INTRODUCTION TO OPEN SOURCE PRODUCT DEVELOPMENT

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Abstract

This thesis is a literature review about open source product development (OSPD). The open source model is mainly known as a method of producing, and developing computer programs, and it is introduced as such within this thesis. More extensively, this work focuses on open source product development, that being, how this method, for developing intangible products performs, when physical products are targeted. The thesis also addresses economical, and legal aspects of the open source concept as well as social aspects. Traditionally, product design, and development often involve copyright laws, confidentiality agreements, and strict regulations, which will secure the product, but will make product development slow, and expensive in the future. Open source enables open, rapid, and cost-effective product development cycles in a way that traditional, highly protected product-based operating models cannot. The open source computer software industry, which was born in the 1980s, is still young, and its correlation with product design is still in its infancy. However, the success of open source software programs suggests that open source product development can also have a favorable future.
This bachelor's thesis introduces open source product development, and the information around some tangential topics required to understand it. Because the subject is relatively young, some texts have been used as sources that deal with the open source method through intangible computer programs only. The subject of hardware in open source is still relatively unknown, and this is a main motivation behind writing this thesis. The aim of this thesis is to provide the reader with sufficient knowledge about OSPD, and to present to them some platforms that it currently operates on, what its strengths, and weaknesses are, and what its role, and importance will look like in the future. This Bachelor's thesis is aimed at design students, professionals, or others interested in open source development of physical products who have no previous comprehensive knowledge of the subject.

Keywords Open source, product design, product development

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Tiivistelmä

Tämä kandidaatintyö on kirjallisuuskatsaus aiheesta avoin lähdekoodi tuotekehityksessä (engl. open source product development). Työssä avataan lyhyesti avoimen lähdekoodin konsepti tietokoneohjelmien tuottamis- ja kehitysmenetelmänä. Tarkemmin ja laajemmin tässä työssä perehdytään avoimeen lähdekoodiin tuotekehityksessä, eli siihen miten tämä aineettomien tuotteiden kehittämiseen luotu menetelmä suoriutuu, kun kehittämisen kohteeksi otetaan fyysiset tuotteet. Työssä käsitellään myös avoimen lähdekoodin ajatusmalliin liittyviä ekonomisia - ja lakiteknisiä -, kuin myös sosiaalisia puolia. Tuotteiden suunnitteluun ja kehitykseen liittyy perinteisesti usein tekijänoikeuslakeja, salassapitosopimuksia ja tarkkoja määräyksiä. Tällainen toiminta turvaa tuotteen, mutta tekee tuotekehityksestä jatkossa hidasta ja kallista. Avoin lähdekoodi mahdollistaa tuotekehityksen kierron avoimuuden, nopeuden ja kustannustehokkuuden tavalla. Menetelmän pohjana toimii vahvasti yhteisön merkitys ja siihen kuuluvien yksilöiden ajattelutapa: vapaa levittäminen, oppiminen, tuotteen vapaa muokkaus, tasa-arvoisuus käyttäjien kesken ja avoimuus kaikin puolin, ovat avoin lähdekoodi – innovaation kulmakiviä. Vasta 80-luvulla syntynyt avoin lähdekoodi -tietokoneohjelmien liike on vielä nuori ja sen korrelointi tuotesuunnittelun toimintamalliksi on vasta aluillaan. Avoin lähdekoodi -tietokoneohjelmien menestys viittaa kuitenkin siihen, että myös avoin lähdekoodi -tuotekehityksellä voi olla suotuisa tulevaisuus.
Tässä kandidaatintyössä esitellään avoin lähdekoodi -tuotekehitys ja sen ymmärtämiseen vaadittavat tiedot. Työn tavoitteena on, että lukija saa riittävät pohjatiedot aiheesta. Tavoitteena on myös inspiroida lukijaa tutustumaan aiheeseen syvemmin ja rohkaista heitä itse osallistumaan avoin lähdekoodi -tuotekehitykseen. Tämä kandidaatintyö on suunnattu muotoilun alan opiskelijoille, ammattilaisille tai muille avoimesta lähdekoodista fyysisten tuotteiden kehityksessä kiinnostuneille, joilla ei ole aiempaa kattavaa tietämystä aiheesta.

Avainsanat Open source, avoin lähdekoodi, tuotesuunnittelu, tuotekehitys

ACKNOWLEDGEMENTS

I would like to thank my friends, and classmates, Laura Kytömäki, and Josefiina Falck, for their invaluable guidance, advice, and support, especially during the final stages of my thesis.

1 CONTENTS

2 INTRODUCTION

This thesis is a literature review about open source product development. The open source model is mainly known as a method of producing and developing computer programs, and it is introduced as such within this thesis. More specifically, and more extensively, this work focuses on open source product development, that being, how this method, for developing intangible products performs, when physical products are targeted. The thesis also briefly addresses economical, and legal aspects of the open source concept as well as social aspects. Open source product development will also be referred to as OSPD, open source hardware as OSHWin and open source software will be referred to as OSS.

Traditionally, product design and development often involves copyright laws, confidentiality agreements and strict regulations. Product specifications are to be protected, for economical, and security reasons. Such activities will secure the product, but will make product development slow and expensive in the future. Open source enables open, rapid, and cost-effective product development cycles in a way that traditional, highly protected product - based operating models cannot. The method is strongly based on the importance of the community and the mindset of the individuals involved: free dissemination, learning, open design of the product, equality between users, and openness in all aspects are the cornerstones of open source innovation. The open source computer software industry is still young and its correlation with product design is still in its infancy. However, the success of open source software programs suggests that open source product development can also have a favorable future.

