for various reasons. Thus, one cannot associate the sharing environment with all people who will use the technology. What is revolutionary is the use of the technology to share through the global network open designs⁶ of 3d objects that can be later modified, discussed, improved and finally printed at homes, workshops or hackerspaces.

What is a hacker?

we hate those who demand respect without earning it. we phase in and out of different realities and change our personae like underwear. we are digital conquistadors, exploring the strange new plane that produced us.

First of all, the stereotypical understanding of a hacker as a malicious techno-criminal is misleading and has to be clarified. Therefore I find it necessary to firstly define what a hacker is and provide a basic background about what I later describe as a hacker culture. For the purpose of this paper, I will use Bruce Schneier's definition of a hacker, which was proposed to me by one of the member of the hackerspace:

A hacker is someone who thinks outside the box. It's someone who discards conventional wisdom, and does something else instead. It's someone who looks at the edge and wonders what's beyond. It's someone who sees a set of rules and wonders what happens if you don't follow them. A hacker is someone who experiments with the limitations of systems for intellectual curiosity. (Schneier 2000: 43)

⁶ A digital models of physical objects that are available under various open licences, hence are part of digital commons.

This broad definition does not specify what the system is. Therefore it does not have to be related to technology. Hence, hacker is a person defined by the quality of their activity – hacking, which is not related to a subject but to a cognitive doctrine in which one looks at a system and search for way to overcome it's limitations, to think beyond it, and by it to change it. Hacking therefore can be understood as "an appropriate application of ingenuity'. Whether the result is a quick-and-dirty patchwork job or a carefully crafted work of art, you have to admire the cleverness that went into it." (Raymond et al 1992). Accordingly, being described as a hacker is rather perceived as a compliment and is related to the social status, which one has to earn. (maxigas 2012) When I asked my informants do they consider themselves to be hackers, I repeatedly heard that it is "inappropriate" to name oneself a hacker, as you have to hear it from other people. The participant observation at the hackerspace allowed me to verify that most of the member of the space can be indeed defined as hackers.

Even though hacking is usually associated with lucid computer programming or fringe DIY (do it yourself) activity, it does not have to involve cyberwarfare or other illegal activities. As I was able to observe during my stay at the hackerspace, it has a subversive edge but it is more creative than destructive. Tom, one of my informants, whose profile I will describe in detail later in the next chapter, told me that "hacking is not necessarily what ordinary people think it is." At metalab people are hacking various things, mainly electronics and hardware, but also music instruments or photography by building their own cameras. Tom for example, is 'hacking products', i.e. he is "getting something more out of them", improving them. For him hacking is to "look behind the curtain of things... to see what you can to with what is given and improve it or do something with it", Hacking in this scene is a process by which people adapt, redesign or customize products for their own purposes. Innovation is therefore a key aspect of hacking.

Through its very nature, hacking is revolutionary as it tests the boundaries of the system and transcends them. In this understanding of hacking, a hacker can be anyone who who engages in this

type of activity, not only technologically savvy members of the population who like to experiment with computers. I came across an opinion that for example Leonardo DaVinci and Nikola Tesla could be considered as hackers *avant la lettre*, and the Pirate Party, as well as acts of 'hacktivism' can be an example of non-technological hacking, as they are pushing the boundaries of the political system.

This broad understanding of hacking, i.e. hacker practice, has reflection in the scope of the activities exercised at the Hackerspaces. It consist mainly of but is not limited to programing, tinkering, art, various D.I.Y. (do it yourself) projects, or 'hacktivist' projects of political hacking. While observing the everyday situations at the hackerspace I witnessed different acts of hacker practice, all of which oscillated around their main activity repetitively described by informants as 'projects'. A project is a temporary occupation of a member or a group of member that they focus their hacking activity on within the space⁷.

Even though there is a wide variety of projects that members of the space engage in, most of them share same features, characteristic to the hacker culture. (Coleman, Golub 2008) First, they reflect author curiosity. According to one of the informants often justification for a project is to challenge oneself and a given system, i.e. to empirically prove that something is doable. Secondly, projects often involve "abusing" of the technology, i.e. when one uses a device in a way it was not firstly designed for. One of my informants argues that "abusing is one of the ways that hacking project can start" and he finds it "a great part of the technology". Third, as the project originates out of curiosity, and not necessarily from the pragmatic need, they are often a sort of play or a joke. Finally, according to the credo of hacker ethic (Levy 1984) "all information should be free". The results of the hacker practice therefore are a contribution to the process of production and sharing of knowledge, as their designs, descriptions, source codes and instructions are released under free and open licenses through the Internet. This characteristics applies to the very most of the projects that

⁷ As in this paper I focus on hacker practice within the hackerspace I decided to narrow down the spectrum of projects to those mediated by the space. However, hacker's projects, including production of designs for 3D printers, are also realized outside of hackerspaces, mainly in the cyberspace or at private workshops.

I have seen in the hackerspace.

Metalab: a hackerspace and the community

we inhabit new worlds inside and outside our heads our ancestors didn't dare to dream about. we are leaving their dreams of material wealth behind and spin new ones of liberty and life and happiness. (kewagi, the new)

According to the hackerspaces.org (2013), "Hackerspaces are community-operated physical places, where people can meet and work on their projects." The important implicit feature of a place such as metalab is that it is a space for free exchange of information and collaboration between mostly technical-creative enthusiasts, hackers, founders and artists. The hackerspace provides infrastructure for conducting projects and offers a physical space for collaboration of interested people from the fields of IT, new media, art and hacker culture. As it was described to me when I first entered the field and as I could later verify, it is a common place for the "Internet people" to share resources, hardware, but also ideas, meet face-to-face and engage in common activity. The major reason for the existence of such places is the need for a space where people with similar interests can give life to their projects, alter already present items, and share their knowledge in the process, so they can become more proficient in the sphere they are interested in. I have observed the members of the space have certain basic predisposition that were formed prior to their membership to the hackerspace, that can loosely fit into some ambiguous notions as "a technical mind" or an "inventor". On the one hand people come to metalab "with schematics and ideas" and on the other, with "questions" which they seek answers for. They are driven by their personal pursuits to enhance their knowledge and to realize their own projects, but also to reciprocate and help other members of the community.

