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Copyright Regulation of 3D printing

Master thesis

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I hereby declare that I am the sole author
of this Master Thesis and it has
not been presented to any other
university for examination.

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Table of Abbreviations

BC	Berne Convention
CC	Creative Commons
DMCA	Digital Millennium Copyright Act
DRM	Digital Rights Management
ECJ	European Court of Justice
GUI	Graphic User Interface
InfoSoc	Information Society Directive
WCT	WIPO Copyright Treaty
TRIPS	Agreement on Trade Related aspects of Intellectual Property

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Introduction

3D printing technology is a new emerging technology on the verge of a breakthrough. Michael Weinberg has said: "/../[j]ust as computers have allowed us to become makers of movies, writers of articles, and creators of music, 3D printers will allow everyone to become creators of things".[1] New digital technologies make copying a lot easier than it has been before and as 3D printing of physical things at home might become the "new normal", it will pose threats to traditional intellectual property laws, which were created in an era, when copyright infringement of physical objects, or also defined "physibles"[2], was yet to come. In particular the issues are capable of emerging in relation to copyrights. The topic is intriguing and due to personal experience with the technology, the author was encouraged to pick this as a topic for master thesis. As the master thesis is written under the curricula of Law and Technology, what better way to combine these two, than to analyse a novel and promising technology and its legal implications.

Though the topic is relatively new, there are enough authoritative sources to build the thesis on. Articles used in the thesis are mainly peer-reviewed scholarly articles from authoritative journals, but at parts the author includes news articles and media coverage from the Internet, to give the thesis the latest approach. White papers by Michael Weinberg give great insight to the technology and future of 3D printing regulation as well as reports concluded in the UK for future 3D printing policy. Untangling the issues related to CAD files and their suitability for copyright protection are at large part based on an article by Kyle Dolinsky. Material on the future perspective of 3D printing digital rights management solutions will be obtained from U.S. granted patent application on the relevant subject matter.

The methodology used in the thesis is qualitative analysis, which is common for researches like this, analysing different legislative sources. The leading approach to 3D printing and the interpretation of applicable law to 3D printing originates mainly from the U.S., where there has been more litigation, more experience and contact with the subject matter. For this reason, in most aspects the US approach will be handled as an example and compared to the EU approach.

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[1] Weinberg, M. (2013). What's the Deal with Copyright and 3D Printing?. *White paper from Public Knowledge's Institute for Emerging Innovation*, p 1.

[2] The online peer-to-peer sharing site The Pirate Bay launched a category for 3D designs called "physibles". See, for example: Walters, R. (2012). The Pirate Bay Declares 3D Printed "Physibles" as the Next Frontier of Piracy. Available at: http://www.extremetech.com/electronics/115185-the-pirate-bay-declares-3d-printed-physibles-as-the-next-frontier- of-piracy (accessed 15.04.2015).

The hypothesis of the thesis is that the existing measures for enforcing copyright protection need to be reviewed in order to comply with the complex nature of 3D printing technology. The aim of the thesis is to evaluate the distinctive characteristics of 3D printing in the context of existing legislation and other regulative measures, which could be applied to regulate 3D printing technology.

The research questions of the thesis are:

1. Is the existing copyright regulation suitable to comprise the specific characteristics of the computer-aided design (CAD) files and physical 3D printed objects?
2. Which measures could be implemented to achieve a regulative solution for 3D printing technology?

The first chapter of the thesis focuses on the existing copyright regulation, which could encompass 3D printing. As the technology is unfamiliar to many, for practical considerations, an overview of the 3D printing technology will be given, including the methods used for printing, the process of 3D printing, main advantages of 3D printing, the success stories and aspects that are holding the technology back. 3D printing combines in itself two separate processes - the creation process begins with the designer designing a CAD model and afterwards the 3D printer follows the specific instructions given with the CAD model and prints out the physical object layer by layer. It is possible to create a CAD file via 3D scanning an already existing physical object, which is the fastest way of copying that does not require creativity and thus poses a threat to the author of the copyrightable work. 3D printing is just starting to become available for home use and the issues accompanying it, mainly copyright protection of 3D printing technology, are becoming more relevant. The field of 3D printing does not have a specific regulation, naturally the process of drafting and enforcing new laws is time consuming and it takes a while for legislation to catch up with the technological developments. The research question to be answered in the first chapter is, whether the existing copyright legislation is suitable to comprise the specific characteristics of 3D printing technology, meaning the CAD files and physical 3D printed objects. To bring clarity to this question, first an overview of existing international legal framework, U.S. legislation on copyright and EU harmonised copyright regulations will be given and the categories of copyrightable subject matter are analysed in the context of 3D printing technology, with the purpose of trying to find a suitable analogue, which could be capable of

comprising the characteristics of 3D printing. The biggest issue is, that intellectual property rights in a CAD file and in a 3D printed object could be different. To determine, whether a CAD file and a 3D printed object are copyrightable subject matter, the originality aspect of copyright should also be evaluated. Further on, the second issue a CAD file and 3D printed object need to overcome is the problem of usefulness – no useful idea is protected by copyright. The utilitarian purpose of works will be analysed under U.S. law, where "useful article" is clearly defined and under EU law, where the concept is undefined, similar considerations are given under the industrial design regulation.

The second chapter of the thesis will address different regulative measures, which could be implied to achieve a regulatory framework of 3D printing technology. The different options include possible expansion of copyright law either for expanded protection of CAD files or 3D printed objects. Another option suggested by scholars is setting a *sui generis* right for 3D printed objects similarly as was done with databases under EU law. Due to 3D printing being such a novel and immature technology, many suggest that it should be left unregulated for as long as possible and at the same time, if some regulation is to be pursued, the best method of regulation would be self-regulation or setting industry standards, where different parties on the market have been included into the drafting process. Later on mandatory rules could be enforced based on the rules that have emerged through self-regulation. So far, the 3D printing community has largely practiced the use of Creative Commons licenses, which can be seen as a tool for digital copyright and are found to be especially suitable for 3D printing and CAD designs, as they are often altered and re-shared. The digitalisation of things has lead to the implementation of different DRM measures and some initiatives are already pursued in relation to 3D printing DRM solutions. The possible future solution will be described on the basis of a patented method for 3D printing DRM. Potential legal issues related to application of DRM measures to 3D printing will be brought out and analysed, whether the new DRM solution could overcome these issues. 3D printing industry is often compared to the digitalisation of music industry. The issues are practically the same and thus 3D printing industry could possibly skip a step and follow the example of where the music industry has come to now and take on a similar business model as iTunes and Netflix are using.