This bachelor thesis introduces open source product development and the information around some tangential topics required to understand it. Because the subject is relatively young in the development of physical products, number of texts have been used as sources that deal with the open source method through intangible computer programs. I've found that the subject of hardware in open source is still relatively unknown also among my own colleagues and this is my main motivation behind this thesis. The aim of this thesis is to provide the reader with sufficient knowledge about OSPD and to present to them some platforms that it currently operates on, what its strengths and weaknesses are, and what its role and importance will look like in the future. I want to inspire the reader to explore the topic more deeply and encourage them to participate in open source product development themselves. This Bachelor's thesis is aimed at my peers; design students, but also professionals or others, interested in open source development of physical products who have no previous comprehensive knowledge of the subject.

3 OPEN SOURCE

Open source is a development model that supports free access to a product's design through free licensing. This licencing extends to the product's blueprints and allows redistribution and modification of the original product (Lakhani 2003).
One of the main advantages of open source is that there is no need to reinvent the wheel. By sharing their work, open source contributors might reduce the time for the next user, who would otherwise be wasting their time doing the same work. Open source content can also be used as material to understand and learn from.
Using open source material for learning, however is risky, because the shared material might have been developed, or modified by a person who is unqualified to do it, or there might be errors in the source material. Open source is also generally not very straightforward to use and requires the user to adapt to the mindset. There is also no financial incentive for the contributors, which many people might find aversive and this lack of monetary transactions also calls for a specific licencing structure.

3.1 Open source licensing

These kinds of open to all projects present some issues when it comes to copyrights. Copyright laws are regional, which means one international copyright law does not exist. The difference in these national copyright laws may lead to legal challenges when sharing content across borders, though, efforts have been made to unify copyright laws in Europe and other regions.

When a copyright holder wants to grant permission, for others to copy, or change their work, they (the creator) can apply a public copyright licence, for it. By applying this licencing to the work, others are allowed to use and alter the original content as long as they obey the set terms and conditions of the licence. The authorization granted with the public copyright licencing enables open source activity to take place, since its philosophy would otherwise disaccord with copyright law.
Creative Common licensing (CC) is the most commonly used type of licensing, for open source projects. There are four types of CC license elements: Attribution (BY), NonCommercial (NC), NoDerivs (ND) and ShareAlike (SA). The borders of these 4x4cm squares mark the cutting lines, its diagonals mark the assembly points and its enclosed inner circles define common diameters. The borders of these 4x4cm squares mark the cutting lines, its diagonals mark the assembly points and its enclosed inner circles define common diameters. The borders of these 4x4cm squares mark the cutting lines, its diagonals mark the assembly points and its enclosed inner circles define common diameters.

1. Attribution BY
Lets others copy, distribute, display and perform the copyrighted work even, for commercial use, but only if they credit the creator/creators. This also applies to derivative works that are based upon the original work.

2. Noncommercial NC
Lets others copy, distribute, display and perform the copyrighted work, including derivative works based upon it, but they can't be used, for commercial purposes

3. No Derivative Works ND
Lets others copy, distribute, display and perform the original work in its verbatim form. Publishing an edited version of the original work is not allowed under this licencing.

4. Share Alike SA
Allows others to distribute derivative works, but only if they are released under the same licencing as the original work.

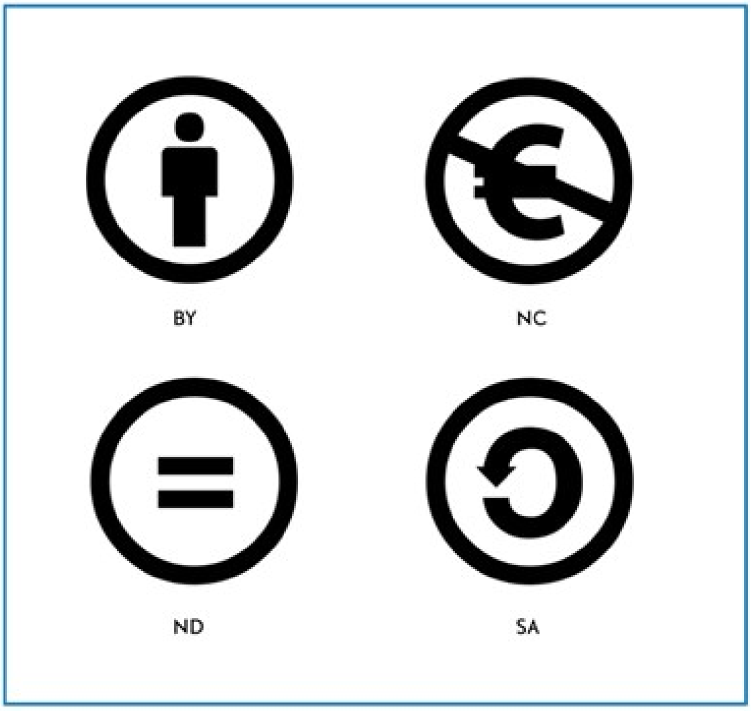

Figure 1, Pictograms of the CClicence feature, downloaded from https://meta.wikimedia.org/wiki/Open_Content_-_A_Practical_Guide_to_Using_Creative_Commons_Licences/The_Creative_Commons_licencing_scheme/en in August 2019

Combinations of these licence elements form the Creative Common licenses. The differences in these licenses allow projects to be licensed according to particular needs the creator, or creators see relevant. There are six different Creative Common licenses. Works can also be placed under Public Domain, CC0, which means no right are reserved and the content can be used by anyone without restriction under copyright, or database law. The following list describes these seven licenses in more detail:

0. CC0 Public Domain Dedication
CC0 helps (...) by giving creators a way to waive all their copyright and related rights in their works to the fullest extent allowed by law. CC0 is a universal instrument that is not adapted

to the laws of any particular legal jurisdiction, similar to many open source software licenses. (Creative Common official website)

1. CC Attribution - CC BY
"This license lets others distribute, remix, tweak, and build upon your work, even commercially, as long as they credit you, for the original creation." (Creative Common official website)

2. CC Attribution-ShareAlike - CC BY-SA
"This license lets others remix, tweak, and build upon your work even, for commercial purposes, as long as they credit you and license their new creations under the identical terms. (...) All new works based on yours will carry the same license, so any derivatives will also allow commercial use." (Creative Commons official website)