The primary place of my research – Metalab – is one of the largest and oldest hackerspaces in the world. It is located in the first district of Vienna, at Rathausstrasse 6, just between the Austrian parliament and the town hall. Inspired by example of Chaos Computer Club and c-base hackerspace in Germany, it was founded in 2006 as "an open center for people who do creative things with technology" to collaborate and freely change information and knowledge. (metalab.at 2013) On 220 m² it offers a space to accommodate over 200 members by offering following infracstructure: a multifunction room for talks, presentations and workshops, free wireless network and public terminals, electronics- and hardware-lab, a medialab, a library, a lounge (a recreation and social area), a chemistry and photography laboratory, and a kitchen "for catering at events and to stimulate creative exchange". (ibid.) However, as it was expressed to me on multiple occasions, the most important resource that is being shared at the metalab is knowledge. As I could verify myself "for almost every problem you can encounter during a project, there's someone who's capable and willing to help." (ibid.)

The most importantly for my research, at metalab there are many people who experiment with 3D printers and open designs. They have four desktop 3D printers that anyone can use – Ultimaker, Makerboot Cupcake, RepRap Mendel and Makerbot Thingomatic. The RepRap printer was constructed by some of the members themselves, but the project was abandoned at some point and it is not used currently. The Ultimaker printer, which belongs to Uniq (one of the regular members who often helps people in their first experience with 3d printers) is currently being used most often, as it provides better print quality and is easier to use. The other two Makerbots were donated to the lab by Marius, who used to be a frequent member of metalab but currently lives in Canada. Apart from the 3D printers, they also have an expensive, professional laser cutter and a self made CNC mill, both of which are also used for manufacturing from digital designs. The production process in the case of all of those devices is similar, as all of them use digital instructions from computer-aided designs. Furthermore, behind the printers a careful observer may notice an old, long time abandoned device that somehow resembles the other printers. It is one of the first prototypes of Makerbot 3D printer, developed here at metalab by Bre Pettis, the one of the founder of the Makerbot Industries⁸ and the ex-member of the Viennese hackerspace.

⁸ Makerbot Industies is one of the leading companies selling inexpensive (below 3000\$), home purpose 3D printers.

As it was told to be but one of the funding member, the main idea of metalab can be described as a place of public infrastructure, which encompasses a plurality of interests, professions and genders, This idea is expressed in the symbol of the space – a telephone booth, which is part of public communication infrastructure that anyone can enter and use. It also can have some abnormal mythical qualities as described in the fiction stories such as Doctor Who, Matrix or Superman. The idea of openness expressed in metalab's symbol is a core value of the space. Even if you are not a member you are always welcome to come in and participate.

Even though metalab is first of all a place of sharing: a workspace, tools, and knowledge, it also serves as a meeting place, where people can simply meet and socialize. In the daytime at metalab there are mostly freelancers who use the space as an office, a place to work. In the evenings on the other hand, the space gets more crowded and turns into a community meeting center where people not only work but also hang out. However this division is rather elusive as I observed many people 'hanging around' the place for whole days without any particular reason except to socialize. It occurred to me that the place for some of its members becomes 'a second home' where they spend most of the time, or even in extreme cases even a place where they live. One of the members even told me that when he did not have a flat to stay at he spent some half a year living at metalab.

I came across the opinion that it is "an experimental laboratory for social movements". It has played a significant role in development of hackerspaces movement, giving inspiration and providing design patterns for many hackerspaces around the world, including Noisebridge in San Francisco, NYC Resistor, or Hungarian Autonomous Centre For Knowledge in Budapest. Sabina, also known as Vandebina, who is currently volunteering holding a position of the president of the metalab⁹ told me that it is "a space for social invention." Metalab, considered as a part of broader

It is also a host of Thingiverse.com, the most popular open sharing platform for 3D designs.

⁹ Metalab functions as an association (Gesellschaft), which makes it officially recognizable by Austrian law. It requires to have a president and a board of members, and enables metalab to accept external founding from the local government and other entities.

hackerspaces movement, can be considered as an extensions of the existing hacker movement into the material world. The space is a meeting point for broadly understood hackers, 'a coffee house ver. 2.0' where people meet, exchange ideas, and work. By this it resembles what Oldenburg (1991) calls a "third place", i.e. an important for individual social surrounding different from usual environments of home and workplace. The hackerspace is in fact for most of its members the third place or even in some situations it merges with the workplace but still it remains a place of communal engagement. The emergence of relatively novel but successful movement, which as of 2012 consisted of estimated 700 hackerspaces (hackerspaces.org), as one of my informants aptly observes might be particularly relevant in the situation when conventional social movements and politics are paralyzed, hackers movement becomes a vanguard of the society. Especially in the times of information technology enabled communication the hacker movement has a prospect to reach the masses globally with ever growing use of technology.

The important about the place is that people here tend to respect differences. The opinions and lifestyles here are diverse (not only preferences about which programing language is better). And even if conflicts or personal animosities occur it is an unacceptable behavior to discriminate other persons beliefs, choices, or opinions. On the social level of the space hacking occurs, not as invading borders of others but as 'peaceful truism' where people 'cross the borders of themselves' their own limitations and test their opinions confronting them with others, changing your own routines. The member's social status and place in the internal economy of the space is based on meritocracy, where the value is related to the knowledge and possession of certain skills, for example ability to use a laser cutter. As the internal value created within the space is based on skills and meritocracy, thus it is the value of relationships between the members.

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Chapter 3

Portraits of the open designs creators

we consider gender, skin color and spiritual alignment as accessories we can wear, not as defining aspects of ourselves. we disregard nations, for we are children of the city and the river.

From among 18 of my informants and circa 80 people I had interaction with, during my stay at metalab I have chosen 4 representative individuals that present 4 distinctive patterns of attitudes towards 3d printing, sharing culture and economy. Two of them (Wizzard, Jascha) are established members of metalab, whereas other two (Tom, Marcel) started to frequent the space recently. Secondly, Wizzard and Tom can be categorized as experienced creators and users of 3D printers, whereas Jascha and Marcel just started to experiment with open designs and 3D printers. The choice of these specific individuals reflects the typology of the members of metalab and their relation with 3D printing. It serves more focused, thick description of the profiles of participants engaging in creation of open designs for 3D printing, and to some extend allows generalizations about patterns of social behaviors relevant to the case. It also reflects a statistical data on an 'Average' member of hackerspaces community, described as a a highly educated, 26 - 31 years old male from Europe (39%) or North America (48%). (Moilanen 2011) To my knowledge, the most of the members of the space who engage in similar activity, to some extent can be associated with the characteristics visible in the presented four profiles. Hence, the most of the people at the space I have interviewed that engage in investigated activity, can be characterized by a pattern of attitudes of the profiles of the participants presented below.