1. Existing copyright regulation of 3D printing

1.1. 3D printing technology

3D printing technology, which can also be referred to as rapid prototyping or additive manufacturing, has been around for quite some time. As a manufacturing technology 3D printing became established in the late 1970s. David Jones first described the technology as a joke in a newspaper article, and later on, a patent was granted to Wyn Kelly Swainson in 1977 for the same idea, which was filed independently before the newspaper article.[3] 3D printing can be described as a method of joining materials, layer by layer, on the basis of a CAD model or 3D scanned file.[4] 3D printing is comparable to traditional inkjet printers - they are both revolutionary in the same sense. At first it was also doubted, that anyone would ever have a personal computer, let alone an inkjet printer on their desktop, but it happened and now it is predicted that the same success will follow the 3D printers.[5] The inkjet printers print pixels from the screen onto a paper, using ink on a XY-axis, but the 3D printer prints on a XYZ-axis, making the object 3-dimensional.[6] The prices of desktop printers are just now starting to become affordable, making the technology soon widespread and available for home use.

The low-cost printers, affordable for home use, normally use the fused-filament fabrication technology, which is most easily describable as a computer-controlled glue-gun. The plastic filament is melted by a hot nozzle and distributed onto a plate, creating the bottom layer of the object. After that, the plate drops a little, allowing the printer to lay the next layer of filament, thus forming a 3D object.[7] As the technology creates the objects from bottom to top, it has been compared with creating an object by using Lego bricks.[8] The plastic materials used for 3D printing are most commonly oil-based sturdy plastic called ABS or a biodegradable plant-based

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[3] Bradshaw, S., Bowyer, A. and Haufe, P. (2010) The intellectual property implications of low-cost 3D printing. ScriptEd, 7 (1). pp 7-8.
[4] Stahl, H. (2013). 3D Printing–Risks and Opportunities. Öko-Institut e.V. Institute for Applied Ecology, pp 3-4.
[5] Storch, J. C. (2014). 3-D Printing Your Way Down The Garden Path: 3-D Printers, the Copyrightization of Patents, and a Method for Manufacturers to Avoid the Entertainment Industry's Fate. *New York University Journal of Intellectual Property & Entertainment Law*, *3*, pp 308-309.
[6] Howells, J. A. J. (2014). The Intellectual Property Right Implications of Consumer 3D Printing. Available at: http://pure.au.dk/portal-asb-student/files/71036699/The_Intellectual_Property_Right_Implications_of_Consumer_3D_Printing_Final.pdf (accessed: 06.06.2014), p 13.
[7] Bradshaw (2010), *supra nota* 3 pp 8-9.
[8] Campbell, T., Williams, C., Ivanova, O., & Garrett, B. (2011).Could 3D Printing Change the World? *Technologies, Potential, and Implications of Additive Manufacturing. Washington, DC: Atlantic Council*, p 2.

plastic called PLA. Recently there have been researches to identify the health risks of molten plastic. Already the smell that originates from a working 3D printer can generate questions, whether it is safe for the health. A study by researchers in Illinois Institute of Technology shows that 3D printers can pollute the indoor air with harmful nano-sized particles, which can be toxic to the human body in a badly ventilated room[9]. The health risks should be further evaluated, as the technology spreads even more. Other methods of 3D printing are stereolithography and selective laser sintering, which are not that common for home-use.[10]

An interesting characteristic of the 3D printing technology is the possibility to print a new 3D printer with the existing one. The technology is capable of self-replication, which from the conventional industry point of view is useless. The hypothesis was that nobody would want to sell a machine, that is capable of self-replication, because the machine is of value to the people, but not to the sellers - thus there is a market failure and due to that, it was decided that the machine and all of its designs should be available for free under General Public Licenses on the web. This was the start of the Rep-Rap project, under which a new printer could be created for about 400 dollars, undoubtedly it makes objects of lower quality and all the improvements arose from the users own initiative. [11]

Low-cost 3D printers for home desktop use are starting to become more affordable and widespread, while previously the prices of desktop 3D printers started from 20,000 dollars, it is now possible to buy a decent quality 3D printer for about 1,500 dollars or cheaper. As the industry is developing, many new manufacturers of 3D printers have entered the market. Leading manufacturers include MakerBot, the owner of 3D marketplace Thingiverse, Ultimaker, Leapfrog, Flashforge, MassPortal and the list continues. All of these different printers initially have different software, which makes managing many printers at once quite difficult.

Before printing is possible, a 3D model of the object has to be created by a CAD software or by 3D scanning. The prices of 3D scanners have also decreased and are now available for most enthusiasts. The MakerBot Digitizer consists of a turnable platform, a camera and two lasers. But

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[9] Stephens, B., Azimi, P., El Orch, Z., & Ramos, T. (2013). Ultrafine particle emissions from desktop 3D printers. *Atmospheric Environment*, *79*, pp. 334-335.
[10] Gilpin, L. (2014) 10 facts on 3D printing: Understanding tech's next big game changer. Available at: http://www.techrepublic.com/article/10-facts-on-3d-printing-understanding-techs-next-big-game-changer/ (accessed 01.03.2015).
[11] Bradshaw (2010), *supra nota 3*, p 9.

still, the technology is time consuming, labour intensive and complicated and the quality of the home-scanned digital models is low, thus there is need for further developments to stimulate the market for 3D scanners.[12]

Usually in legal research the CAD files are treated as the digital representation of a physical object, which needs to be saved in a .STL file, before it becomes readable for a 3D printer. STL stands for Surface Tesselation Language and it has been a universal file format for 3D printers for almost 25 years. STL file is the digital form of physical objects and Michael Weinberg explains the STL file format to be an equivalent to PDF for text files, as they are both universally printable.[13] STL files carry in themselves the information about slicing the objects into layers and calculations of the machine paths and consist of triangles, which are derived from the surface of a 3D CAD model.[14] It is doubted, that STL files will become the industry standard and maintain the title of a universal 3D printing format, because STL format files are insufficient for high resolution 3D printers,[15] and may be replaced by AMF (Additive Manufacturing Format) files.[16] For the sake of this thesis, the designs of 3D printed objects in further analysis will be referred to as CAD files.

