STATISTICAL STUDIES OF PEER PRODUCTION
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Emerging Commons Design Economy

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Open source, communities around various OSS projects and applications have changed the world during the past decade. Probably the most best known examples (and worn too) are Linux, GNU, Apache and MySQL. Some of us don't even know that we are using Linux in our daily routines. One such example is Brazilian cash withdrawal machines, which can be found from every corner in any city[12]. People draw money from the machines, some even daily, and use Linux. Another example is not daily for most of us: in-flight entertainment systems in long distance airplanes[13]. Third example is from schools. If you would live in Kerala state in India and you were in school, you would not use anything else except Linux [14]. The above are just examples from different aspects of life and such examples can be found a lot more. Therefore it's not far fetched to say that results and practices of Open source are becoming part of our daily lives.

Open Source practices have revolutionized the cultural content universes of music and software. Why shouldn't it also be able to change the way design is both made and distributed? Should the art and design teaching be directed away from nurturing the image of the genius as an individual artist? Should communication among artists be fostered instead of merely rewarding originality? Should the artists also learn that copying is not a sin and derived work has value? Design can be taught differently. Mushon Zer-Aviv has experimented, with successes and failures, teaching design with elements known from Open source practices[16]. Same kind of experiments have been done in larger amount under "Openwear", a collaborative clothing platform for fashion creation[20]. In one example students were expected to design and prototype digitally fabricated interactive objects. The instructor of that course took "open source" approach:

The workshop didn't require any knowledge in fashion design or sewing, and when you don't know anything about a topic is pretty hard to be creative especially when you have, at the same time, to deal with leds, sensors and programming. That's why I thought it would be useful to start from some Open Design, to "copy" from a series of ready-made that could be easily adapted to the different necessities of a wearable interaction and, in a way, adapt their shape to it.[19]

Answers to above questions contain elements such as ethics and morale and thus are not easy to approach or solve. But if open source culture has solved such issues, what makes art any exception? Code is poetry, as WordPress mantra says. There is beauty in well-written code. It is not valued by all, but neither is classical music.

Openness – matter of survival

Furthermore, Zer-Aviv argues that adapting openness is not an option, it's

a matter of survival. Systemic challenges such as climate change, or resource depletion – these 'problems of moral bankruptcy' – cannot be solved using the same techniques that caused them in the first place. Open research, open governance and open design are preconditions for the continuous, collaborative, social mode of enquiry and action that are needed. [15]

The above argument contains elements which can be found from "revolutionary" thoughts of several economists and theorists of innovation including Jeremy Rifkin, Yochai Benkler, Michel Bauwens, who have concluded that the Third Industrial Revolution is at hand [4, 5,6,7,8,9,10, 22]. Often the discussion around this topic refers to emerging new technologies and processes such as three-dimensional printing or the new wave of rapid manufacturing developed by the open source/hardware community, and the associated distributed ways of organizing design and production. 3D Printing is still very limited, especially when it comes to using different materials, combining materials, but as evolution of technology goes forward, anything is possible.

3D Printing hype

Much has been written about the 3D printing technology and the promise it holds. 3D Printing has been on GartnerHype Cycle for years. It has been stagnating in the technology trigger phase for years until 2012 when 3D printing jumped to peak point of Peak of inflated expectations[figure 1]. Cloud computing has been added to hype curve as comparison. The two are different technologies in nature, but it shows that the other went from technology trigger to trough of disillusionment in steady 'leaps' while 3D printing stagnated in the first stage for years. One explanation for the difference might be that cloud computing is more about software and algorithms and 3D printing development includes also overcoming hardware related problems and (re)innovations. "Reinnovations" refers to find new methods to get same results with different kind of means. This has been needed mostly because of patents, which might have hindered the technological development of second wave mostly open source driven 3D printers.

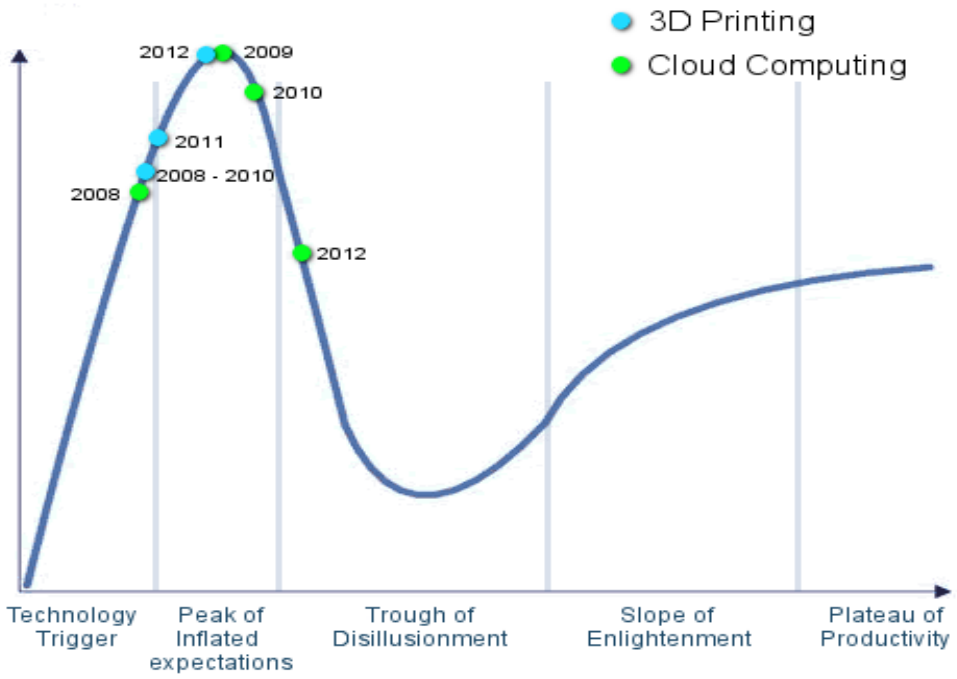

Figure 1: Gartner Hype Cycle – 3D Printing and Cloud Computing (2008 – 2012)

Being at the apex of hype cycle means that awareness is maxing out and we're looking at a rather rapid descent into more realistic and less over enthusiastic headlines and less news about people (easily and effortlessly) 3D printing guns[17,18].