Philipp (Wizard)

Philipp is a 30 years old male. Born and raised in Austria, he is a computer programmer by

occupation. He is one of the founders and the core members of the metalab, known among other members for his superior skills in programing and electronics. In this sense, his Internet nickname, Wizard is appropriate, as it is told that he can do 'magic' with computers and electronics. He was recommended to me as a prime source of information by a few members independently, some of whom even insisted that I 'must' talk to him. Unfortunately, for the first week of my stay at metalab I did not have a chance to meet him because he has gone to the 3D printing conference in Munich, Germany. Nonetheless, when I finally met him I was able to quickly verify that all the claims that I heard about him were true, and he proved to be a highly valuable informant.

After hearing many stories about a high esteem of Wizzard, I expected that our communication will have more official tone, because of his internals social status at the metalab. However, he presented himself to be on the contrary – extremely friendly and helpful, to the extent that even he invited me along with some members of the metalab to his apartment where over the night we 3d printed various objects on two of his 3d printers, older solidudle 2, and brand new MakerBot Replicator 2X, that he won in Thingiverse Customizer Challenge for his design of a Parametric Music Box,which cylinder can be customized directly on the Thingiverse website to play any tune.¹⁰

Philipp works as a computer programmer. However, this occupation does not consume much of his time, as he spends only 20 to 30 hours a week working for one company. He told me that he do not spend much money, thus he does not find a need to work more. Instead, he prefers to devote his spare time to work on different projects that, even if not paid, are more challenging, hence entertaining. In his extensive lesiure time he engages in a various hacking activities, not only programing, but also electronics and most importantly for my research – 3D printing.

Even though he does programming at work and in a spare time, he says these are "totally different things". At work he is doing things that he is told to, not necessarily ones that still interest him, as they often are repetitive or not challenging enough. On the other hand, when he works for a

¹⁰ For more information see <u>http://www.thingiverse.com/THING:53235</u>

project of his own choice, such as developing of his author gadget called 'magic shifter'¹¹, whether it is payed or non payed activity, he finds it more stimulating and pleasant. He says that his main motivation for engaging in various projects is to "get things done", which is a popular attitude among members the members of the space, and even can be considered as a part of hacker ethics. (Pettis, Stark 2009)

Wizzard is also an active user and contributor to the open source initiatives. For most of his works he use open licenses, such as General Public License for software and Creative Commons licenses for hardware or designs. He likes in those licenses that they allow commercial use of the content but at the same time they are 'contingent', i.e. require that if you use even a small part of the code or work, you should release your work under the same license (base idea of GPL license and Share Alike feature of CC licenses). He says that "the only problem with GPL license is that everyone can sell the final product and Chinese will always make the best price." It is why he considers applying non-commercial variant of CC license on the hardware of his magic shifter, instead of using GPL.

Philipp express an opinion that "if you share knowledge with others you don't loose it yourself. Rather on the contrary, you learn more through sharing." It is why a great part of his experience is based on openness. He stresses that he took a lot from the open source community and he is aware that he gained from it. Hence, he knows from personal experience the benefits of sharing information and it is why he considers it to be a good practice to contribute the common pool of knowledge and culture by sharing his works under open, copyleft licenses¹². Moreover, he claims that he would never done anything alone: "Everything that I did, I didn't do alone. I talk to people, cooperate with them... This is how open content works. It enables mankind to develop its

¹¹ <u>http://magicshifter.net/</u>

¹² Copyleft is a self resignation from part or whole copyright privileges that author imposes on their work, which results in dedication of the work to the public domain or restriction of only some of the rights ("some rights reserved" instead of "all rights reserved")

full potential which comes out from cooperation."

For Wizzard a 3d printer is a great device, because it allows him to do rapid prototyping at home, i.e. to quickly materialize his ideas. He currently uses 3d printers develop a case for his magic shifter project but he also prints many decorative elements. He uses one of his printers almost every second day. If you look around his apartment, especially the living room, you will see that there are many 3d printed elements decorating the room or laying around. He showed me a box full of different projects he printed: some toys, the geometry of which, is based on mathematical algorithms, or some complex objects presenting potential of additive manufacturing.

Philipp argues that 3d models are just yet another form of digital instructions, which production can be similar to wiring a source code for programs. Similarly, one can use them the same way as programs: "You can just use it or you can change it, modify it." Depending on a level of involvement, you can be an end user (free rider) or you can contribute by making derivatives (forks). In this scene there is not much difference between developing an open software or an open design, as the intimal motivations, production process and finally usage have similar characteristics. This proves my previously stated hypothesis that open designs due to similar characteristics can be compared to other forms of open source activity and generalized as open content.

Tom (Tom_Korn)

Tom is 28 years old male from Austria. When asked about his political and ideological orientations he quickly answered "none". He is skeptical about any mata-narratives that he perceives only as a political tool of gaining and sustaining the power and ruling legitimacy. Instead he prefers to "stick to the practice." He describes himself as an inventor and works in product development industry. Until recently he had his own company, in which he employed a few software developers, including ones from the metalab. He studied industrial design but he dropped out from university to pursue is professional career. Tom claims that the most of his design and work skills are self educated, i.e. not acquired through the official state education but learned from

the books, the Internet, or from other people, including members of metalab. He feels emotional about his occupation affirming that "software and product development, as well as 3d printing is what I do and what I love." Ergo, there is no difference between what he does for work and 'for fun', except that if a developed product is intended to bring profit (to him directly or to company that he is doing it for) he rather imposes copyrights on it and do not reveal the source code for public. On the other hand, projects that he does 'for fun' (not for profit) are released under open licenses. In the case of printable designs, usually he uses Creative Commons Share Alike license.