Advantages of 3D printing include the speed to market, meaning that an entrepreneur or a designer can think of a product, finish the design and immediately start 3D printing of the product. The traditional long manufacturing chains can be eliminated, making the field vulnerable to intellectual property infringements. Another upside is the low risk of a new product failing in the market. As there is no prerequisite number of products for print, the manufacturer can first test the idea and continue manufacturing according to feedback from customers. 3D printing makes it possible to test even the craziest ideas on the market. The technology of 3D printing is capable of creating very detailed products, which cannot be made otherwise. Another bonus of 3D printing, is that it consumes less material than other manufacturing methods, this is why it is called additive manufacturing. It uses precisely as much material as necessary for making the product, thus it creates less waste and can be considered to be a greener method for

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[12] Howells (2014), *supra nota 6.*
[13] Weinberg (2013), *supra nota 1* p 14.
[14] 3DaddFab. (2011) What is an STL File and is it Obsolete? Available at http://3daddfab.com/blog/index.php?/archives/4-What-is-an-STL-file-and-is-it-obsolete.html (accessed 15.04.2015).
[15] *Ibid.*
[16] 3DaddFab (2011) AMF – The 3D Printing Format to Replace STL? Available at: http://3daddfab.com/blog/index.php?/archives/5-AMF-The-3D-Printing-Format-to-Replace-STL.html (accessed 15.04.2015).

manufacturing than the traditional one. [17] Though the assumption of more "green" should be looked at critically, as the printers do pollute air with some nano-sized particles, which can be toxic to humans, but in the end, the pollution level from the printers could be smaller than what traditional factories produce.

Success stories using 3D printing come from different industrial fields and relate to anything that needs to be customized to certain conditions. As additive manufacturing is not yet suitable for mass production, it is precisely fitting for making specialized products in low-volume quantities. The technology can be used for creating spare parts; craft and hobby items; for educational uses; for creating fashion accessories and so on. [18] 3D printing is used for printing automotive components and aircraft components. Many success stories also come from the field of medicine, and it is obvious that the whole humankind can benefit from this technology. For example, custom hearing aids can be printed with 3D printers according to the ear shape and size of the patients' ear. 3D printing is already used successfully in dentistry, where tooth crowns, bridges and stone models are printed on a daily basis. It is also useful in custom orthodontics, where custom made braces can be created according to the dental situation of different patients. [19] Printing functional prosthetic arms or legs will enable people to save a lot of money. Parts of bones have already been printed, which are even degradable, meaning that after some time they will be replaced with the body's own tissue. [20]

Though the technology is accompanied with lots of interesting and beneficial usages and possibilities, it has not yet reached its full proficiency. Monitoring media coverage, one can notice that the headlines and evaluations are divided roughly into two categories – they either support it or claim that the technology is being unreasonably hyped.[21] People are expecting a lot from 3D printing, and unfortunately, many aspects of the technology are not complying with the expectations. One main concern that is holding back the breakthrough of 3D printing is the limitation of desktop printer materials to rough plastic. People are waiting for materials with better quality, for example leather to print custom made shoes. There are only limited amount of

[17] Mendis, D. (2013). The Clone Wars'--Episode 1: The Rise of 3D Printing and its Implications for Intellectual Property Law-- Learning Lessons from the Past. *European Intellectual Property Review,* 35(3), pp. 155-169.
[18] Bradshaw (2010), *supra nota 3,* pp. 11-12.
[19] Campbell (2011), *supra nota 8*, p 4.
[20] Milkert, H. (2014). 3D Printed Biodegradable Metal Bone Scaffolding Created. Available at: http://3dprint.com/1604/3d-printed-biodegradable-metal-bone-scaffolding-created/ (accessed: 15.04.2015).
[21] Finocchiaro, C. W. (2013). Personal Factory or Catalyst for Piracy: The Hype, Hysteria, and Hard Realities of Consumer 3-D Printing. *Cardozo Arts and Entertainment Law Journal, 31*, pp. 474-475.

things a person would like to print out with the ABS or PLA plastic filament that is used for printing now.[22] Lego bricks are probably the best example of objects made completely out of plastic. The bricks with interlocking system are popular toys among children all ages and it is already possible for children with the help of parents to design their own Lego figurines or to 3D print different coloured or sized bricks on demand – 3D printing technology is capable of offering exactly this kind of variety. [23] Lego is also known for their ability to overcome all obstacles the new emerging technologies have thrown at them, e.g. Lego has turned the industries of video games and interactive toys into their favour and are certainly looking to do so with 3D printing industry. So far Lego has been granted a patent in the field of 3D printing, which would allow users to print their own customized bricks. The invention stands for the 3D printing of plastic onto pre-moulded Lego block bases – this would allow Lego to sell new bricks with the added-value of the possibility for users to print their custom made bricks. Lego's approach to 3D printing technology is a great interpretation of the quote – if you can't beat them, join them.[24]

Another issue is that the 3D printers still have room for development when it comes to printing speed. Printing of a model will depend on many things, among others the size, layer thickness, necessity for supports and so on, and the timeframe can vary in hours. For now the person needs to physically monitor the process to make sure that printing goes without obstacles. Startups are already trying to eliminate this issue by suggesting to integrate cameras to 3D printers, that will stream live feed from 3D printer to computer, so the process could be monitored from distance and physical presence is not necessary.[25]

According to Deloitte predictions, 3D printing will not be the next industrial revolution in the sense that every household will become a personal factory, instead the revolution could happen in schools and educational facilities, which could start to act as mini factories. In addition what is holding back 3D printing is also the complication of the machines, they are hard to calibrate to meet the needs of the customer and they can be compared to the early age personal computers,

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[22] Deloitte. (2015) 3D printing is a revolution: just not the revolution you think. *Technology, Media & Telecommunications Predictions*, pp 13-15.
[23] Moskin, J. (2014). Roll over Gutenberg, Tell Mr. Hull the News: Obstacles and Opportunities from 3D Printing. *Trademark Reporter*, *104*, p 811.
[24] Gardner, A. (2014) Lego Awarded 3D Printing Patent, May Allow Users to Print Own Bricks. Available at: http://3dprint.com/1383/lego-awarded-3d-printing-patents-may-allow-users-to-print-own-bricks/ (accessed: 03.03.2015).
[25] For example, 3DprinterOS, http://www.3DprinterOS.com. See part 2.6.2. of the thesis for more information on 3DprinterOS.

when PC-s were still hard to use. The prediction states, that by 2020 10-20% of homes have a 3D printer, but they will rather be used rarely than on a daily basis.[26] This gives 3D printing technology still time to mature and for the issues of 3D printing to develop.

1.2. International legal framework

Since 3D printing industry began to emerge, the main concern has been the protection of intellectual property rights and especially protection of copyrights. Regulation and legislation for intellectual property rights were drafted in an era, where consumer infringement of physical objects was very difficult. 3D printing technology will simplify the copyright infringement of physibles. According to future predictions made by Gartner in 2013, by the year 2018 3D printing technology will be responsible for a loss in the sum of at least $100 billion per year in intellectual property.[27] The digitalisation of things has lead to a situation, where designers are feeling reluctant to upload their designs in fear of their IP being stolen, which is crucial to follow-on creativity. 3D printing is capable of infringing practically all branches of intellectual property rights. Copyrights automatically exist for any original literary or artistic work that has been expressed in a tangible medium, they do not require any previous registration are completely free, which are the two important benefits that differentiate it from other forms of IP rights. Due to that, 3D printing infringements would most likely occur in relation to copyrights. Copyrights offer protection for original literary and artistic works that do not incorporate in them a useful element or an idea and the duration of copyrights is usually for 70 years after the death of the author. The two basic elements of 3D printing, the digital CAD file and the physical 3D printed object easily meet the fixation requirement of copyright protection.[28] The next form of vulnerable intellectual property branch is design law, which in the EU can be registered or unregistered design. Patents and trademarks are also open to infringements from 3D printing, but these issues will be left aside in this thesis, as the focus is mainly on copyright protection.