Motivation, methodology and data

3D Printing is hyped subject. It is however a part of bigger economical transformation that has began lately. In this article I describe Commons Design Economy, which is one side of the bigger picture. The idea or concept of Commons Design Economy started to find initial form while doing another article with a researcher from Aalto University. Initially the material presented here was supposed to be part of another paper, but the direction and content of this concept and the other paper got distracted. Thus it made more sense to separate the two articles.

This research contains elements of inductive reasoning. Previous theories of peer production researchers such as Bauwens and Benkler are explored and used as ground for new theory, but new theory was not derived directly from existing theories. Previous theories function as framework in which new theory can be located at. Previous research especially about open design touches the same concepts and ideas discussed later. One of the rare attempts to describe open design as a whole, is Michel Avital's four interdependent conceptual layers: object layer, process layer, practice layer and infrastructure layer. Intention is not to provide rival theory, but compliment Avital's work and construct more detailed model of 'open design economy'. Open design is discussed in this article with some details.

Data used in this research is mostly statistical and thus this research uses statistical methodology. Data from surrounding world, namely open design related world, was gathered during October 2012. Data for this article has been collected with two methods. Firstly, author has been in personal contact with companies such as Ponoko,Shapeways, i.Materialise, 3DTin and TinkerCAD. Some of the statistical materials are from those connections. The other statistical material is collected with web scraping, which is a computer software technique of extracting information from websites. In this research, Thingiverse.com content was scraped with ruby script. This solution was selected based on authors perception and also suggested by Thingiverse.com administrators. Another reason for scraping was that Thingiverse.com administrators did not have enough time or resources to make query in the database for the purposes of this research. Some previously collected statistics was also used in this research. Those statistics included survey data from annual peer production community surveys as well as data from 3D printing community survey conducted 2012 by the author and Tere Vadén. Some of the data has been collected through observation and participation in local hacker-minded communities during 2009 – 2012. The author is active member of several hacking communities such as local hackerspace (one of the co-founders) and Devaamo ry (member).

Research questions are:

1. What is the composition and layers of 'open design economy'? What kind of different technological elements, companies and communities it contains?
2. What kind of role CAD applications, 3D printing services, DIY communities, sharing platforms have in open design?
3. How open is open design economy license-wise?

P2P and open design Theories

Bauwens has described in several articles a vision of commons based economy and road to it. Some scholars refer to commons design as open design[21]. Open design has been researched by several scholars. Massimo Menichinelli has focused on Open P2P Design. His concept differs from Open design by stressing the need of co-operation instead of focusing on just distributing designs under some commons licenses:

Open P2P Design is useful to co-design a collaborative activity with and for a community: this activity can be the very act of designing, developing and managing participatory public services (including Open Data projects), creating businesses based on communities or just managing interactions between business and communities (as for the Crowdsourcing projects, being careful just not to exploit the users as a way for saving money through participation).[37]

Sharing platforms such as Thingiverse.com or online CAD platforms should not be mixed with platforms focused on Crowdsourced Design and Products. In those "designers of both immaterial products and material products can offer their work for sale, but where some form of collective aggregation or filtering takes places." or "services that gives companies access to a distributed pool of ideas, talent, services, but are defined by an 'open call' and some form of collective aggregation "[10].

Bauwens uses the title "collaborative economy with mixed focus:shared infrastructure for 'making'" to include

1. crowdsourced design and products under,
2. shared design and distributed manufacturing and
3. open innovation.

According to Bauwens, DIY (do-it-yourself) experiences are included in the shared design and distributed manufacturing[10]. The view can be agreed to some extend. DIY as a term refers to one person, doing something alone. Sometimes this one person is following or replicating something that another person has done before, sometimes he or she is experimenting something new. In either case, it's still doing alone. That is also the case when one person does alone the design and manufacturing. Bauwens also adds that web technologies which enable online repositories boost this activity. Thingiverse.com seems to fit into this classification.

However, there is another model as the name of this category suggests, "shared" and "distributed", which can include co-operation in various formats. In that case it should be "DIWO", Do It With Others. DIWO can be as simple as one or more people does the design, the same crowd or another crowd does the manufacturing eg 3D printing.

Commons Design Economy is at the moment a hybrid model. There are traditional companies doing design behind closed doors, often with closed source applications and production is based on closed hardware. However, the interest towards different kind of economy is rising. This new **design economy is partly commons based**. Design includes notion of innovation and participation.

Above discussed sharing platforms are one of the key elements in current more or less hybrid model innovation and design economy. Design of models can be done for free, either on desktop or in browser. However, printing is in the hands of corporations especially when high quality or metal 3D prints are needed. Sometimes results of low cost printers are enough and products can be manufactured self especially when low(-ish) quality and small(-ish) size 3D prints are enough.

Towards Commons Design Economy

Design of products has become more and more popular over the past years. Enablers of this open design can partly be explained by

1. second generation open source and open hardware based low-cost 3D printers,
2. new (closed source) online CAD applications such as TinkerCAD and 3DTin,
3. commons driven co-operation spaces like hackerspaces, fablabs and makerspaces,
4. and sharing platforms such as Thingiverse.com.

None of the above mentioned technologies or communities alone could push forward emerging Design Economy, but the sum of them, co-operation and connections between different parties is what makes the difference.

3D Printing – production and services

Low cost 3D printer boom can be seen to begin from RepRap community open source/hardware driven efforts. RepRap project released the first printing machine “Darwin” in March 2007. After that there has been three more: “Mendel” (October 2009), “Prusa Mendel”(2010) and “Huxley” (2010) [1]. RepRap is the most commonly used 3D printer in 3D Printing community according to global survey conducted 2012 by Moilanen and Vadén[2](figure 1). Erik de Bruijn has done research on RepRap community and according to Erik “The RepRap project is existing proof that the open source development methodology also works for the design of physical objects.”[24] RepRap project has created several spin-offs such as Protobox (Ultimaker), Fab@Home, RapMan (BitsFromBytes), CandyFab (Evil Mad Scientists) and Cupcake CNC (Makerbot Industries).