On Thingiverse, where he uploads the most of his designs, he is known as Tom Korn. He has two 3D printers - solidoodle, and self build oversized RepRap Mandel Max, both of which he uses frequently. He finds it the most important aspect of the 3d printing that it allows him to "get hands on the ideas", i.e. with it a user has a possibility to prototype things fast end relatively easy. In this scene, 3d printers has to be considered a great facilitators in a creative manufacturing process. He is currently developing a commercial model of a 3D printer of his own design, which he intends to sell. The project is funded by one of the industrial companies from Germany. "It's gonna be a mixture of Solidoodle, Makerbot Replicator 2X and a professional printer, a high precision one." - he says. A design of the hardware for the printer will not be openly available on-line. However, as Tom underline, the printer "will use some open source parts and software, so people will be able to enhance it." For example, he is now working on an extruder for the printer and if it works he will put it out on Thingiverse, so other people can use it and experiment with it. Therefore, the project is an example of a mixed logic, where open source solutions are mixed with closed, even patented elements, in order to maximalize profits, while still enabling community in an active engagement in product development. It is approach similar to the case of Wizzard's Magic Shifter, both of which I will analyze in the next chapter.

Unlike Wizzard, Tom started to frequent metalab relatively recently, around half a year ago, hence he can be categorized rather as a 'new member.'¹³ He first time came here, because he was

¹³ Even though the distinction is not clear or visible in the social reality of the space, it is used by the author for the

working on a project that he wanted to discuss with people. He consulted Wizzard on how to produce a Printed Circuit Board (PCB). Then he brought to the metalab his Mendel Max printer and quickly found people who liked his ideas and wanted to work with him. He finds it one of the most amazing things in the space, that the ideas are here quickly coined into practice - "If you have an interesting project on you will have a lot of manpower to work on it within minutes." Currently, with two other member he is developing a software for bitcoins (emerging virtual currency) that sends notifications to users about change in exchange rates. "You just sit here in the lounge, and three hours later you have a concept of graphic interface design. One week later you have already a website and service ready to launch." - he says about the origins of the project. In the process he also got acquainted with many members of the space, which resulted in some friendships and Tom's getting attached to the community. It represents a reoccurring pattern of hackerspace community building, in which community is being formed out of pragmatic actions of sharing resources, where the primary motivation is to share space, tools and knowledge. This practice, as it involves physical interactions and peer collaboration, results in an emergence of a secondary motivation related to the personal identification with the community built in the result. (Wykretowicz, Vachkov, Ilioaia, Nd.)

Even though Tom has a relatively short experience of being the member of metalab, it does not mean that practice of openness and sharing knowledge were not exercised by him before. On the contrary, he has been using open source software and hardware for years, and as I mentioned before, his education was mainly based on an open access to knowledge shared through the Internet in a form of tutorials or on thematic forums. He seems truly keen on open source content and its advantages: "One of the coolest thing about open source software is that you can easily look into its source code and see how other people do stuff, use parts of it, or even a whole thing for your project. You don't have to reinvent everything on your own." He argues that open source practice

analytical reason. The distinctions that I have observed are first of all of the meritocratic nature – what do you do and how well do you do it, and of personal preferences – which informal group of friends you are part of, where the second factor is influenced by the first and by the length of frequenting the hackerspace

saves you time and enables him to see how other people struggled with similar problems. Moreover, he stipulates that because of the openness and transparency, "open source initiatives can be much more powerful than anything that is closed source, as it becomes a constantly improving mechanism." According to Tom, this also allies to open designs shared on platforms such as Thingiverse: "In many cases you have one major build [an original design – dw], and then people keep making it better and better part by part, improving all the time the design." In the process the primary idea or a design concept is developed further by other peers which also stimulates the original poster, by comments, bug reports, discussion and new approaches towards their concept. On the other hand Tom recognizes an unpredictability as a potential disadvantage of open source projects: "you cannot put a time schedule on open source activities, because they are developed by volunteers who choose a time and an extend they want to contribute."

In Tom's life there is a balance between open sourced and copyrighted activities. He says that the ratio is 50% to 50%. There are a lot o "funny little things" that he release on Thingiverse or Github under open licenses. On the other hand, he uses copyrights on products that have a potential to generate profits and those that do not require active community contribution. Nonetheless, he underlines that discoveries significant to the society, such as efficient ways to produce energy or life saving drugs, should not be copyrighted. He emphasizes the importance of conscious business models which take into consideration their impact on the society, which parties are influenced and how.

Jascha (Manarius)

Jascha, also known as Manarius, is a 30 years old, self-educated computer programmer and an activist. He finished his official education at the gymnasium level, failing mathematics. "I never was good in maths but I'm good in poetry... and programing is like poetry. You have to find the way how to rhyme the code."- he explained to me referring to the Wordpress slogan - "Code is poetry" (wordpress.org). He has Austrian citizenship, however, as a declared anarchist, he rejects a concept of a nation state. His political orientations and strong feelings towards sharing and openness were formed early in his life. Before starting his adventure with programing at the age of 20, he was a part of a squatting subculture. For three years he (illegally) occupied abandoned houses with other squatters. During that times he was taking part in many protest and other activist initiatives against the FPÖ right wing government. This experience made him realized "how constraining the real world is" and "how hard is it to get a message through." He realized that one can reach masses only through the digital means of communication. He argues that without computers it is nowadays impossible to change the world. It is why he decided to develop his programing knowledge.

Jascha presents a 'minimal' approach to the consumption. He lives "cheap and lightly" with minimal impact on economy and ecology. He spends less than 500 Euro per month and has to work only 2-3 months in a year to secure his finances. He says that he could work more and earn significantly more but instead he prefers to enjoy freedom "to do what he wants to do" or what he thinks "is the right thing to do at the moment". It complements with his ideology and is further expressed by choice of work for "open causes". Even in the times when he works as a freelancer for external companies he seems consciously choose who he wants to cooperate with, refusing to work for employers that he considers to be 'evil', i.e. acting against openness. He enjoys a privilege that he can choose which projects he wants to work at. Sometimes he even does a work for a company or NGO without a charge, just because he supports some ideas behind it or finds a project interesting. He expresses strongly an opinion that "humanity needs spaceships soon!"