3. CC Attribution-NoDerivs - CC BY-ND
"This license lets others reuse the work, for any purpose, including commercially; however, it cannot be shared with others in adapted form, and credit must be provided to you." (Creative Commons official website)

4. CC Attribution-NonCommercial - CC BY-NC
"This license lets others remix, tweak, and build upon your work non-commercially, and although their new works must also acknowledge you and be non-commercial, they don't have to license their derivative works on the same terms." (Creative Commons official website)

5. CC Attribution-NonCommercial-ShareAlike - CC BY-NC-SA
"This license lets others remix, tweak, and build upon your work non-commercially, as long as they credit you and license their new creations under the identical terms." (Creative Commons official website)

6. CC Attribution-Non-Commercial-NoDerivs - CC BY-NC-ND
"This license is the most restrictive of our six main licenses, only allowing others to download your works and share them with others as long as they credit you, but they can't change them in any way, or use them commercially." (Creative Commons official website)

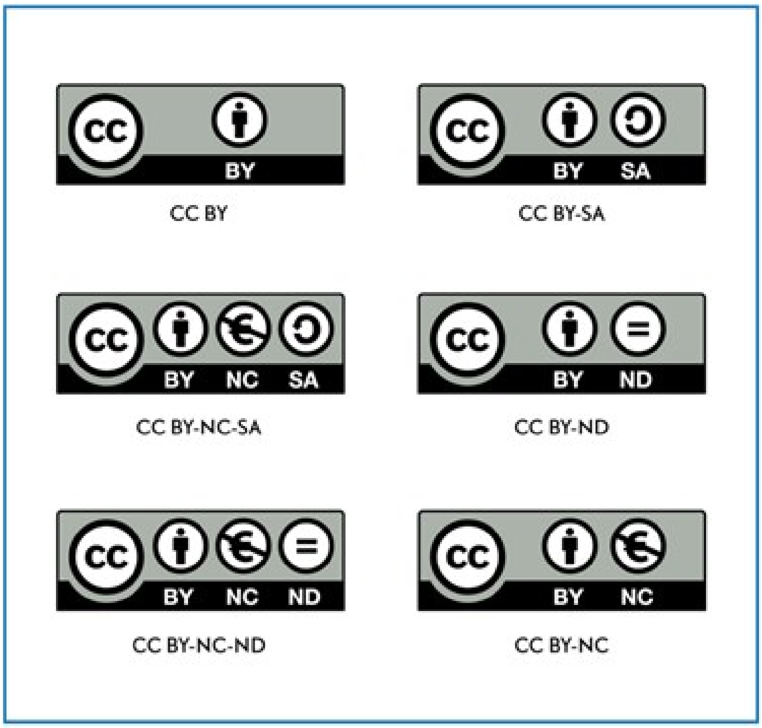

Figure 2, The six variations of the CC licences. Image downloaded from https://meta.wikimedia.org/wiki/Open_Content_-_A_Practical_Guide_to_Using_Creative_Commons_Licences/The_Creative_Commons_licencing_scheme/en in August 2019

On 26th of March 2019, the European Parliament voted about a directive concerning copyright rules, for the internet with the votes of 348 in favour, 274 against and 36 abstentions. The aim of this directive is to ensure that the longstanding rights and obligations of copyright law also apply to content on the internet. However, it is stated in the text, that the directive does not affect open source platforms. The text specifies that uploading works to open source software platforms, will be excluded from the scope of this directive.
'Free and open source software, where the source code is openly shared and users can freely access, use, modify and redistribute the software, or modified versions thereof, can contribute to research and innovation in the market, for digital content and digital services. In order to avoid imposing obstacles to such market developments, this directive should also not apply to free and open source software, provided that it is not supplied in exchange, for a price and that the consumer's personal data are exclusively used, for improving the security, compatibility, or interoperability of the software.' (Supply of Digital Content and Digital Services 2019, art.32)
This specification does tell that open source softwares are not affected by the directive, but when open source is applied to product development, we are talking about hardware, rather than software. It is also stated in the directive that it shall not apply to the provision of services other than digital ones, regardless of whether digital forms or means are used by the trader to produce the output of the service, or to deliver, or transmit it to the consumer. Open source hardware services fall into this category, and thus, are also not be affected by the directive.

3.2 Open source community

The mindset, for participating in open source activity, whether talking about knowledge, programming, or hardware, has to be open to many things. Most importantly the contributors must be willing to share their creations with little to no financial profit. The benefit, however, is that sharing goes both ways. What goes around comes around. There isn't necessarily a distinct division between the provider and the receiver of the content; an open source contributor may be both at the same time. Because of open sources' nature, the contributors must be able to adapt fast. When starting a new project, it is not necessary to have all the information needed for it. Any lacking knowledge can be gathered and studied during the working or researching process. These information pieces come from other projects and can be implemented as they are or be modified to fit the new project better if needed. This process of learning however, happens in a limited time, so the contributors must really be open to learning and have a desire to develop their projects and themselves at a fast pace. Environmental factors are usually closely tied to open source activities. Industrial waste, natural resource depletion, pollution of air, water and land, deforestation and increasing carbon footprint are just some of the many issues we face in today's world. Open source contributors should be aware of these environmental problems, understand the need for change and act upon them. The potential of open source lies in its ability to create an alternative way, for development in an open, fast and cost-efficient direction. The desire to make a difference exploiting all these characteristics of open source is what identifies the community around it.

According to Hars and Ou (2001), individual participants can be split into two main categories based on their source of motivation to participate: (1) internal motivations, where the person contributes in search of things such as eligibility, satisfaction and fulfillment, and (2) external rewards, such as expansion of one's skills, or knowledge, self-marketing and direct, or indirect monetary compensation. Similar conclusions have also been made by other researchers such as Lakhani and Wolf (2003), who present the same idea of intrinsic (value of performing the activity itself) and extrinsic (indirect rewards from the activity) motivations in OSS developers.