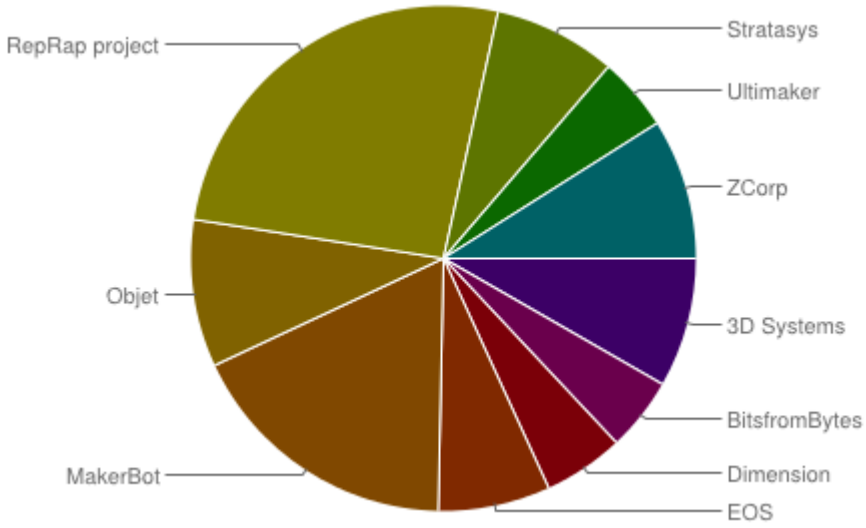

Figure 2: Most common 3D printers 2012

The popularity of 3D Printing services has grown greatly during the past few years. Ponoko is one of the well-known and commonly used 3D printing service. The amount of uploaded 3D models has steadily grown ever since the beginning. See figure 3.

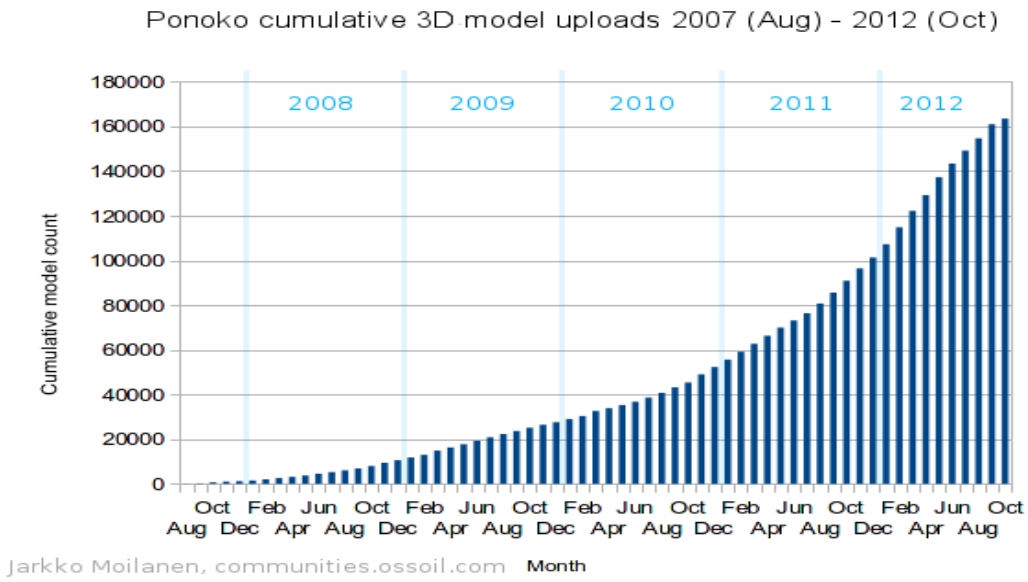

Figure 3: Ponoko cumulative 3D model uploads 2007 – 2012

Design is everywhere

Design has been traditionally done on desktop applications. Design has been the privilege of professionals and companies. This design barrier has been breaking for sometime now. On desktop front, open source CAD and animation applications such as Blender, OpenSCAD, BRL-CAD and Art of Illusion have become better known and more popular.

The other element in design front that is causing changes is the emerging online CAD platforms or applications such as TinkerCAD and 3DTin. These applications are browser based and by so do not require any installation. To label TinkerCAD and 3DTin "just" CAD applications is a bit misleading. I prefer to use term platform because such solutions offer more than just modeling apps. They offer a place to store and share models, and build-in connections to 3D printing services. The rising popularity among the public is partly explained by easy access (no installation), somewhat easy to use interface, free (no payment) to get started and enough features to enable simple designs.

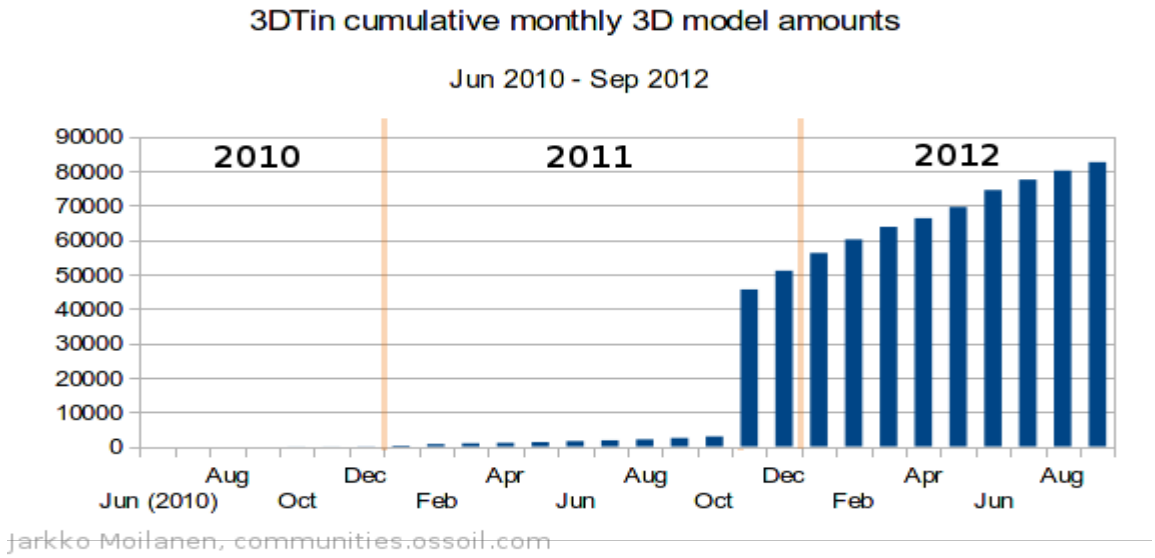

Figure 4: 3DTin cumulative upload count. Source: personal communication with 3DTin personnel (Jayesh Salvi)

The data for above figure was delivered by Jayesh Salvi (3DTin). It shows enormous spike of uploads in November 2011. Author requested more information about the spike from 3DTin, but without any response. It does not seem probable that the amount of uploads would have grown from a few thousand to over 40000 in one month only by user uploads. One of the logical reasons for the growth is that some third party model repository has been merged with 3DTin. Nevertheless, the growth since November 2011 has been steady and the amount of uploaded new models is several thousands each month. The designs or sketches as they prefer to label user creations can be licensed under commons licenses. 3DTin encourages sharing via Creative Commons licensing. However, distribution of licenses was not available. 3DTin offers all features for free as long as results (sketches) are shared under Creative Commons. Paid subscription offers private storage.