Due to his work routine, Manarius is one of the most frequent visitors at metalab, where he utilizes the abundance of time as often to work on his projects as to engage in discussions and socialize with other members. "I am one of those guys at the lounge, who you go to if you want to have a funny talk (laugh)" - he says. As some of the members describe him, is one of the "freakier persons" at metalab. He perceives metalab as a successful example of "anarchy in practice", as it is based on self-organizing structure and organic hierarchy. It also tests "how society would work if

everyone was free to say what he wants to say", which also works fine to him. He claims that many members of metalab are "caffeine and dopamine junkies". It means that firstly there are many people addicted to drinking caffeine beverages, usually Club Mate, a fizzy drink based on mate tea popular at hackerspaces. Secondly, following Jascha's argument, those people also require extensive brain stimulation by being amazed with how things works or with a clever hack, which eventually would result in production of dopamine hormone to the brain. Both of the mentioned characteristics applies to Jascha as well.

Jascha recently started to experiment with 3D printers to create an open source table-top science-fantasy miniature game. His motivation was that with a few other member they decided to play a strategy game at metalab but "not one from companies that care only about their money but not gaming." He realized that with 3D printers available at the lab they have means of production to fabricate a game themselves, where a printing of one figure would cost them less than 0,1 Euro. Because of his love to the space and spaceships, as a figures for the game he dedicated to print models of planets, space stations and of course spaceships. All the models he have created so far are freely available on his public github repository¹⁴, where others can contribute to the development of the project by commenting, pulling requests, reporting bugs, or even forking the project, i.e. creating independent derivatives. The working title for the game is PVPVZ, which stands for Players vs Pirates vs Zombies and it is a reference to the popular computer game Space Pirates and Zombies.

Basing on his relatively short, but positive experience with 3D printing, Jascha is highly optimistic about the technology. He argues that the most amazing thing about 3D printers is that

¹⁴ Github.com is an on line tool for "collaboration, review, and code management for open source and private development projects." (Github.com 2013) It is one of the most commonly used tools for peer production of open digital content, mostly software but also as Jsascha's example confirms, it is also used to share and develop open designs for 3D printable objects. The progress of PVPVZ project can be review at https://github.com/manarius/pvpvz-fleets

they enable him to "easily create additional parts of the world" and to see the results instantly. For example, when he was young he liked a lot to play with Lego blocks, but he could not connect different lego systems together. With a 3d printer he can download or create himself a connector between different types of blocks. He explains that, instead of going to a shop and choosing a product from limited selection, affordable desktop 3D printers enables people to customize products according to their products, instead of choosing "what there is" to choose "what they really want." He says that possibilities to use 3D printing are endless. However, for many people the biggest problem is that they just do not know what to print.

Jascha is optimistic about open content and express an opinion that collaborative process of peer production starts to make change in the world. He mentions rapidly growing number of open initiatives and thinks that it will soon become a standard. For himself the peer production practice is already a "natural way of collaboration" which "after 6 years practice comes to your bloodstream." He finds such collaborative initiatives an opposition to centralizing attempts of capitalism, which bring back a human factor to the market economy of dehumanized neoliberalism. Furthermore, he aptly observes that cooperation through open source projects is beneficial for the collaborative, because the group is more efficient than individuals working separately, and at the same time in mass collaboration production is not obstructed by individuals, because contributor can be replaced by others.

He is critical about the idea of copyrighting intellectual property because "the code is just a language" and words are public domain. Hence, if he creates a program he is always basing of the knowledge carried by the society. In the current systemic situation he is in favor of reducing the duration of copyrights. He finds it a justifiable practice for example to keep new products closed source for a year or so, and after they gained some profit, they could be made open. In this way there is a balance sustained between commercial and social reasoning. He argues that "learning not to be greedy is a lesson that humanity must learn, if we really want to start space travel." Therefore

he proposes a division for "mission critical problems" and "first world problems"; first ones should always be open source and "it is a crime not to release it open source", whereas second are just solutions such as pizza automated delivery systems which makes some of the aspects of life easier but are not essential for development of the society.

Marcel (Spindoctor)

Marcel is 30 years PhD student of Economics at University of Vienna. On the Internet he is known as Spindoctor. He comes from a middle class family and all of his life he lived in Vienna. As a researcher he is interested in social welfare and as a human he wants to "make the world a little bit better." In this respect he was inspired by his mother, who is a political activist. He believes that granting people an open access to information and to welfare is one of the ways how to secure this goal. It is why he supports the idea of the basic income. He argues that people should keep on sharing to the extend that one day such practice will become a common sense. Even though he started to frequent metalab recently, he sees a potential of such cooperative initiatives in achieving the mentioned goal.

As an economist Marcel thinks that sharing the free culture and information, especially facilitated by use of digital desktop fabrication leads the society towards post-socialism, a post market economy, where needs are fulfilled without the market. When he thinks about the future he imagines "an ideal 3D printer" which resembles 'the replicator¹⁵' from Start Trek movies, which is able to produce any thing that it is told to, with no difference if it is food or a complex, technical object. He believes in the technology but sees that it needs time to develop. He notices that for the time being the most of commodities cannot be provided by 3D printing and open source

¹⁵ It is worth mentioning that the latest model of Makerbot 3D printer is also called Replicator. Apparently it is not a coincidence, as the makers of Makerbot were inspired by the RepRap project and the idea of "general-purpose" self replicating manufacturing machine" (reprap.org 2013)

communities. Raw materials or food are goods that still have to be produced traditionally; they are limited and cannot be copied. Hence, the question of guaranteeing needs of subsistence cannot be resolved by downloading them from the Internet. The replicator is not yet ideal.

Marcel learned how to use 3D printers and printed his first design while I was conducting my research at metalab. This gave me an opportunity to observe both: his first struggles with novel technology and process of learning through free exchange of knowledge at the hackerspace. For his first project he chose to print a lock mount for his bicycle. In the printing process he was assisted by Uniq, the owner of Ultimaker, who explained him how to use the machine, helped in setting proper parameter for the print in order to achieve desired effects. As I could observe the process had to involve a notion of experiment; they had to restart the printing for four times and adjust some settings, before they finally managed to print a working part. Marcel told me that his motivation for printing first of all came out of curiosity. He wanted to verify if he is able to print a part himself, instead of simply buying it in the shop. He wanted to print something with 3D printer and for some time he was looking for an "excuse" to do a project. Finally he realized that he needs the lock mount, which was enough justification to engage in 3D printing. First, he had to learn how to use OpenSCAD¹⁶, which allowed him to make a precise model of the mount that would perfectly fit the size of his frame and the lock. Then, along with Uniq, they had multiple attempts to print the part with the proper settings. All in all, he spent a lot of time on this project. As he argues, in the economical scene, this part coasted him more that he would have to pay in a store. However, in the result of producing the part himself, he gained not only a use-value of the part, but most importantly a satisfaction which comes from mastering the craft. When I asked him if he will do another 3D printing project, he was not sure: "When I know it now, maybe I will try something else."