The open source community is usually divided into three member groups, which are: core group, active group and user group (Sokolov, 2016). The core group, consisting of individuals who are most often experienced in project management, or equivalent fields, can be illustrated as the leaders of the community as they are the organizers of working processes within the open source community. The active group consists of the makers. As this group directly benefits from the improvement, development, or implementation of the product, they are most often found to be engineers, designers, or professionals in other similar fields. The user group can be described in a very similar fashion as in most fields of design; the user group is vital as their feedback is invaluable to further develop a concept, product, service etc.. Whether the user group exists within the open source community, or outside of it, the feedback for improvement is crucial as it is in open sources' nature, that a project will never be truly finished.

4 OPEN SOURCE PRODUCT DEVELOPMENT

Open source product development is defined as the development of open source hardware products, or components of a product, that allow participation in the process, for anyone who is interested. The nature of most open source development projects is that they are rarely finished after the product is first completed; instead, they shift to the continuous improvement process loop. When the whole open design process is examined, it can be noted that OSPD can be seen as a sequence of practices rather than a project. These remarkable differences between open design and traditional design processes are seen as a crucial aspect, as they raise challenges of data management, not only with products, but also with knowledge (Bonvoisin and Boujut, 2015).

4.1 Potentials and opportunities

The Maker Movement is a trend that places value on an individual's ability to not only be the consumer of things, but also the producer of them. This movement has been referred to as the new industrial revolution (Anderson, 2012), for its ability to create an alternative way, for development in an open, fast and cost-efficient direction. This is possible by exploiting the widely accessible technologies of today. If a job can be done with a normal computer, the question of *what is done?* shifts to *who does it?*.
When product development is looked at from the economical point of view, the existence of proper patents can be seen as obligatory measure, to preserve the innovation. There are situations, where keeping information hidden is more costly than releasing it, that firms find openness more beneficial (Allen, 1983). Economic factors are only one of the many layers when it comes to value creation. In the current state of our planet, it can be argued that environmental factors overthrow the economic values and one of the main cornerstones of OSH is sustainability in its many forms. Sustainability is defined by The World Commission on Environment and Development as something that "meets the needs of the present without compromising the ability of future generations to meet their own needs." The potential of OSHW, when discussing environmental advantages lies in its ability to reduce things such as waste, pollution and fuel consumption with its on-demand production mindset.

4.2 Challenges

In any open source project, there must be enough developers behind a project for development to happen. If participants no longer want to develop a project further, it will be left to its own devices. Open source projects may be at a standstill for a variety of reasons, and errors will not be corrected unless corrected by the user themself. Buying a commercial product also guarantees faster and more secure customer support when needed. Open source free support services are generally limited just to various forums and rely on the activity of the community in question.
Introducing anything new also often causes resistance to change whatever the subject may be. Although switching to open source product development can bring new perspectives, it can also cause resistance and reluctance in companies, associations and individuals. People who are doing things the same way for years can be hesitant and even refuse to learn or accept new methods. Studying for a new one also takes up working time and arranging training

funds. Therefor it is not advisable, for someone to suddenly move all at once into new systems, throwing away all the old methods at once.
Open source and its community also have their own cons. In a large group of contributors, there is a high probability to be inexperienced contributors whose skill level is not of sufficient to design products with admissible quality. Open source software development struggles with wolves in sheep's clothing that can hide security holes, dangerous spyware for the user, or other problems in the code. This worry however is not as relevant in open hardware as possible intentional mischief will not cause damage in a large scale and it does not pose major security risks for the user community. Open source products, hardware, or software should still be treated with certain caution and criticism if any reason to doubt the authenticity of the product is found.

4.3 Openness

Openness as a concept is applied to many intellectual productions, such as the Arduino (arduino.cc) microcontroller system, extensive family of operating systems within Linux (linux.org) and the RepRap (reprap.org) project that has the initiative to create self-replicating 3D-printers. The production of physical products, however, is coming short, since it still lacks a physical manufacturing system, in addition to this, there is no single widely recognized term for the matter. Terms such as “open production”, “open manufacturing”, and “crowd manufacturing” alongside other variations of the paradigm’s name exist and have been used by various authors (Bonvoisin and Boujut, 2015), but the correct term is yet to be formalized in the OSPD community.
There have, however been projects tackling the challenge of open source physical products; Free Beer (Freebeer.org) started as a collaboration between students of IT-University of Copenhagen and an artist group, Superflex, and is now recognised as the world’s first open source beer. Free Beer consists of a recipe and the branding elements, which are available for the public to use, for brewing their own beer. The project is published under the Attribution-ShareAlike CC license, which means that anyone can brew the beer, modify the recipe, and even sell it. They must, however, publish their modified recipe under the same licencing and credit the original work.

Open design must not always be considered entirely open. Out of six studies conducted by Raasch, Herstatt, and Balka (2009), five proved there to be some limitations to openness. They identified multiple cases that have openness limitation in two aspects: 1. Limitations in degree, which refer to the amount of openness of the component, and 2. Limitations in scope, referring to the availability of components (Raasch, Herstatt & Balka, 2009). Despite of projects such as Free Beer, it must be admitted that users are unable to produce many designs themselves that thus, must be manufactured commercially.

Designing products for openness is not always straightforward, although open source offers seemingly endless possibilities for product development, it also sets some rules that must be considered consistently throughout the project. The biggest of these challenges are related to materials and manufacturing. The materials must be selected in a way that everyone should have easy access to them. The use of these materials should be taken into account in such a way that tools and equipment for it are also inexpensive, or preferably free and readily available. However, other key points in open source product development are easier to follow. The interface is to be made public and even more importantly, the design must be made public. These steps are important in the process because they ensure that anyone can implement, develop, build and improve the product and learn from it.