3DTin users are not limited to operate only in 3DTin.com site. 3DTin offers a chance to run their online modeling application in user's local computer by providing access to it via Chrome Web Store[39]. This kind of usage is kind of hybrid version; it's not installed as traditional desktop CAD applications, neither is it run from cloud service (as 3DTin service is), but it is installed as add-on to user's browser. However, this version of 3DTin has rather limited features compared to 3DTin.com service.

Examples of service based economy

TinkerCAD was also asked to provide statistical information about model counts, but without any success. TinkerCAD was lauched 2011 and has become more popular ever since. In November 2012, TinkerCAD announced to give away $50,000 worth of its software to qualified academic institutions, home schools, and other teaching organizations[40]. Giving away might be a bit misleading. In practice the announcement meant that they give access (for a year) to paid services for qualified members of educational institutions. Qualification criteria was set by the company (not community). Interesting detail in the offer is that designs created within the offer will be licensed for non-commercial use only. Requirements included "access to a 3D printer OR have the intent to purchase one", "provide accreditation or non-profit status verification" and suitable course curriculum[40]. A big question mark is continuity. If educational institutions take this offer and add is to their current course curriculum, having access for one year is not enough.

TinkerCAD is testing this sharing idea for one year and if it's a success, they will continue it. How they define or evaluate what is success remains unknown, but one criteria might be how many normal paid subscriptions this "free" offer creates. Nevertheless, this experiment is an example of semi-democratizing design; taking it to schools for free. From TinkerCAD's perspective this is probably a method to get more customers, since after getting familiar with the tool, it's easier to stay with known tools than learn new tools. It must be noted that this kind of strategy has been used widely in the context of desktop applications including 3D modeling/animation/CAD application giants like Autodesk. This time applications are not given away (for some period), instead service (or access to it) is. This also reflects another phenomenon in current economy; namely that we (at least in Western world) are on the road towards service based economy.

Communities as libraries and anchors

Third ingredient in the design evolution are commons driven co-operation/co-creation/co-working/co-production spaces such as hackerspaces and makerspaces. Much of the development of new wave low-cost 3D printers has been commons driven. These spaces offer tooling and community for developers. Some of the spaces are more business allowing that others and some of the 3D printer manufacturing companies have origin in these spaces. The amount of spaces around the world can be count in hundreds if not in thousands. Hackerspaces alone sum over 600 spaces[3]. The nature of these co-working communities is commons prone and motivation to participate follows the findings from other open source research.

Troxler has created a "Map of Fabbing" in which different forms of "fabbing" communities are put based on two aspects. Model classifies different forms of 'fabbing communities' based on how project or infrastructure oriented they are and whether they are generative or reproductive.

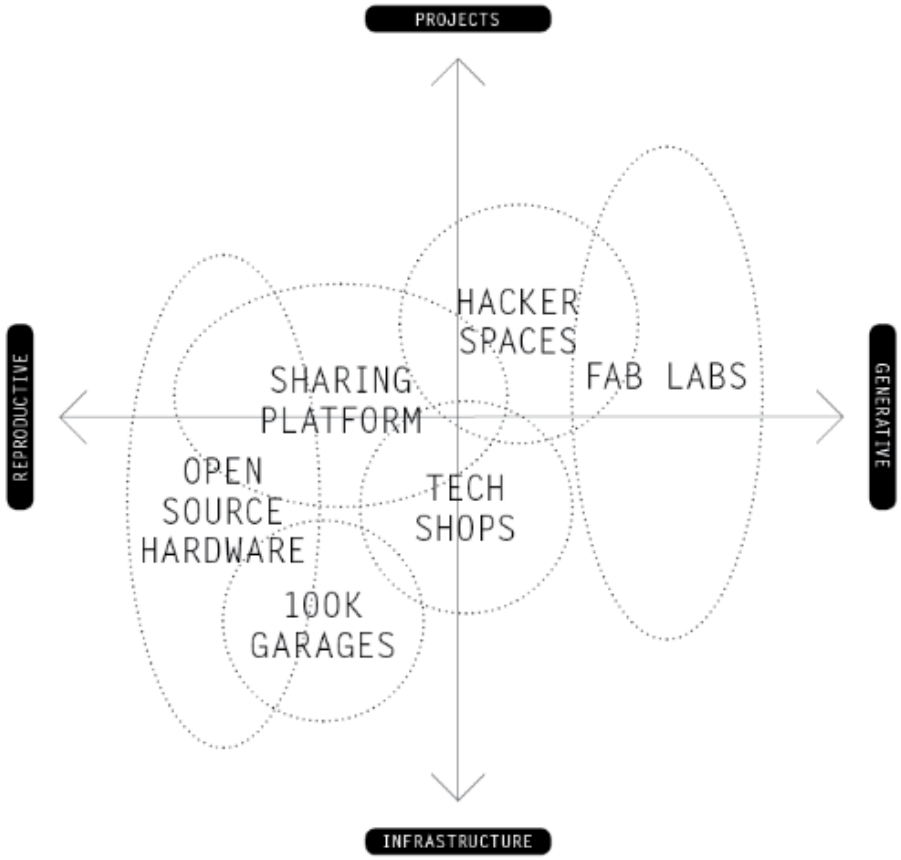

Figure 5: The fabbing universe according to Troxler. Source http://opendesignnow.org/index.php/article/libraries-of-the-peer-production-era-peter-troxler/

Troxler's model is a good start but it lacks some forms of 'fabbing', namely Makerspaces and DIYbio. Troxler mentions TechShops, but based on my research and observations in DIY community, it has a lot of similarities compared to Makerspaces. Yet in hackerspaces discussion mailing list makerspaces and hackerspaces intertwine at least in discussion level. In addition to that a lot of makerspaces are listed in hackerspaces.org list of spaces. Another community type which has been rising lately and is missing from the map is biohackers which are organized as DIYbio community. An attempt to add DIYbio to Troxler's map was made by the author. A DIYbio community focused survey was launched during summer 2012, but the amount of respondents was too low (27) and thus analysis was not done.