Marcel will release his design for bicycle lock mount on Thingiverse under the Creative Commons license, so other people can also make use of it without "reinventing the wheel." He already has a paid job at the University of Vienna, which allows him to share for free the result of

¹⁶ A free and open source software for developed by ... one of the members of the metalab.

his secondary activity, as he does not depend on it. In fact Marcel's work and leisure play rather visibly separated. Unlike other people I describe, his primary occupation is not related to his activity at metalab nor to technology in general. However in his work he tries to use as much open software as he can. For example he uses R, an open source statistical computing software, an open document preparation software LaTeX but his professors do not support it. He supports open source and open access initiatives. Especially as an academic, he realizes the advantages to open access to knowledge, as he depends on it to a great extend. Also he uses Stack Exchange¹⁷ whenever he looks for solution for a problem he is having. For him such practice of sharing knowledge and experience is a part of "a search for the absolute answers." He believes that when you put a question on the Internet everyone connected can answer the question, and the answer can be improved infinitely. On the other hand there are things that he would not release under open source or at least he would like "to get paid for them once" if it was a part of his main profession. "You want to get paid for your work" he argues. Because of such reasoning, he finds it justifiable to postpone releasing content's source under open licenses. He argues that you can build a business model with such attitude thanks to on-line crowd funding platforms such as Kickstarter, where startup initiatives are backed financially by on-line community and where "you can promise to share results of your work with community after they show appreciation."

Even though the technology enables people to do things, he is rather skeptical it will push people to create more. Not everyone is creative in their nature. Actually, only a small part of the society shares hacking attitude, will for experiments. Most of the people want things that work and they use them in the simple way. He believes that 3d printers even if they soon become popular method of digital desktop fabrication, their use will be rather recreating, repetitive or merely limited to printing objects that other people made, even if they have to pay for the design.

¹⁷ Stack Exchange is a network of community-run question and answer sites on various topics including, but no limited to software programing, education, cooking, etc.

Chapter 4

Analysis of hybrid motivations

First of all I found that the creation of the open designs have significant similarities to the other forms of creating open content and can be situated in the broader practice of peer production. As Wizard aptly observes a computer-aided design is yet another set of instructions that can be coded in a similar way to computer programs. People at the metalab most often work on various projects and contribute to the production of commons in different ways, not only by creating open designs but also by creating open software, hardware, or even poetry and different forms of art. It reflects the scope of the projects that people at the space engage in. All of my informants were involved not only in creation of designs for 3D printers but in a wider range of hacking activities.

According to Moilanen (2013) altruism, community commitment and having fun are to be considered the most important motivations for engagement in peer production of commons, which suggest a strong 'social motivation factor'. He argues that "having fun is one of the most important motivation factor and having fun is fundamental part of social life. Without having fun (while doing things), there would not be any social activities." My research has verified Moilanen's thesis and extended it. In this chapter I present my analysis of the motivation of participants to create open designs for 3D printing, which they share with community. I argue a drive to engage in such activity has a hybrid structure. Firstly it is an expression of curiosity, which is a primary characteristic of hacker culture and a motivation to start a project, which in the result also becomes an expression of freedom through action. Secondly, the sharing the designs with a community can be considered as an act of conscious act of reciprocity, where contributors are motivated share the result of their labor with others in order to contribute to a broadly understood development of the society. Thirdly, after they upload the designs to on-line sharing platforms, they might receive a positive feedback from the community in a form of appreciation and recognition of their contribution by their peers,

which influence their esteem and motivates to continue this type of activity.

Later in the chapter I analyze the limits of the social drive to produce open designs and other digital commons. Torvald (2001) distinguishes three types of motivation for hacker's activity, which can be categorized under survival, social life and entertainment. I follow his reasoning that the survival is the basic motivation and two others belongs to a higher category, i.e. one's actions are not motivated merely by need of survival but are done for social reasons or for entertainment. By analyzing relation between informants' paid their paid work and leisure activity, I stipulate that their voluntarily engagement in sharing their knowledge and result of their labor (higher motivations) is often being compromised by economical reasons, as the creators in the first instance need to secure their needs of subsistence.

Curiosity and liberation through action

As I have shown in the previous chapter while discussing characteristics of hacker movement, activities that members of the metalab engage in share some features. They reflect author's curiosity, which is a cause for emancipating action expressing freedom to do (Fromm 1968). According to the relations of the informants presented in the previous chapter often justification for a project is to challenge oneself and a given system, i.e. to empirically prove that something is doable. Wizzard's and Marcel's first experiments with 3D printing where motivated by curiosity and only after they proved themselves to be able to create a functional 3D design that can be fabricated with a use of a 3D printer, they decided to share the results of their work with the community. Furthermore, in all four cases my informants the hacker's curiosity was related to challenging ones abilities to create, i.e. if they can create an object themselves, instead of buying it or downloading a ready-made design from the Internet. The successful challenge, as the informants suggested was followed by satisfaction from mastering the craft, as described in Marx (Marx 1976)

The participant's motivation that emerges out of curiosity can be hence interpreted as an

expression of positive concept of freedom (Berlin 1992; Fromm 1968), which states that we are free when we are active. Presented above hacker practice within the hackerspaces, which involves production and distribution of digital commons in a form of computer-aided designs is firmly based in pragmatism and focus on doing. Their DIY activity can be easily interpreted in the terms used by Holloway (2002). He defines the activity of doing as a "scream of an active refusal" (15) which has to be inherently plural, collective. The power in Holloway understanding is related to agency, and can be understood as a "can-ness", a capacity to do. The social power of peer production practice is analogically exercised by a collective action, where the open content movement aggregates its power, capacity to do, which results in decentralization of power and opposes centralizing attempts of the capitalist system. Instead of selling their capacity to do, hackers devotes their time and energy to work on their own projects, to develop themselves personally, and to contribute to the common pool of information. By doing so, members of hackerspaces liberate their power-to, and oppose commodity fetishism which is "a relentless rupture of the collective flow of doing". (30) As it is visible in the presented profiles of the participants, they all to some extent are conscious of such results of their actions or even ideological engaged in the practice of opposing neoliberal capitalist system (Jascha).