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[26] Deloitte. (2015), *supra nota 22,* p 13.
[27] Gartner. (2013) Gartner Reveals Top Predictions For IT Organizations and Users for 2014 and Beyond. Available at: http://www.gartner.com/newsroom/id/2603215 (accessed: 03.03.2015).
[28] Dasari, H. (2013). Assessing copyright protection and infringement issues involved with 3D printing and scanning. *American Intellectual Property Law Association Quarterly Journal*, *41*, 279.

The international legal framework for copyrights includes international treaties, which are the basis of many national and new regulations and also define the minimum standards for states to apply. [29] The most important international agreements on copyright law for this thesis include the Berne Convention[30], The Agreement on Trade Related Aspects of Intellectual Property Rights (TRIPS)[31] and the WIPO Copyright Treaty (WCT)[32]. TRIPS and WCT are dependent on the Berne Convention in the aspect that they both refer back to the Berne Convention regarding the defined list of protected works.

Berne Convention is the oldest international copyright treaty open to all states, it was concluded in 1886 on the protection of literary and artistic works. The aim of the BC is defined in the preamble and states that it seeks to offer as effective and uniform protection as possible for authors of literary and artistic works. BC defines the minimum protection that states have to grant the authors, but states have room to provide higher measures of protection. Due to rapid development of new technologies, it has been revised several times, but the last revision dates back to 1971 in Paris and the last amendment was in 1979, which is fair to say, was a very long time ago.[33] The TRIPS Agreement was concluded in 1994, under the General Agreement on Tariffs and Trades (GATT) system. The main purpose of TRIPS is to enforce members of World Trade Organisation (WTO) to comply with Berne Convention, with the exception of the provision of authors' moral rights. Under the TRIPS agreement in addition to the provisions of BC, computer programs are to be protected as "literary works" within the meaning of BC.[34] TRIPS Agreement Article 10 also gives the form of expression in which a computer program shall be expressed and it is in the form of a source code or an object code. The rapid changes in technology in the 1970s and 1980s, which included the increased importance of computer programs and electronic databases also called for a special agreement and thus the WIPO Copyright Treaty (WCT) was adopted in 1996. Article 20 of BC allows for members of the BC to conclude special agreements among themselves to grant the authors more extensive rights than are granted with the Convention, or to contain other provisions, which do not contradict to those given by the Convention. Thus the WCT is directly connected only to the BC. The aim of WCT

[29] Sobel, L. S. (1989). Framework of International Copyright, The. *Cardozo Arts and Entertainment Law Journal*, *8*, p 4.
[30] Berne Convention for the Protection of Literary and Artistic Works of 9 September 1886. Paris Act of 24 July 1971, as amended on 28 September 1979. WIPO, Geneva.
[31] The Agreement on Trade Related Aspects of Intellectual Property Rights. 15 April 1994, WTO, Marrakesh.
[32] WIPO Copyright Treaty. 20 December 1996. WIPO, Geneva.
[33] World Intellectual Property Organization. (2004). *WIPO Intellectual Property Handbook: Policy, Law and Use* (No. 489), p 262.
[34] Tritton, G. (2008). *Intellectual property in Europe*. 3rd ed. London, Sweet & Maxwell, 469, pp 4-032.

was to grant computer programs protection as literary works, regardless of their mode or form of expression, in the meaning of Berne Convention Article 2(1).[35] Some scholars propose that it would be possible to protect the CAD files as computer programs and thus, if CAD files were to be equated with computer programs, they would end up also being protected as literary works.

As mentioned before, the 3D printing technology started out in the late 1970's, thus it is clear that 3D printing technology and its implications have not been addressed in the revisions of Berne Convention (BC). Trying to find a suitable definition for 3D printed objects and CAD files leads to Article 2 of the BC, which contains a non-limitative list of works protected by copyright. A non-limitative list means that the list is illustrative and non-exhaustive, which is reasonable and necessary, as technology keeps constantly developing and changing our society and the non-exhaustiveness of protected works allows for interpretation of different types of new mediums and forms of expression under copyrightable subject matter. Clearly, there is no specific definition or mentioning of CAD files or 3D printed objects in the BC. The list of works eligible for copyright protection under Article 2(1), which could be analogous to CAD files or 3D printed objects, include works of: "drawing, painting, architecture, sculpture, engraving and lithography; or illustrations, maps, plans, sketches, and three-dimensional works relative to geography, topography, architecture or science." Though the list even includes the term "three-dimensional", it does not specifically relate to works printed by a 3D printer. 3D printers are without a doubt useful tools for scientists and architects to create CAD models and 3D print them. In case a 3D printed object relates to geography, topography, architecture or science, the situation is more understandable and the object is covered under BC. But the regular home user can print out a variety of things, some merely decorative and some useful, which do not necessarily relate to those abovementioned fields. Second category, under which 3D printed objects could be categorized, is sculptures. As there is no specific definition of a sculpture as well, the process of reaching the end result can be different and might incorporate 3D printing. Although many forms of expression are specifically mentioned in Article 2(1) of the BC, the mode or form of expression is irrelevant, as long as the work includes any original production in the literary, scientific or artistic domain.[36] Considering the revolutionary nature of 3D printing and its capability to change manufacturing, it could be reasonable to either revise the BC once again and include a new category under the list of protected works or to adopt a new special agreement

[35] World Intellectual Property Organization. (2004), *supra nota 33,* p 269.
[36] *Ibid*, p 262.

under the meaning of Article 20 of BC, as was done with computer programs. This suggestion is based on the assumption that many scholars deem computer programs to be the best match to 3D printing from different analogous categories of copyrightable subject matter and if 3D printing were to be equated with computer programs, they could possibly follow the same legislative route as computer programs did. On the other hand this analogy gives legislators the possibility to learn from previous mistakes. Protecting computer programs as literary works and applying copyright to them is often debated and some suggest, that bending copyright laws to cover computer programs was a mistake and establishing a *sui generis* protection would have been more appropriate. This issue is more specifically discussed in the *sui generis* part of the thesis.