In his paper [25] Troxler identifies one limitation in his research "yet the approach is lacking at least one fourth element, the study of actual users of Fab Labs. Such a study based on participant observation and other methods should be able to clarify attitudes and behaviour of Fab Lab users as important stakeholders of a hybrid innovation model." One such attempt is annual Peer Production community survey, which has been conducted 2010 – 2012[26, 27].

According to Moilanen, average 'fabbing world' member is 27-30 years old male who has college level or higher education (64%) and lives in Europe or Northern America[27] and is committed to one local community. Altruism, community commitment, meeting other hackers in real world and having fun seem to be the most important factors of motivation. Compared to motivation models created in/by Open source research, peer production communities have strong 'social motivation factor'.

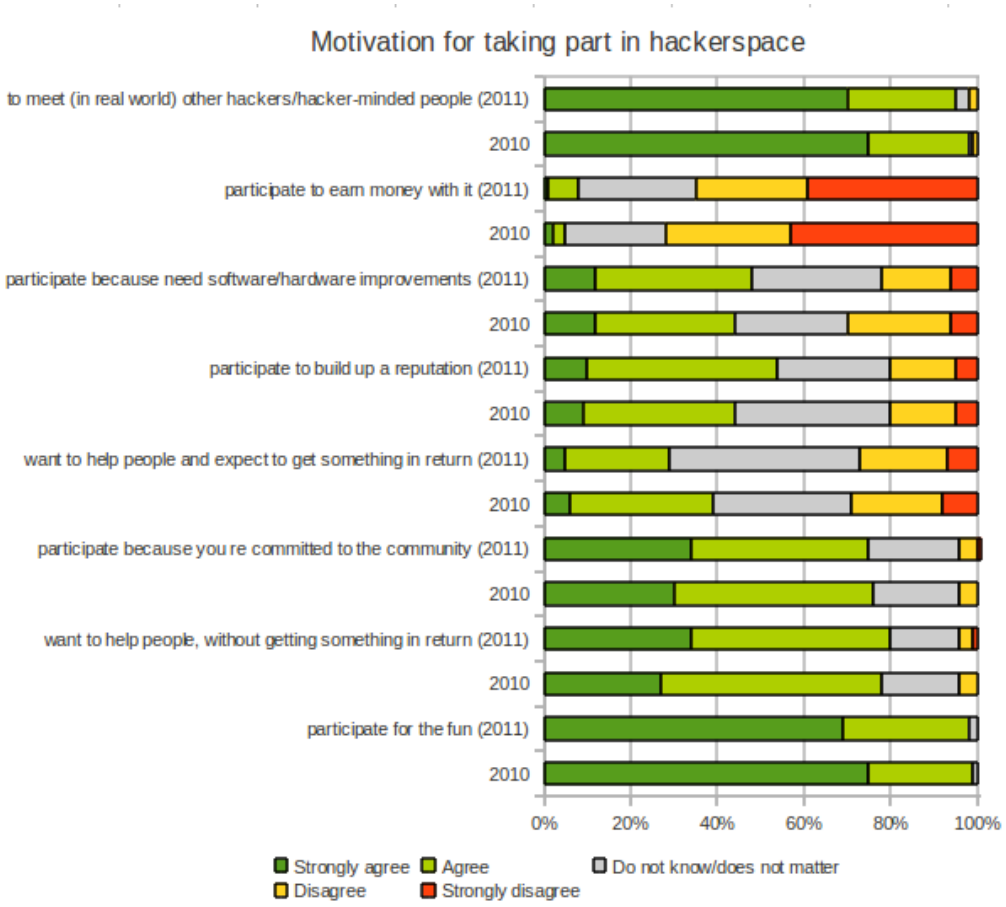

Figure 6: Fabbing community motivation 2010 and 2011 comparison

Peer production communities have high interest towards meeting other hacker-minded people in real life. Most communities aim to have physical space to function as community center. They are also known to arrange a lot of real life activities which are often related to learning, education and of course having fun. 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.

The above mentioned communities and physical spaces are not just places in which hackerminded people meet. They can also be seen as examples of modern time libraries[28]. The amount of information among the members is huge and it is shared freely. Some of the information is 'hidden' and transfers only by spoken communication and doing. According to Nonaka and Takeuchi, this kind of information is tacit knowledge. Tacit knowledge can take another form, namely explicit, by writing down the knowledge. Knowledge stored in community wikis and blogs is an example of explicit knowledge[see 30,31].

The spaces can also be seen to reflect 'third places' defined by Oldenburg[29]. The third places are 'anchors' of community life that facilitate and foster broader, more creative interaction, serve as focal points of community life and are needed to reconnect to each other and strengthen community ties.

Fablabs – open (P2P) design oriented spaces?

At least some of the open design focused researchers (in which I don't include my self yet) seem to be fixated on FabLabs[37, 38]. Menichinelli as one of the Open Design researchers and movement leaders seems to use fablabs in his examples[34, 36]. It must be noted that Menichinelli does not speak for the

open design but prefers to use term Open P2P Design[37]. According to Menichinelli Open P2P Design differentiates from the Open Design concept

the basic idea is that an open and collaborative project cannot be developed just by open licensing the related documents: instead we need to co-create a community that collaborates in a common activity.[37]

Yet fablabs are just small fraction of design and hacking oriented movement. FabLabs are almost always connected/hosted by a college/university or similar higher educational institution. Promoting one entity, namely MIT, controlled movement does not seem very objective or commons oriented. Yet Fablabs ride under the Peer production label. Perhaps the focus should be broader. Perhaps research should include all forms of fabbing spaces to widen perspective from one form to include all forms thus making the perspective more holistic. Annual Peer Production survey conducted under the wings of P2P Foundation is an example of such holistic and broad approach[27]. The surveys are spread around different fabbing communities including hackerspaces, fablabs, makerspaces, DIYbio communities and alike. Perhaps it is valid to draw a connection between FabLabs and Open Design, since some of the newly established FabLabs stress the open design even in their name. One such example is fablab in Berlin, called Open Design City[35]. This connection between fablabs and open design movement would require more attention and research to verify relationship between the two.