Conscious reciprocity

Conscious reciprocity is a part of hacker ethics and ideology represented by my informants. According to the credo of the hacker ethic (Levy 1984) "all information should be free". Therefore, the results of a hacker practice are most often contribute to the process of peer production and sharing of knowledge, as their designs, descriptions, source codes and instructions are released under free and open licenses through the Internet. This characteristics applies to the very most of the projects that I have seen at metalab. Hence, its members can be considered as a part of a productive social movement of hackers within the hackerspace. As it was repetitively underlined by the informants "if you share knowledge with others you don't loose it yourself. Rather on the contrary, you learn more through sharing." (Wizzard) All of them are aware of the benefits of sharing participate extensively in a reciprocal activity, where they take from and contribute to the common pool of knowledge and culture available freely through the Internet. They also empathize that if they already have taken an effort to design an object for oneself it is not a problem to share it with others who also can have a use of it. The process of sharing do not involve any extra cost for the participants, who already created a digital use-value for themselves and it does not matter how many people will later use it – one or one thousand. Furthermore, they collectively agree that it is a moral obligation that "mission critical" discoveries important to the development of the society should be open source, thus the information would be shared. Hence, their practice is an expression through action of the culture of sharing, which in their beliefs enables mankind to develop its full potential. It explains their motivation to share the results of their work as they want people to make a use of it, and in the result make them feel content about their contribution to the society.

This complements with Sahlins typology of reciprocity (1974), even though the case of peer production of digital commons, cannot be perceived strictly as form of economy based on gift exchange. Because the digital objects are copied and shared, rather than exchanged, there is in fact not a gift exchange understood in the Maussian terms. On the other hand it is a particular form of exchange of immaterial goods: experience and knowledge. My argument is that peer production in the case of open designs is based on the generalized reciprocity, in which a person donating to the general pool of commons do not keep track of their value, and do not expect instantly anything in return, but has often expectation that their contribution will be balanced in the future (Sahlins 1974). In the complexity of the shared network of knowledge, it is not relevant from whom you take or to whom you give. At some point the reciprocity comes back to you from unknown direction, from often a nameless contributor to the general pool of knowledge. The practice, I argue is not a

metaphysical, but a practical economical calculation, which aims for maximization of outcomes: the more you put into the system, more you get back from it, as cooperation results in something greater that a mere sum of individual efforts (Marx 1976). In the case of sharing open content, I find applicable the notion of 'everyday communism' explored by the authors of *Human Economy*, "a common human propensity for sociability that, with some redirection of emphasis, might serve as ground for non-capitalist economic organization" (Hart et al. 2011:15). As I have shown above the description of the human economy is particularly accurate to the organization of the investigated hackerspace community and to ongoing practice of peer production, which through collaboration rather than competition serves the needs of communities and even humanity in general, instead of individual egoisms, yet at the same time is based on individualism.

Esteem

In the process of sharing open designs or other form of open content, their creators may receive an appreciation and recognition by their peers, which in influence their esteem and motivates to continue this type of activity. Through the interviews I found that often a motivation for the informants to upload their designs and share them with the community is to see what other might think of it – will they like it, will they print it? Each of my informants respectively admitted that they "feel happy" when other peers use their designs, and print or fork them. The appreciation and recognition of their work in a result makes them feel better about themselves. Hence, the act is not only a form of conscious generalized reciprocity or pure altruism, but it also includes building an esteem of the creator.

This notion is especially visible in the case of open designs which are most often attributed to one particular individual, i.e. the original creator. In this respect the open designs differs from classical case of collaborative production of software, as the individuality of the creator is embodied in the design. The designs are mostly individually created and only then shared with communities, through sharing platforms such as Thingiverse. This way is more similar to production of arts, where people share their piece with communities, and just later other people can improve it or remix it by creating derivatives (Lessig 2004). Unlike GitHub, Thingiverse is not equipped in advanced tools for collaboration, which makes simultaneous peer production process less efficient (Jascha). As my informants (Wizzard, Marcel) argue it resemble more a "Youtube for 3D designs" than a collaborative platform. Similarly to the the amount of views on Youtube builds an esteem of a user, same amount of positive comments and more importantly prints and applications of their models, builds up the esteem of the contributor.

Even though creation of computer-aided design than can be fabricated using a desktop 3D printer is usually done by an individual, in some cases it can be considered as a peer production. Marcel's example confirms this thesis. In his case, he believes that his bicycle lock mount can be considered as peer produced through collaboration and otherwise he would not be able to do it alone. Even though he designed the item himself, he firstly was basing on the knowledge of others. Many people assisted him in creation of the design by providing know-how to model it. Furthermore, he used the infrastructure of metalab in order to print it. Later peers assisted him in the process of printing, showing how to do it. Finally, he received a feedback, which allowed him to further improve the design. In this case, the feedback that he reviewed at each stage of creation and distribution of the design has to be accounted as a contribution to the peer production of the design.

Limits of the social drive to create commons

As I have shown above, the motivations of the open design creators are not of financial origin. However the drive to create and share open designs is compromised, as the creators in the first instance need to secure their needs of subsistence. Only after then they can consider engage in the open activity in their leisure time. My argument is that there are contradictions internalized in both individual motivations and collective consciousness of the space, which are a result of tension that occurs on the contact surface between internal, non-market economy of the space and external

commodity market economy of capitalist system. It happens because the community and their members are not yet fully self sustainable as their members relies on material elements of external reality. Their source of income in most of the cases does not come from their open source activity, which results in production of digital commons, but from selling their labor to market based companies. They livelihoods depend on wage labor and not on their leisure time, open source activity, which enables them to release open content free of charge. In this scene their actions can be perceived as sharing with community the results of their surplus labor. The necessity to secure needs of subsistence is therefore a motivation to engage in a wage labor, whereas the leisure time can be devoted for exercising a positive freedom (Berlin 1992; Fromm 1968) through action (freedom to) by developing as an individual through taking and contributing to the common public good. As Marx argues "only in community [has each] individual the means of cultivating his gifts in all directions" (Marx 1976), as freedom is attained only through through and in the community, which is an only environment enabling development of full human potential.