5 OPEN SOURCE HARDWARE PLATFORMS

Open source needs a platform for operating, but of course there is no single platform for all operations. Different projects run on their own platforms, implementing the general open source principles as well as some of their own. Some of these platforms provide contributors with the ability to design products and all related parts, while others provide them with pre-designed lego-like parts that they are free to use in their own designs. Open source platforms provide contributors with a wide range of challenges and opportunities in various areas of design as well as architecture, engineering and other similar fields.

5.1 OpenStructures

OpenStructures is a project that explores the open source concept for hardware and allows people to design together. Modularity, which has been perceived particularly suitable for open source design (Raasch, Herstatt & Balka, 2009), is strongly present in OS design principles. Parts submitted to the project must be designed using the OS modular grid, which ensures that all parts designed using the OS grid are compatible and allow the OS community members to utilize eachother's parts in new designs. The community consists of a variety of people,because anyone can participate in the project in the similar way anyone can contribute to open knowledge sharing on Wikipedia, or open programming on Linux. The OS project has three main design principles that should be followed during the design process.

1. Design for disassembly

   Designs that allow disassembly without permanent damage to any of the parts is preferred in order to facilitate the re-use of the components.

2. Design with recyclable materials

   The use of recycled and recyclable materials is preferable as often as possible. Achieving infinite material cycle for all parts (after disassembly) is pursued.

3. Design from the OS grid

   In order to make the parts compatible with each other, the OS grid must be used as the basis of some, or all, dimensions, assembly points, or connecting diameters.

The main requirement, for designs to fulfill the OS standards is that they have to be designed using the OS grid. This means that every part, in one way or another, must fit in the 4x4cm square measurement system of the grid to ensure that they will be compatible with parts designed by other users.

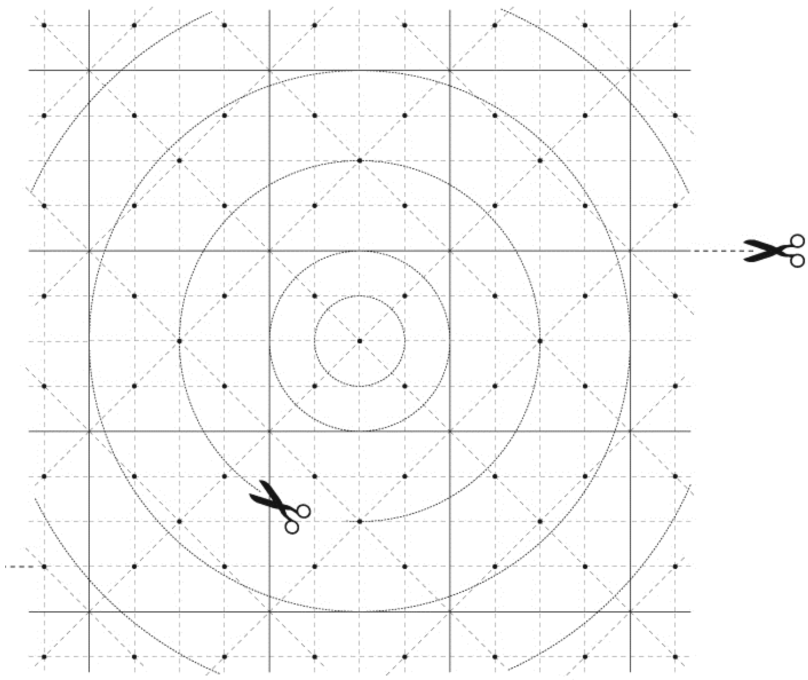

Figure 3, The borders of these 4x4cm squares mark the cutting lines, its diagonals mark the assembly points and its enclosed inner circles define common diameters. Image downloaded from http://hybridpublishing.org/2013/07/open-structures/ in August 2019

There are three methods that the OS grid can be applied to the design process: Choosing the dimensions, positioning assembly points, and choosing interconnecting diameters. At least one of these conditions should be fulfilled, for the part to be OS compatible. Using combinations of these three methods is also possible, but not mandatory.

1. Dimensional match

First option is to apply the OS grid for the dimensions of a part. One, or more of the measurements of a part (length, wideness and thickness, or height) should be in relation to the grid. Corresponding measurements are 0,125cm / 0,25cm / 0,5cm / 1cm / 2cm and multiples of 2cm.