1.3. United States approach

Since 3D printing technology and the legal issues have been more specifically addressed in the United States, this section will first give an overview of the subject matter according to the U.S. copyright regulation. Copyrights in the U.S. are covered with the U.S. Copyright Act and the Digital Millennium Copyright Act (DMCA),[37] which entered into force in 1998. The concept of a CAD file or a 3D printed object is obviously also not expressly defined in U.S. Copyright Act or the DMCA. The main question is, whether CAD files and 3D printers are independently copyrightable, or whether they are dependent on each other, and which one is more pivotal in determining the suitability for copyright protection. It is fundamental to recognise that CAD files differ from MP3 files used as music carriers and MP4 files used for audiovisual content, for which there is no doubt about their suitability for copyright protection.[38] There is a controversy between scholars in evaluating the copyright protection issues regarding 3D printing and there are mainly two types of understandings. Some scholars are certain that the main issues of copyright are centred on CAD files and others on the contrary that the main question is the suitability of 3D printed objects for copyright protection. This kind of conflict of opinions may have emerged due to insufficient understanding of the 3D printing technology and because legal issues and regulations have not yet received the in depth interpretation by the courts and the technology is not that commonplace, it is still hard to ascertain which approach is more

[37] The Digital Millennium Copyright Act of 1998.
[38] Twomey, P. (2014) A New Dimension to Intellectual Property Infringement: An Evaluation of the Intellectual Property Issues Associated with 3D Printing. *Trinity College Law Review*, vol 17, p33.

appropriate. Trying to bring some clarity to the situation, the scholarly ideas and analogies to 3D printing brought under US law are to be analysed in this section.

1.3.1. Legal protection of 3D printing

According to Dolinsky, there is no question in the copyrights of 3D printed objects, which are protected as "pictorial, graphical and sculptural works*"* and the main question will be the copyrightability of CAD files. The possible analogues to CAD files that Dolinsky offers, are architectural plans, other technical drawings, recipes, computer programs, video games and computer generated works.[39] Rideout on the contrary states in his work, that the copyrightability question of a CAD file is conditional to the eligibility of copyright protection of the 3D printed object. According to Rideout, it is the CAD files that would likely fall under "pictorial, graphic and sculptural works" and more specifically under "technical drawings, diagrams and models".[40]

Comparison to architectural plans and blueprints seems like a potential analogue, which would grant the designer the desired copyright protection for both the design file and every printed end result[41]. The U.S. law provides clear definitions about many concepts, which are not specifically defined under EU regulations. Copyright protection under architectural works is provided for the design of the building expressed in any tangible medium, including the building itself, as well as for architectural plans or drawings and because the plans represent the building, copyrights will extend to the physical building, even prior to construction.[42] Even though the building is a useful article and has a utilitarian purpose, it is still protected by copyright as an exception. Architectural plans and blueprints nowadays also exist in the form of a CAD file, the underlying idea and software to create an architectural plan or blueprint is the same as for CAD files embodying 3D printable designs. The main difference between architectural plans and CAD files containing 3D printing objects derives from the realisation time from digital to physical, which can vary practically in years, as designer of a CAD file can achieve the physical 3D printed end

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[39] Dolinsky, K. (2014). CAD's Cradle: Untangling Copyrightability, Derivative Works, and Fair Use in 3D Printing. *Washington & Lee Law Review*, *71*, pp. 629-631.
[40] Rideout, B. (2011). Printing the impossible triangle: The copyright implications of three-dimensional printing. *Journal of Business, Entrepreneurship and the Law*, *5*, pp. 167-168.
[41] Osborn, L. S. (2014). Of PhDs, Pirates and the Public: Three-Dimensional Printing Technology and the Arts. *Texas A&M Law Review*, *1*, p 824.
[42] Dolinsky, *supra nota 39,* p 629.

result already in a few hours, as opposed to the building process of a house, which can take years. The method of realisation is also essentially different, as for 3D printing there is the need to convert the CAD file into an STL file, which makes it machine readable for a 3D printer and enables to print out the design, but the architectural plans and blueprints will be realised through human input. Thus the fundamental differences make it hard to find this comparison appropriate.[43]

Another possibility is to compare CAD files with other "technical drawings", which are protected under "pictorial, graphical and sculptural works" within the meaning of the U.S. Copyright Act. For technical drawings there is no extended protection for whatever object is created based on the information obtained from these technical drawings, differently from architectural plans, the copyright protection limited only to the drawings. Technical drawings are not traditionally considered to be creative, because they usually contain information about a functional item, which falls out of the scope of copyright protection, but they were granted an explicit exception under U.S. Copyright Act. By creating a technical drawing of a real-life object, there could be inherent or accidental creativity or contains creativity in the process of how the technical information has been displayed.[44] There is a similarity to CAD files, which also can contain information about creating a functional non-copyrightable object. Considering the dual nature of 3D printing, the equation of CAD files to technical drawings will only protect the first phase of the process and such copyright protection might be undesirable for designers. On the other hand, objects created according to technical drawings, which are not excluded from the scope of copyright protection due to their utilitarian purpose, will acquire copyright protection regardless of the fact that such dual protection is not clearly defined for technical drawings and the same can easily apply to 3D printed objects. One major difference is once again that technical drawings similarly to architectural plans contain in themselves information for human beings to construct the object according to the plan, but CAD files contain the same kind of information for a 3D printer, that creates the physical 3D printed objects without the human input.[45] Osborn highlights that the purpose of most CAD files containing 3D designs is to be used by a 3D printer and not simply for viewing in two-dimensional format.[46]

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[43] Dolinsky, *supra nota 39,* pp. 629-631.
[44] Osborn, *supra nota 41,* p 829.
[45] Dolinsky, *supra nota 39,* pp. 631-634.
[46] Osborn, *supra nota* 41, p 830.

An unlikely comparison by Dolinsky is comparing CAD files to recipes. Literary expression of necessary ingredients for a recipe is not suitable for copyright, only in the case where there is some added value in the form of presentation tips etc., it could acquire copyright protection. In the same sense computer codes need to have a form of literary expression to be suitable for copyright protection, but the underlying difference is again the fact that recipes contain information for humans and CAD files to 3D printers. Thus recipes cannot be found as suitable analogues to CAD files. [47]