In conclusion, the fabbing spaces around the world are not just simple places run and in some cases maintained by members. They are libraries, community knots (just as Menichinelli seems to think), places to innovate, design and manufacture in the spirit of commons.

Sharing platforms

Hackerspaces, makerspaces, fablabs and alike are physical places for cooperation and innovation. However those represent just the other half of innovation and sharing platforms. Forth element in Commons Design Economy is sharing platforms. Bauwens et al describes sharing platforms as:

corporate platforms create the possibility for users to share their own creative work, or what they have found, but no common code or knowledge base is created. The platforms are owned by corporations, and the attention and behavioral data are sold to advertisers. Regulations over these platforms are established by the corporate owners. Apart from generic platforms such as Facebook, Twitter, YouTube, Flickr, there are many specialized platforms including for creative work that is shared under 'sharing licenses' such as the Creative Commons licensing scheme. [10]

3D models and designs need to be stored. As it was mentioned before, online CAD platforms offer 3D model storing too. Those who use other tools such as Blender need another kind of storage. For them (and online CAD platform users as well) exists several different options. Most commonly known sharing platforms is Thingiverse.com. It enables 3D model and images upload, and users are encouraged to leave instructions how to manufacture models for example with 3D printers. Some of the sharing platforms enable *easy derived* e.g. continue and enhance existing models as "forks". The popularity of sharing platforms has increased over the past 5 years. The amount of 3D models/designs in Thingiverse.com has grown vastly over the past 4 years[figure 7].

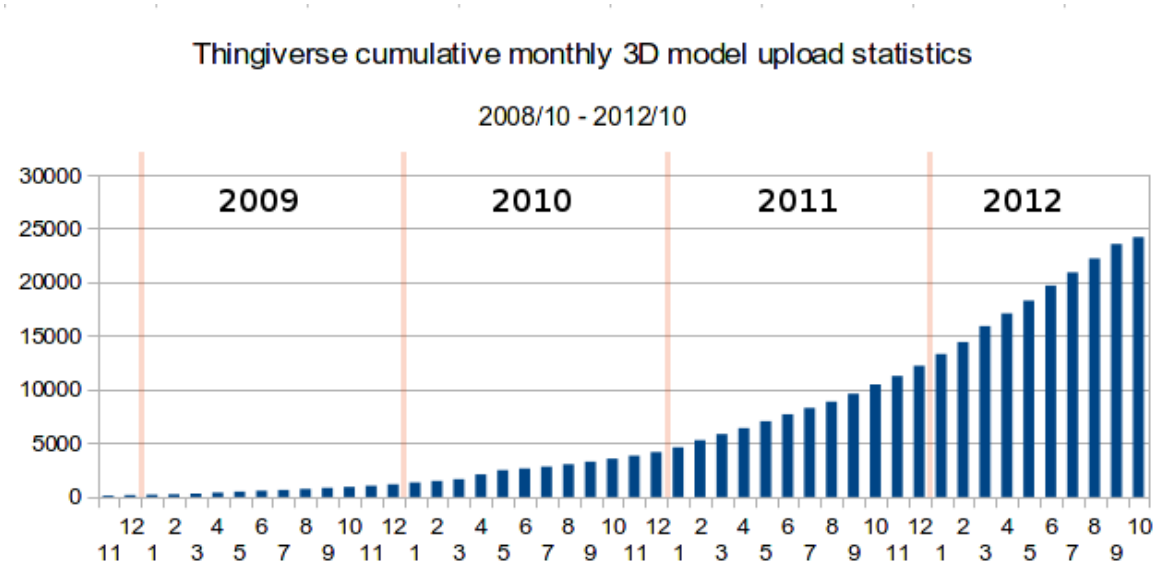

Figure 7: Cumulative upload count of 3D models in Thingiverse.com

When thingiverse.com is compared to Bauwens loose definition, we can find several similarities. Thingiverse.com is owned by a company and not by any company, but a 3D Printer manufacturer Makerbot Industries. They regulated the platform, community has very little (or none) to say to it, what happens in it, what is allowed and what is not. Users upload models which is the core of thingiverse.com. There is no 'common code or knowledge base'. Thingiverse.com users can attach different kind of licenses to their creations. Most of the thingiverse.com designs are licensed under one of the commons licenses.

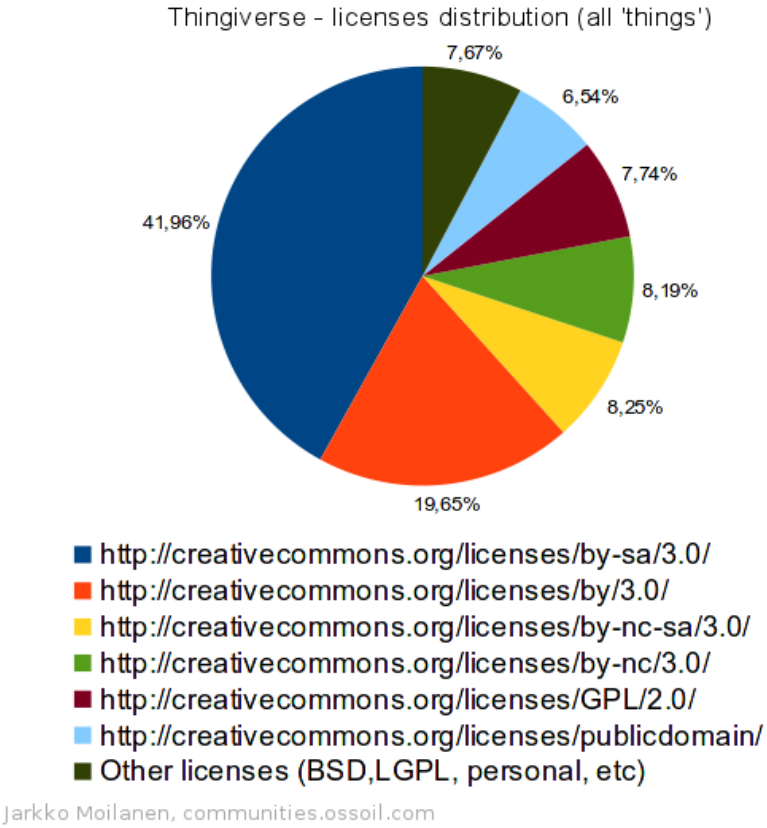

Figure 8: Thingiverse 3D model license distribution

Interlinked elements and joint interests

Of course the four elements overlap with features and functions. For example 3D printing services, sharing platforms and online CAD platforms all enable 3D model upload and storage. 3D printing services focus on selling manufacturing of models uploaded and created by community members, own or someone else's. 3D Printing services also enable other kind of business namely design business. Members of community can upload own models to service and get profit either by offering own models for sale or by getting own models re-printed (ordered) by others.