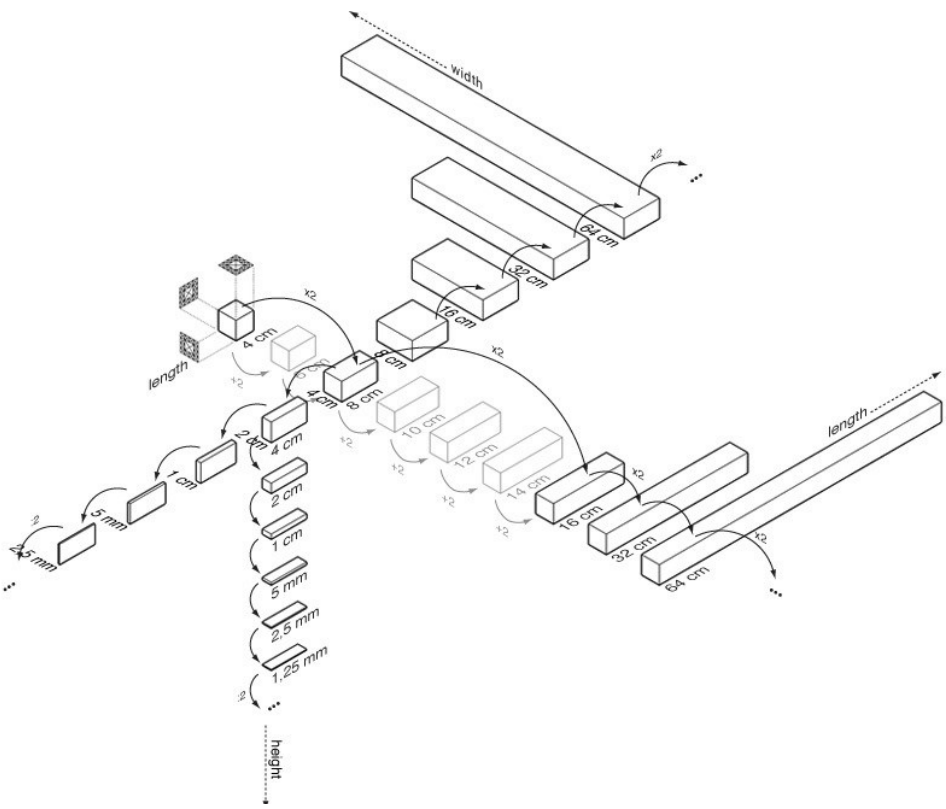

Figure 4, The dimensional changes for components according to the 4x4cm grid. Image downloaded from *https://openstructures.net/* *in March 2019*

2. Assembly point match

Second option is to exploit the grid when designing assembly points. Points of assembly should be placed where the grids' lines intersect with each other to ensure compatibility with other parts.

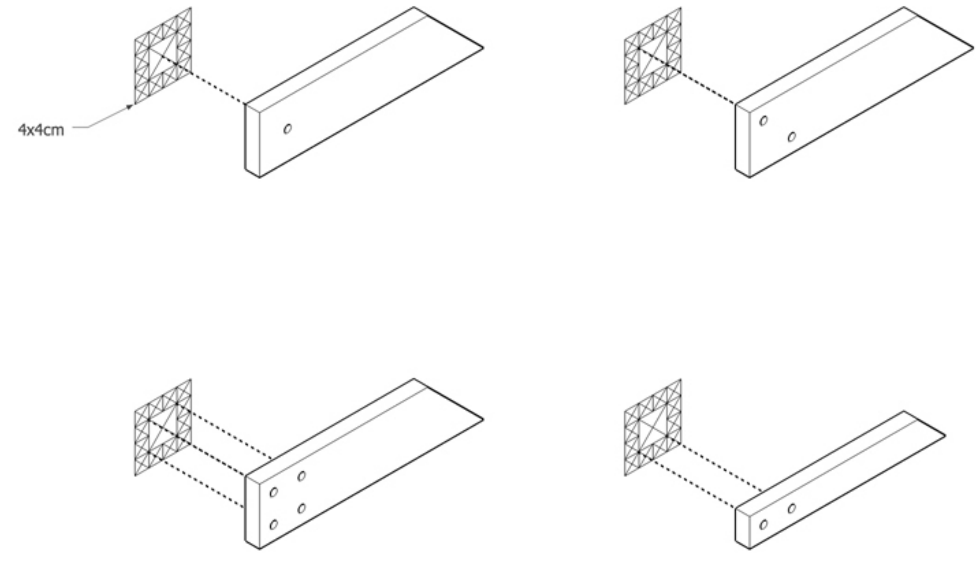

Figure 5, Some assembly point options according to the 4x4cm grid. Image downloaded from *https://openstructures.net/* *in March 2019*

3. Interconnecting diameter match

Applying the OS interconnecting diameters when designing a part is the third option. In this case the diameter of a part should be either 20mm, 40mm, or a multiple of 40mm. To ensure compatibility, this measurement should be the outer diameter of the part.