The most promising analogue, which could easily be found in the relevant EU legislation, is computer program protection. Computer programs under U.S. Copyright Act are defined as "a set of statements or instructions to be used directly or indirectly in a computer program in order to bring about a certain result".[48] Osborn finds this definition perfectly compatible with CAD files and ascertains that CAD files fall under computer programs, because CAD files also "contain all the information to be used by a printer to print a three-dimensional model". It could again be arguable, whether CAD files actually contain all the necessary information for a 3D printer, but Osborn has specified, that he uses the term "CAD file" in a meaning that it incorporates all the useful information. Computer programs are most similar to CAD files out of the analogues, because computer programs are also protected two-dimensionally in the U.S., firstly the code is protected as literary work and secondly the output can be protected as audiovisual work. The dual protection approach has had criticism, because it is difficult to interpret the computer program as a literary work or an audiovisual work, as those two are also quite narrow definitions and not perfectly suitable for the computer program.[49] The problem with protecting computer programs as literary works is that the computer program usually carries a utilitarian purpose and differs from the usual literary works, such as, for example, books. Thus putting these under the same category of literary works might cause confusion. The same goes for CAD files, the special characteristics should be taken into consideration before categorising them as literary works.[50] The problem is also, that a designer normally never writes the code of the CAD program, but only uses the software to create a CAD design, which is not the equivalent of a software code written by a programmer. Some CAD programs are even simplified to the extent that the designer only picks pre-designed objects and aligns them

[47] Dolinsky, *supra nota 39,* pp 634-635.
[48] 17 U.S.C. § 101.
[49] Swanson, S. (2014). 3D PRINTING: A LESSON IN HISTORY: How to Mold the World of Copyright. *Southwestern Law Review*, *43*, p 488.
[50] Ibid, pp. 488-489.

according to his needs.[51] Thus the copyrightability of computer programs extends to the software itself rather than to the work produced via the software.[52]

Continuing on the similarity route, next category to assess will be computer-generated works, which at large have been analysed only by Dolinsky. Authorship of computer-generated works is granted to the person who created the work, not to the programmer who had programmed the code of the computer program.[53] Courts of U.S. have created some controversy on the subject matter of computer generated works, by granting copyrights over program outputs in the case of video games to the video game creators, regardless that physical players are in control of the onscreen image.[54] But CAD files are different from video game outputs in the sense, that CAD designer has an impact on the end-result even in the course of aligning pre-determined shapes, because they can still alter the dimensions of the creation.[55] When using the CAD program, two outputs are created simultaneously, the design drawing and the code component, which is the reason why CAD files differ from other computer-generated works, such as Word files.[56] There is no doubt that the design drawing is a computer-generated work and the copyrights are granted to the author, but Dolinsky poses the question, whether the code component created during the course of creating a design drawing can be treated as a computer-generated work or a program output.[57] The code component develops in connection with the design drawing and in most cases, the designer has no contact with the code, it is usually not visible for the designer and the designer does not write the code components in most cases.[58] Trying to categorise CAD files under computer-generated works will pose new questions in need of evaluation, for example the question of authorship in the code will arise, whether it is attributable to the designer or the software programmer[59]. The latter question makes the evaluation of copyrightability of CAD files under the category of computer-generated works unnecessarily complicated and thus fails to be a suitable analogue.

All of the abovementioned analogues have different issues and none of them is perfectly compatible with the CAD file, because CAD files essentially incorporate three different

[51] Osborn, *supra nota 41,* p 829.
[52] Dolinsky, *supra nota 39,* pp. 637-639.
[53] Ibid, p 639.
[54] Ibid, p 640.
[55] Ibid, p 640.
[56] Ibid, p 640.
[57] Ibid, p 641.
[58] Ibid, p 641.
[59] Ibid, p 641.

purposes. CAD files act as a technical drawing, a computer code and also serve a purpose to be utilised by the 3D printer. Many analogues put together would add up to a CAD file, but insofar as it has not been regulated specifically, it would be useful to simply define the CAD file as an independent literary or artistic work, to improve legal certainty and make interpretation for courts easier, and as 3D printing and its implications will probably result in numerous litigation, a clear definition will come in handy. The copyrightability of 3D objects could possibly be handled separately from CAD files, because in many cases the printed objects could be similar to sculptures and thus would easily fall under copyright protection. If the 3D printed object embodies a useful feature, the visual appearance of it could be protected as industrial design. There are different options of handling the aspects of 3D printing technology and this will be a complicated issue nonetheless.

1.3.2. Originality criteria

A core element of copyright is the originality of a work. The concept of originality is defined and interpreted slightly differently in common law and civil law systems and different countries in general. In the US originality is also a fundamental requirement for a work to be eligible for copyright protection and since 1991 landmark decision in *Feist Publications, Inc. v. Rural Telephone Service Co.* case, a two-step originality test has been used to determine originality and suitability for copyright.[60] The digital era inevitably changes the playground and many concepts need to be revised. The 3D printing process begins with the CAD file, which is created digitally and following the information contained in the CAD file, a physical object will be printed out by a 3D printer. Thus the originality aspect relates to a digital creation, which might need a more specific interpretation method or a new definition, because digital technologies make copying very easy. The originality issues relate more commonly to CAD files resulting from 3D scanning technologies, because the mere scanning of a product does not require any creativity.[61]

Edward Lee analyses the requirement of originality for acquiring copyright protection in the context of the digital era and the two-part *Feist* test used in the U.S. to evaluate the existence of originality. For a work to be original, it has to comply with the doctrine of originality, which was established in a US landmark *Feist* decision in the year 1991. According to *Feist* two-step test,

[60] Feist Publ'ns, Inc. v. Rural Tel. Serv. Co., 499 U.S. 340, 345 (1991).
[61] Dolinsky, *supra nota 39,* p 645.

for a work to be original, it must be (1) independently created by the author and has to be (2) created with a modicum of creativity. The threshold is said to be so low, that most of the works easily comply with the requirement for originality.[62] The issue is harder to evaluate in the digital era, where modern technologies have made copying for the masses a lot easier.[63] For that reason, Edward Lee has proposed a three-part test, which would enable courts to improve evaluating the originality of digital creations created through new technologies. The three-step test would separately look at the requirement of independency, then the creation process and lastly, the requirement of modicum creativity, he also given an insight on how the new three-part test should be applied to 3D printing technology.[64]

3D printed objects would satisfy the requirement of being independently created, if the designs used for printing were not copied from someone else's work.[65] If a CAD file is created independently from scratch, then both the CAD file and the result of 3D printing would be eligible to fulfil the requirement of independency. In case the CAD file was downloaded from, for example, Thingiverse and was originally created by someone else, then both the CAD file and end result would not satisfy the independency requirement.[66] It is important to note, that derivative works are required a different standard of originality. The original works are always subject to the low threshold of originality, but a derivative work is subject to other restrictions. For a derivative work to gain copyright protection, the changes made to the original work must be "more than trivial" and a derivative work must be limited to elements not found in the original work. Only the elements that the author of a derivative work contributed to the derivative work, which are non-trivial and original fall under copyright. [67] If a work is previously in the public domain, then for a work to reach the level of independency, changes have to be made to the design, which are "more than merely trivial" – changing the colour or size of the object would not be enough.[68] The creation part is very similar to the independence requirement and those two are likely to be satisfied cumulatively, the creation part will fail to comply with the copyright originality test, if the created object bares in itself a useful article, because copyrights do not