While giving away access to services as described above is one option to raise interest and get new paid subscribers, competitions are another. 3DTin has organized at least one design competition early 2012. Some of the 3D Printing companies organize 3D design contests too and in some cases the tool focus on online CAD platforms. 3D Printing companies and online CAD platforms have created natural bindings between each other. They have formed an alliance in which both win.

This alliance has another form as well. At least TinkerCAD has linked 3D Printing services directly into their application. Users can do design in TinkerCAD and then choose to export models and manufacture locally. Another option is to select 3D Printing service to be used without going to another site/service (such as Shapeways.com). Together, printing services, online CAD platform providers and designers (just about anyone) can create a little ecosystem. It benefits the users as well, since it makes the design – to – object process more simple. By throwing in occasional competitions they keep community interest high and in some competitions best designer gets a free 3D printer.

Commons Design Economy layers

Based on the above introduced research results a preliminary construction for Commons Design Economy is introduced below. The model contains four horizontal layers and multiple vertical layers crossing ovals (application areas).

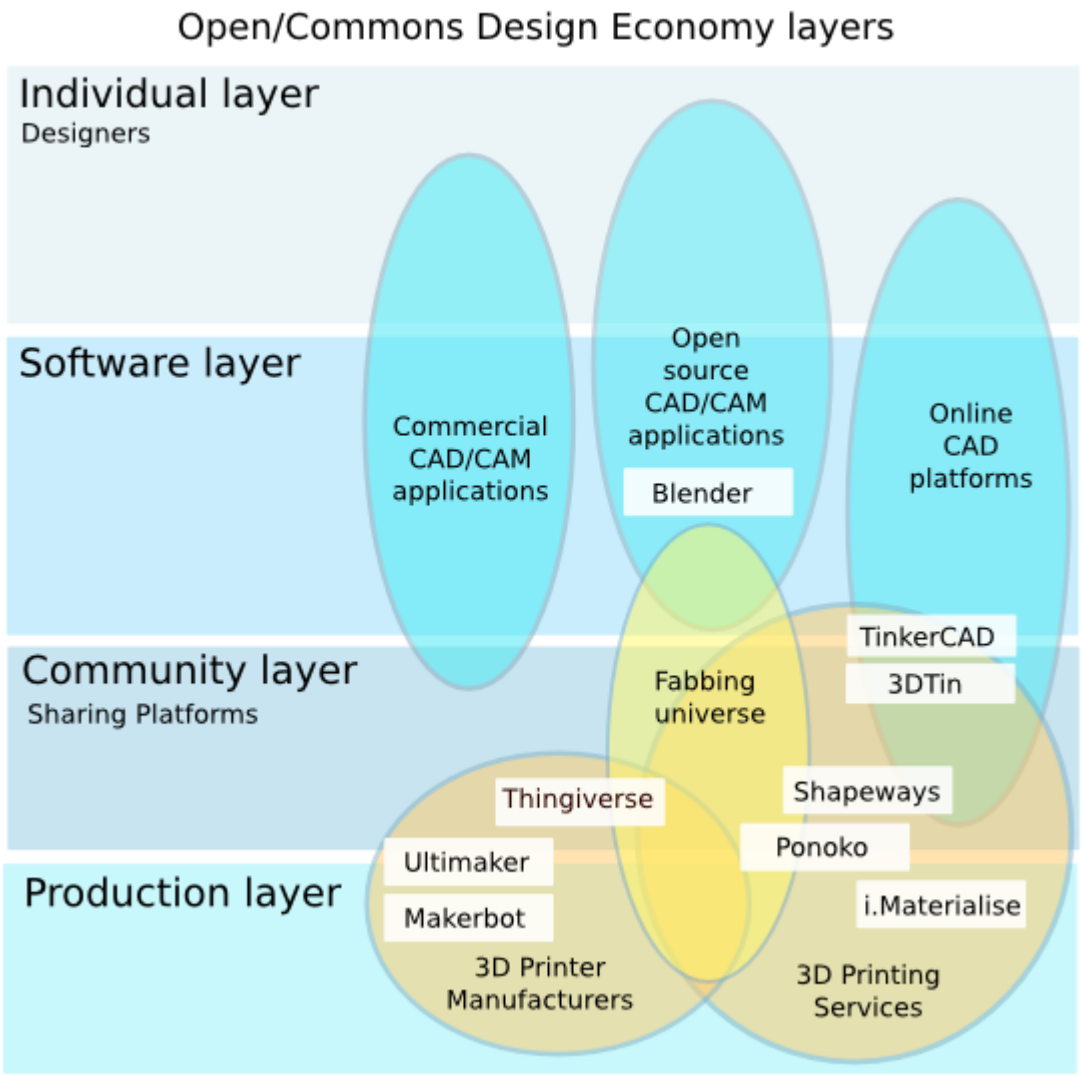

Figure 9: Preliminary Open/Commons Design Economy model.

Individual layer contains people who do design. They are the artists (real or wannabe). Software layer contains tools used in 3D modeling. Those tools can be divided to two categories: desktop and online. I admit that this kind of division is really rough and could be made more sophisticated. Anyway, desktop applications in turn can be divided to open source and commercial. Online CAD tools refers to newly developed browser based CAD applications such as TinkerCAD and 3DTin. Community layer contains sharing platforms and common communication platforms in which people discuss design related issues. An example of sharing platforms is Thingiverse.com.

Some of the services in design world overlap with multiple layers. Online CAD platforms – TinkerCAD and 3DTin – are classical examples of such. Designer uses CAD application in browser and saves the models in same service for others to use. Some of the models however can be private and not available in public. In other words, not all models even in online CAD services are freely used or derived by others. As it was

mentioned before, Thingiverse.com is sharing platform. In the figure, it is however placed near next layer. That is because as far as I know, thingiverse.com is connected to Makerbot industries which develops and sells 3D printers. Shapeways and Ponoko are printing services, which also partly function as sharing platforms, but which also contain possibility to get models printed and shipped to you. It must be noted that online CAD platforms are more and more (more or less loosely) connected to printing services and by so spreading the layer overlapping on their behalf. In some of the above services you are able to sell your designs.