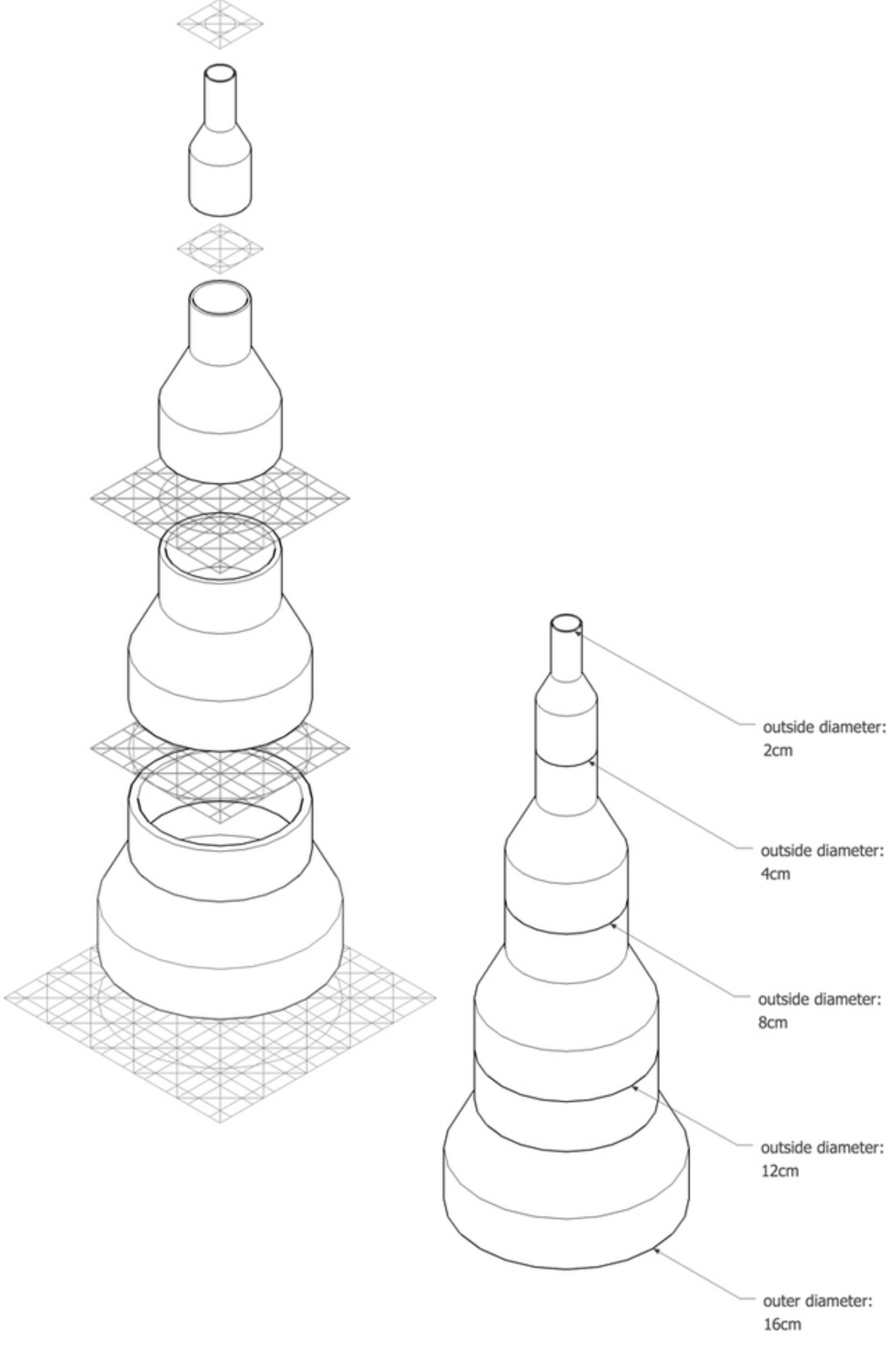

Figure 6, Diameters that match to the 4x4cm grid. Image downloaded from https://openstructures.net/ in March 2019

5.2 WikiHouse

WikiHouse is an open source system that specializes in buildings. The structures construct of standardised parts, enabling the system to be highly adaptable, thus lowering the cost of variants in the design. These parts are designed to be manufactured using digital fabrication tools that are/can be offered by network of local microfactories. The structures can be assembled by professionals, or self-builders (depending on their skill) at a faster pace than a traditional concrete, brick, or block house would be. This rapid building is one of the key advantages when comparing the factors between traditional and Wikihouse buildings (see table below)

	Concrete, brick and block houses	WikiHouse houses
Build cost	1200€-1750€/m2	1200€-1750€/m2
Project cost certainty	Low	Medium-high
Constructio n time	6-9 Months	8-12 Weeks
Constructio n skill level	High	Low
Carbon footprint	350-500 kgCO2/m2	150-250 kgCO2/m2
Re-usable components	0-10%	80-90%

Another significant factor in comparison is the carbon footprint, which is about 40-50% lower in WikiHouse buildings. This difference is largely due to diminished emissions in material transportations and industrial machining.

The design principles of WikiHouse share many similarities with OpenStructures, such as modularity and sustainable material choices, alongside the standard open source values such as open sharing. Global sharing and local manufacturing are keypoints in the WikiHouse concept. Utilizing local manufacturing is not only environmentally friendly but will also boost up local economy to some extent.

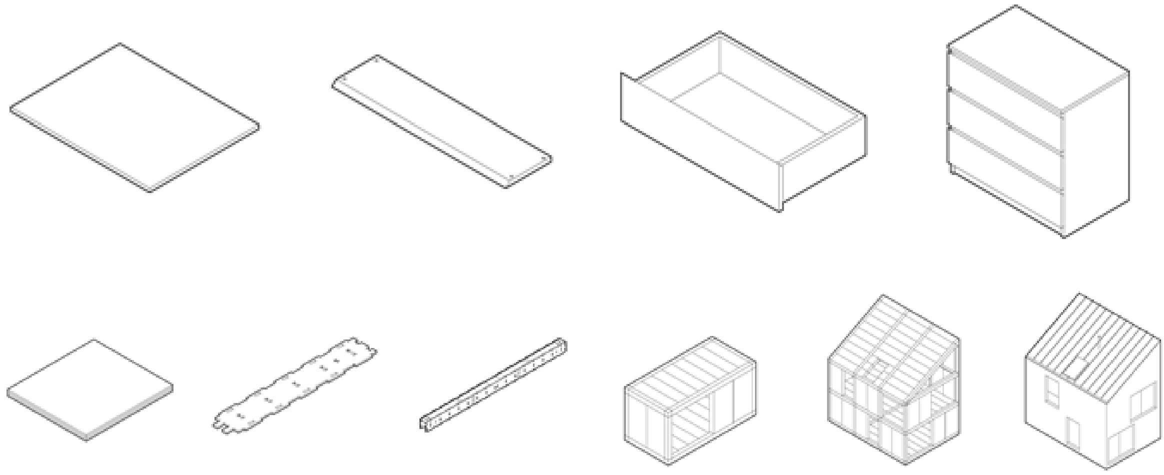

Figure 7, IKEA flat-pack approach applied to a house. Image from The DfMA Housing Manual, Open Systems Lab – Version 1.1 May 2019, 8.

Modularity provides the opportunity to create components and systems that are as little interdependent as possible. As the lifespan of a house is usually longer than many other products, its design must also take into account any repair and maintenance needs. Independent components in WikiHouse buildings enable cost-effective and material-efficient maintenance throughout the lifetime of the structure.

A manufacturing manual as well as a housing manual are provided by WikiHouse and these documents can be read as well as commented on by anyone online. In these manuals, the instructions and rules are written in detail and they also provide an extensive introduction to WikiHouses.

5.3 Open Source Ecology

Open Source Ecology (OSE) is a non-profit open source hardware organization located in Missouri, founded by Marcin Jakubowski in 2003. Its mission is to create an open source economy that optimizes both production and distribution, while promoting environmental renewal and social justice. OSE is mainly known as the Global Village Construction Set (GVCS). With the help of open source, the GVCS will allow to easily and inexpensively build 50 machines from a tractor to a laser cutter needed to give a group of about 200 people a sustainable life with the comforts of modern civilization. These 50 products cover six main areas of living and cultivation that are: habitat, agriculture, industry, energy, materials, and transportation
The design principle corresponds to those of many other OSHW projects, as the items are interchangeable and widely used. The materials used should be as easy as possible to get and be present on site. The plans for the devices are available under open licenses and they are created in e-collaboration from the description all the way to the CAD drawings. The assembly and testing of the prototypes mostly take place in the Factor e Farm (FeF) that is an experimental environment where people can live, work and learn from local and regenerative resources. The devices in the end, should cost about one eighth of the price for comparable

products. Anyone who has access to appropriate tools should be able to copy the machines alone with their own labor or use as a basis for their own plans and develop further.