[62] Lee, E. (2012). Digital originality. *Vanderbilt Journal of Entertainment & Technology Law*, *14*(4), p 920-923.
[63] Ibid, pp. 920-923.
[64] Ibid, p 948.
[65] Ibid.
[66] Ibid.
[67] Spevacek, A. M. (2009). Couture Copyright: Copyright Protection Fitting for Fashion Design. *The John Marshall Review of Intellectual Property Law, 9*, p 611.
[68] Lee, *supra nota 62,* p 948.

exist for works with useful nature.[69] The modicum of creativity requirement is fulfilled, when the produced object has "creative spark" which is not so mechanical to "be expected as a matter of the course". [70]Again, if the CAD file is made from scratch, it complies with the requirement, if it is downloaded from the Internet and only minimal changes are made to the design, then the threshold of creativity likely would not be fulfilled.[71]

CAD files created on the basis of previously existing objects through 3D scanning are often compared to works of photography, more precisely to such creation that embodies photographing of copyrighted items. The originality criteria for photographs has been interpreted by U.S. courts and they are of the opinion that a photograph has to have "creative spark" and the criteria is fulfilled when the photographer has selected different aspects of the work, such as the "/../subject, posture, background, lightning /../". Dasari is of the opinion that different 3D scanners require different amounts of user input and thus some 3D scanners are also capable of requiring different creative decisions, making such 3D models possibly protectable under copyright protection. [72]

The 3D printing technology is very complicated by its nature and poses a lot of new legislative questions, which the courts need to deal with in the future. After analysing the suitability of CAD files for copyright protection it became clear that different aspects need to be evaluated in order to determine the copyrightability. A new digital originality test will enable the courts to familiarise them with the technology and help create better judgments on a case-by-case basis. It is too early to say, whether the originality test to be adopted by the courts in relation to digital creations will be the one that Edward Lee has proposed, but insofar as another test has not emerged, this one will provide useful insight to the possible application of originality test to 3D printing technology.

[69] Ibid, p 949.
[70] Ibid.
[71] Ibid, p 950.
[72] Dasari, *supra nota 28,* p 297.

1.3.3. Copyright limitations

Copyrights are designed to protect creative expression and do not encompass the protection of useful creations or ideas - other forms of IP rights, such as patents are designed to protect those. Thus copyright protection is limited to protect non-functional creations or non-functional parts of a creation. Under the U.S. copyright law the functionalities of an object are evaluated on the basis of useful article doctrine, which aims to separate works of art from works of industrial design.[73] An object is eligible for copyright only if it does not carry a utilitarian purpose, but as some objects carry both the creative expression and utilitarian aspects, it is hard to determine what is copyrighted and what not.[74] The U.S. Copyright Act defines the useful article of a pictorial, graphical or sculptural work as "an article having an intrinsic utilitarian function that is not merely to portray the appearance of the article or to convey information. An article that is normally a part of a useful article is considered a 'useful article'".[75] Though some works are categorised as useful articles, copyright may still be available for some parts of the work, in order to evaluate, whether parts of the work could be copyrightable, there is the need to conduct a separability test, for which in the U.S. there is no clarity yet, as many different tests have been used by courts in determining the separability. The diversity of tests has been criticised, because it creates a situation, where designers should attempt rather to create useless designs in order to obtain copyright protection.[76] In essence there exist two types of separability, conceptual and physical separability. By evaluating conceptual separability there is the need to determine, whether features of the design can separately be identified and for physical separability, whether the features are capable of existing on their own.[77]

With CAD files and 3D printed objects, the evaluation of usefulness can again be complicated. Some say that the CAD file is merely a digital blueprint for a 3D printer to utilize and it does not qualify as a useful article, others say that the CAD file contains all the useful information and has a utilitarian purpose to be the basis of a physical 3D object. Unlike MP3 and MP4 files, which host content that falls clearly under the scope of copyright, the situation with CAD files is not as clear, because CAD files can contain content, which in physical form is not protected by

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[73] Dolinsky, *supra nota 39,* p 609.
[74] Osborn, *supra nota 41,* pp. 832-833.
[75] 17 U.S.C § 101.
[76] Broaddus, M. C. (2009). Designers Should Strive to Create Useless Products: Using the Useful Article Doctrine to Avoid Separability Analysis. *South Texas Law Review, 51*, p 501.
[77] Ibid.

copyright.[78] CAD files also contain in them functionalities in the form of a computer code, carrying the function of sending the code to 3D printer, this makes the evaluation of CAD files falling under a "useful article" slightly complicated, as there arises the need to determine if the design part of the file is separable from the functionalities. One possible approach could be, that the CAD files are treated as bearing only the digital representation of the 3D object and no functionalities, because they serve merely as a blueprint for the 3D software to interpret. Osborn highlights, that in case CAD files are equated with architectural plans and technical drawings, then it is possible to avoid the separability test and declare CAD files as not being useful articles, because courts have already interpreted the architectural plans and technical drawings explicitly to be merely articles that "convey information" and as such do not fall under a "useful article".[79] According to Dolinsky, CAD files are different from architectural plans in the sense, that their purpose is to depict the design drawing, as well as communicate code to a 3D printer, but he highlights that the U.S. courts have found computer codes of being capable of conveying information, so this does also not propose a threat for CAD file copyrightability.[80] In addition CAD files are different from any previously existed medium and the code component is likely falling somewhere in between of computer-generated works and video game outputs and the attribution of the code to a designer will be key question in determining authorship.[81] The separability test can be performed in light of separating the design drawing from the computer code and Dolinsky finds CAD files to be both conceptually and physically separable.[82] Another possibility is to deem "virtual digital models" aka CAD files as merely portraying the appearance of an article and thus making the application of separability test not necessary.[83] Further on, the evaluation of a physical 3D printed object under the separability test will depend on the functionalities of the object, if it is something that is of a useful nature, for example such as a bottle opener or a cookie cutter, which serves a utilitarian purpose of opening bottles and carving out different shaped cookies from the cookie dough, and thus falls out the scope of copyright protection, then no protection is granted for the whole object. Only features of the object that are capable of being separately identified and existing on their own will pass the separability test and be granted copyright protection.

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[78] Twomey, *supra nota 38,* p 33.
[79] Osborn, *suora nota 41,* p 832.
[80] Dolinsky, *supra nota 39,* p 652.
[81] Ibid, p 647.
[82] Ibid, p 653.
[83] Mottley, D. G. (2014). Intellectual Property Issues in the Network Cloud: Virtual Models and Digital Three-Dimensional Printers. *Journal of Business and Technology Law, 9*, pp 160-161.