On the other hand the relations inside-outside are pivotal. Not only the larger structures of the outside influence the space but some of internal values and practice of sharing open content are exported outside and by this contribute to the change of the social relations. Internalized culture of openness and sharing is exercised by individuals also outside of the space (use of free software everywhere), and further disseminated through the Internet, which by increasing visibility of such practices contribute to the change of the social attitude towards open source practice. Nonetheless, the relation is unbalanced, where obviously the dominant is the commodity market economy, constituted by *homo economicus*, an egoistic individual.

This shows that there are not only external, but also internal blocking forces for the commons based economy, where the internal commodification attempts are an "inside man" that seek to obstruct building of open non-market economy from within. Those internalized norms of behavior, which are the result of such practice, come from outer world of market economy that

members of metalab are still depending on. Therefore the project is sabotaged by market commodification attempts and members of the space themselves, whose agency is limited by market actors. Thus, for the time being it seams that the situation is under control of market economy. However with a grow of the open content movement, the emancipatory attempts of the non-market commons-based economy can result in its full self sustainability, which my in effect create a sufficient counter power for a systemic change (Holloway 2002).

Concluding remarks

we are born as the slaves of a dying time, struggling to get free. we are the chosen ones, for we have chosen ourselves. we are the new. (Kewagi 2011)

Through my fieldwork I investigated systems of value of the members of the hackerspace and their motivations for creating open designs that can be used to 3D print physical objects. I found that creation of the open designs have significant similarities to the other forms of creating open content and can be situated in the broader practice of peer production. People at the metalab most often work on various projects and contribute to the production of commons in different ways, not only by creating open designs but also by creating open software, hardware, or even poetry and different forms of art.

My analysis of the issue showed that the most important element of the emerging technology is digitalization of the process of manufacturing. Unlike the Internet, which as a mean of communication 3D printing is not a social technology itself. It can be used in various of ways and for various reasons. Thus, one cannot associate the sharing environment with all people who will use the technology. What is revolutionary is the use of the technology to share through the global network open designs of 3D objects that can be later modified, discussed, improved and finally printed at homes, workshops or hackerspaces.

With an emancipatory attempts of the novel form of production of commons exercised in the hackerspace I investigated, the social movement of hackerspaces aims to create an economy based on peer production, and by it brings back into economics the issue of common goods and democratic political agency. According to some researches such economy would serve the needs of communities instead of individual egoisms, yet at the same time would be based on individualism (Hart, Laville, and Cattani 2011). My observation in this respect are similar to Söderberg (2008), who investigates morality within hacker movements with emphasis on community practices of

opposing commodification of information in the free and open source software movement. His opinion on hacking as a labor struggle against capitalism provides an insight on relation between hackers and capitalism. In this scene the hacker's "play struggle" can be considered in fact an anticapitalist labor struggle.

By production of commons which have no exchange-value the peer production questions existing commodity relationships, hence attempts to change relationships in the current market society. The fact that shared without limitations digital commons posses no exchange-value suggests, that capitalist system of value do not apply in the case of commons-based peer production. Those might stand in the contrary, because as Marx described capital has life of it own, whose mission is centralization through capital accumulation, whereas the principle of peer production is decentralization. In the process of accumulation capital changes its magnitude, grows, replicates itself in the process of self valorization. Capital becomes a living organism, an "animated monster". It acts as independent agent which with change in its form, from money to commodities, perform self valorization. Capital has therefore anability to act itself as a self valorizing value. (Marx 1976: 255). However in the case of peer production, as it is functioning outside the capitalist framework and results in produce of commons instead of commodities, capital losses its ability to function as a self valorizing value. As the pursuit in increase of surplus value is an immanent drive of capital, this drive is undermined by the alternative mode of production. It changes its magnitude, grow, replicate itself in the process of self valorization. Capital becomes a living organism, an "animated monster". It acts as independent agent which with change in its form, from money to commodities, perform self valorization. Capital has therefore ability to act itself as a self valorizing value. (Marx 1976: 255). Furthermore by devision of labor the worker loses ability perform the whole craft. Makers, tinkers or hackers in hackerspace communities oppose this trends by presenting "do it yourself" (DIY) attitude towards fabrication of goods, that results in self sustainability. By this it diminishes the notion of commodity fetishism.

The presented hacker practice within the hackerspaces, which is firmly based in pragmatism and focus on doing, can be interpreted a "scream of an active refusal" (Holloway 2002: 15) which is inherently plural, collective. The power of the movement in Holloway understanding is related to the agency, and can be understood as "can-ness", a capacity to do. The social power of the hackerspace movement is analogically exercised by collective actions, where in the environment of a hackerspace the movement aggregates its power, capacity to do, to collaborate, to hack. Instead of selling their capacity to do, hackers devotes their time and energy to work on their own projects, to develop themselves personally, and in many cases contribute to the pool of public knowledge. By doing so, members of hackerspaces liberate their power-to, and oppose commodity fetishism which is "a relentless rupture of the collective flow of doing". (30)

As I have shown a new for of non-market open economy is emerging within hackerspaces. 3D printers are enabling the emancipation from the market economy by allowing digitalized manufacturing of physical objects for the needs of individuals and communities. But there is an ongoing struggle over disruptive for the markets use of 3D printers for replicating digital commons, where commodification attempts can be expected from the outside but also from within the communities themselves. My informant Jascha wants to be an optimists but he sees that "we are on the edge where we have to make a choice if we want to be free or if we want to be slaves in the world without public domain."

Appendix

Figures:



Figure 1: An entrance to metalab hackerspace



Figure 2: A phone booth at metalab's main room. It is a symbol of the hackerspace



Figure 3: Uniq's Ultimaker (on right) and Marius' Makerbot (on left)



Figure 4: Marcel's bicycle lock mount attached to his bicycle



Figure 5: Wizzard's Makerbot Replicator 2X 3D printer. In the background on the shelve stands Das Capital by Karl Marx

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