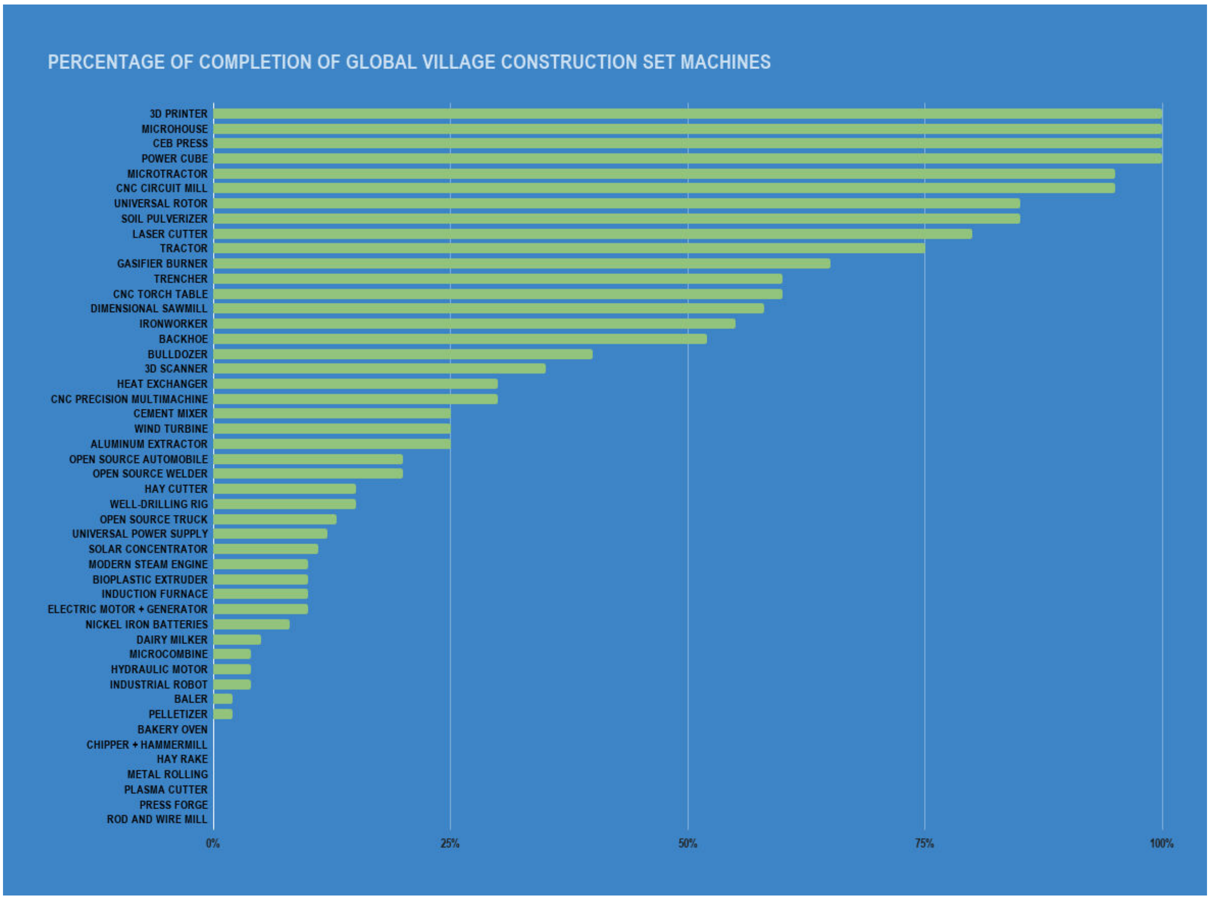

Figure 8, The current completion status of the GVCS products. Image downloaded from https://www.opensourceecology.org/gvcs/ in August 2019.

The development of the GVCS products is a collaborative and continuous process that the staff and volunteers work on at FeF, but also through many forms of collaboration such as workshops, design sprints, and online. The “Civilization Starter Kit” is a freely available working document that contains all necessary information to start building the GVCS products. The goal is to provide a single package to be used by anyone once the development of the project is fully accomplished.

6 CONCLUSION

The purpose of this bachelor's thesis was to study open source product development and to explore its purpose, use and potential. A very personal goal was to introduce the subject to the readers who did not previously possess knowledge of it, as I've found many colleagues and peers to be unfamiliar with it.

Open source product development is a unique part of design as well as other fields such as architecture and engineering. Product development with a community of like-minded people and a shared goal is more efficient, sustainable and, of course, open, than it is with individuals. Open source has created new avenues for creative makers and active users by opening up the possibility of open sharing, development, improvement and utilization. By using open source in product development, time and cost savings can be achieved in the design process by utilizing what has already been done by building upon it or improving it as a whole. The research, design, implementation and improvement processes are progressing faster, when using the open source model. The same, truly comprehensive designs can be worked on simultaneously by different parties within in same, or completely different projects. As long as there are challenges to work on, there will be open source members of the community interested to contribute.

To confirm, or refute these interpretations requires further empirical research. Projects that are not based on secondary data, but direct information and experience, would be beneficial, for making more accurate explanations and conclusions. However, this thesis provides a first proof of the extent of the phenomenon and that OSPD projects can produce functional and profitable products. Future researches could focus on individual subjects mentioned in this thesis, for example, the economics of OSPD or the intentional sabotage directed to open source projects. I believe it would be beneficial to further explain, explore and to go into more detail about various aspects of open source product development to truly convey its relevance as a design process.

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