The last layer in the bottom is Production layer. It can be divided (although partly artificially) to two parts: 3D printer manufacturers and 3D printing services. It contains companies (and communities) which develop and sell 3D printers. Ultimaker is located near the community layer, because it uses community extensively for example in creating and updating assembly instructions. One obvious community in production layer which also would overlap with the community layer is RepRap. The layer contains also 3D printing services, which normally operate globally.

The Fabbing Universe in the above illustration refers to different kind of DIY communities such as hackerspaces, makerspaces and alike. As it was mentioned before such communities often act as 'anchors' of community life. Those spaces also have often extensive tooling and manufacturing devices. Some of those spaces are already oriented to serve external people for example in producing prototypes and such, and are funded by companies such as Autodesk[33] . In that sense it's logical to put fabbing universe oval (bright yellow) both in community and production layer. It is also common that communities of fabbing universe develop tools and software and that's why it extends to software layer as well.

Market-driven entities have strong presentation in the current "Open/Commons Design Economy". Much of 3D Printing is in hands of a few companies (Shapeways, Ponoko, i.Materialise and Sculpteo). According to survey conducted among the 3D Printing community[2], those services are used by 'end-users', not open source/hardware driven developers or early adopters. The latter group uses mainly own locally build or local developer community owned low-cost printers. The presence of market-driven entities in the new design economy appears to extend the range of motivations. Benkler mentions that "this form of link between a commercial firm and a peer production community is by no means necessary for a peer-production process to succeed; it does, however, provide one constructive interface between market- and nonmarket- motivated behavior, through which actions on the two types of motivation can reinforce, rather than undermine, each other."

Kite design and manufacturing example

In Innovation Communities by von Hippel is an example of kite surfing group[32]. That group works together to build kite. The process is simple: some sketches are transferred via internet between the team members, then sketches turn into CAD files, then CAD files are send to local 'kite-cutter' or some other manufacturer, the pieces are combined by the user or external service, and finally user has a kite. The price-tag with above described method is just hundreds, while commercial version of the kite would most likely be more expensive. The example fits the Open/Commons Economy model as well.

To make the same process fully commons, it would go as follows. Group of people would start drawing sketches, or go directly to CAD file based design. They would use Blender or some other open source tool. During the iteration, they would upload the models (under some commons license) to some sharing platform which enables version management. After they would agree on the design, they would go to local hackerspace and use tools to make pieces themselves or with someone at the local community (hackerspace). Then they would assembly the kite from pieces with or without help from local community.

Of course the team could use commercial CAD tools in design process. They could use online CAD platforms in which they would form design group and do design iteration together in online state (not possible now) and store all models in same place. That would be commercial solution since such features are and will be

(most likely) not free in online CAD platforms. The team could also order ready cut pieces from commercial services by uploading models either directly from online CAD platform or manually by manufacturer's service.

The above exemplifies the model's hybrid nature. It is possible to get same result with or without commercial services. Thus it gives users (in the example kite users) more options. Using the fully commons approach could have multiple advantages. Firstly, it could be even faster than ordering parts from commercial counterpart after the model is finished. Secondly, fully commons approach has advantage of making late changes in the models even during the manufacturing. Thirdly, fully commons approach enables manufacturing of all parts in one location. This kite example is not the best possible example to describe the processes and logic of above introduced model. Therefore I'll take another example.

3D Printing example

Figure 10: 3D Printed modified RPi case with memory card shield

Another example which uses 3D printing is from one case in which researcher personally participated recently. It is a case in which 1) derived design, 2) market-driven actors acted together with 3) peer production community, was 4) driven by user needs and 5) resulted to instant user satisfaction.

I'm one of the happy 400 who received free Raspberry Pi development board as part of Qt on Pi device program [41]. Raspberry Pi is simple circuit board, which contains connections such as USB, LAN, HDMI, a slot for memory card, processor and a few free pins. It was not delivered without any kind of case, it was just plain board. Having no covering case was "an itch to scratch" for open source developer community.

Soon 3D models for Raspberry Pi cases emerged from several sources. Some of those are freely available in Thingiverse.com. I knew several developers in local communities that needed cases for the devices. Of course there are commercial cases too and those can be ordered from web. But we took another approach. We have open source oriented developer community called Devaamo here in Tampere. It organizes developer events on monthly basis. Those events are labelled as Hackdays and are free for all. Each hackday has some focus and in October 2012 it was RaspberryPi and 3D Printing. I organized the event in cooperation with another person. We invited two companies to participate in event. Those two companies do research and development in 3D Printing. Both companies brought one Ultimaker 3D printer to hackday event. During the event we heard from several developers that the cases available do not offer any cover for the memory card and it sometimes bends and breaks. Luckily we had some Blender experts (3D modelling) among us. We took one of the models from Thingiverse.com (derived it), modified the case and printed enhanced RaspberryPi case with memory card shield. After a few rounds of iteration, the model[42]

was uploaded to Thingiverse.com under commons license. After the event, same cases have been printed in local hackerspace for different people with the cost of material.

The advantages of using low-cost 3D printer and open design is that 1) we were able to modify product (raspberry pi case) whenever we wanted, 2) we were able to do several versions in relatively short time (an hour per case) 3) with very low costs. Furthermore, we were 4) able to get products out directly to 'customers' without delay that would be inevitable if those were ordered from some company after making the modifications. Obviously the quality is not a high as with commercial counterparts, but it was enough for the users. The example was kind of ad hoc design and manufacturing event and included a lot of face to face cooperation, but it could be done also as distributed via Internet.

Introduced Open/Commons Design Economy model is preliminary and needs more research. The model describes the current situation in design and manufacturing world from 3D oriented viewpoint. We are still far away from peer-to-peer world described by Bauwens:

It would consist of open knowledge, software and design communities, whose members are connected with production entities (companies, cooperatives), who fund their members directly, but also indirectly support the infrastructure of cooperation of the commons on which they depend, practicing benefit sharing, so that the benefits flow back to the open design communities. Productive entities would be more enabled to produce locally, using energy from a peer- to-peer oriented grid, and using peer- to-peer money for the exchange of rival goods, while immaterial and culture goods would be freely exchanged and shared by the whole of humanity.

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