Another issue with considering CAD files to be copyrightable subject matter, is related to idea-expression dichotomy, which in the U.S. is evaluated on the basis of merger doctrine. Idea-expression dichotomy under U.S. law, derives from the Copyright Act of 1976, and in essence is the borderline between copyright and patent law, meaning that copyright protection does not extend to any idea, no matter the form it has been explained or illustrated, because copyright protection is only granted to the expression of the work.[84] The outline of the merger doctrine originates from the idea that when there exists only one possible way to express an idea, the idea and the expression are rendered to be inseparable and copyright does not bar the copying of that expression.[85] Also, when the expression becomes essential to the idea itself and they become inseparable and merge together, the expression becomes non-copyrightable.[86] The idea-expression dichotomy regarding computer software copyrights is problematic, as most of the computer code expression is incidental to the purpose of the program.[87] For courts to determine the idea-expression dichotomy in relation to CAD files, they need to evaluate on a case-by-case basis, whether the expression of a CAD drawing has merged with the idea of the functional, non-copyrightable code. Dolinsky proposes, that for best results courts will pick the most suitable analogue out of the existing ones and evaluate the merger doctrine in the context of the existing analogue or perhaps will adopt an entirely different special test for CAD files.[88]

A topic often discussed in the U.S. is the possibility of tailoring copyright protection for fashion design, which until now has been deemed to fall out of the scope of copyright, specifically for the reason that clothing items are defined as useful articles.[89] Industrial design protection is suitable for fashion design, but in the U.S. there currently is no specific regulation for it, rather industrial design is protected through copyrights, patents and trademarks.[90] Copyrights are considered to be the most suitable form of IP to protect fashion designs, as the purpose of copyrights is to protect creative works and expression, but fashion designs are not mentioned in the Copyright Act, nor have they been found suitable to fall under "pictorial, graphic or

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[84] Dolinsky, *supra nota 39,* pp 606-607.
[85] Ibid, p 607.
[86] Ibid, p 607.
[87] Ibid, p 607.
[88] Ibid, p 657.
[89] West, B. (2012). A New Look for the Fashion Industry: Redesigning Copyright Law with the Innovative Design Protection and Piracy Protection Act (IDPPPA). *The Journal of Business, Entrepreneurship & the Law*, *5*(1), 3, p 62. See also: Spevacek (2009), *supra nota* 67, pp. 610-611.
[90] Afori, O. F. (2009). Role of the Non-Functionality Requirement in Design Law, The. *Fordham Intellectual Property, Media and Entertainment Law Journal, 20*, p 849.

sculptural works". [91] Fashion design is not capable of passing the separability test in both aesthetic and functional aspects. [92] 3D designs and fashion designs might have a lot in common, as fashion design will most probably also start with the process of a designer creating the design drawing, which is further to be utilised into a physical object and these objects, mainly clothes and accessories, will be considered functional objects. Fashion industry is also already making use of the 3D printing technology, as 3D printed shoes are being showcased at Milan Design Week. [93] One main opposing argument for granting fashion designs copyright protection is the fact that copying benefits the industry.[94] Same can be said for 3D printing, as 3D designs are already widely shared among users under Creative Commons licenses and this is considered to be an incentive for creativity, as it is often possible to modify the designs and re-share them. Further on, fashion design has also been compared to architectural works in the same way as was previously done with 3D printing technology, this indicating that fashion design and 3D printing do have a lot in common. [95]

1.4. European Union approach

Under the EU approach section, the initial idea was to analyse the same categories of copyrighted works analogous to 3D printing described under the U.S. approach in the context of relevant EU regulations and case law and then continue with originality criteria. But some of the proposed categories do not have a harmonised approach among the EU member states, such as recipes, for example. Also it seems more useful to handle the legal protection of 3D printing and originality criteria of EU approach under one unified section, because EU law lacks many definitions, which under U.S. Copyright Act are specifically defined, and thus the definition is very much interrelated to evaluations of originality by the courts. Categories of copyrightable subject matter, which have gained more attention and have been harmonised are pursued, these being mainly computer programs and their functionalities and photographs, including some

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[91] Manfredi, A. (2012). Haute Copyright: Tailoring Copyright Protection to High-Profile Fashion Designs. *Cardozo Journal of International and Comparative Law*, *21*, 129.
[92] Ibid.
[93] Molitch-Hou, M. 5 Pairs of 3D Printed Shoes You'll See at Milan Design Week. Available at: http://3dprintingindustry.com/2015/04/14/5-pairs-of-3d-printed-shoes-youll-see-at-milan-design-week-2015/ (accessed: 15.04.2015).
[94] Manfredi, *supra nota 91,* p 139.
[95] Scruggs, B. (2007). Should fashion design be copyrightable. *Northwestern Journal of Technology and Intellectual Property, 6*, p 129.

considerations on architectural works. Copyright regulations in the EU are harmonised in certain aspects, thus directives should be looked at firstly under the EU approach. Copyrights in the EU, in aspects that are relevant to this thesis, are mainly covered with the directives on copyright in the Information Society[96], the directive on the legal protection of computer programs[97] and the directive on the term of protection of copyright and certain related rights.[98]

1.4.1. Legal protection of 3D printing and originality criteria

As previously mentioned, originality criteria is differently interpreted in civil and common law systems and the European law lacks a common definition of a work and originality. The latter is only defined for computer programs, databases and photographs in harmonizing directives on the protection of computer programs, on the protection of databases and on the term of protection. Mainly it was up to each Member State to decide what the threshold of originality will be, which unfortunately worked against the idea of harmonization of copyrights in the EU. For other works, the harmonization for now originates from EU case law, a landmark case *Infopaq* aims to harmonise the originality aspect. Based on current EU law, the originality is the key criterion that EU Member States need to evaluate in determining the eligibility of the content for copyright protection. For computer programs, databases and photographs the originality requirement explicitly defined is fulfilled, when the work is the "authors own intellectual creation". As the originality doctrine differs slightly in the EU countries, the wording is suitable for both Continental European approach, which historically highlights the personality of the author, and for the UK approach where originality threshold has been dependent upon the factor that the creation has to be the authors own creation, meaning the author has not copied the work, but is the originator of it. [99] The authors' intellectual creation approach is also used in the Estonian Copyright Act. [100]

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[96] Directive 2001/29/EC of the European Parliament and of the Council of 22 May 2001 on the harmonisation of certain aspects of copyright and related rights in the information society. OJ L 167/10, 22.06.2001.
[97] Directive 2009/24/EC of the European Parliament and of the Council of 23 April 2009 on the legal protection of computer programs. OJ L 111/16, 5.5.2009.
[98] Directive 2006/11/EC of the European Parliament and of the Council of 12 December 2006 on the term of protection of copyright and certain related rights. OJ L 372/12, 27.12.2006.
[99] Judge, E. F., & Gervais, D. (2009). Of Silos and Constellations: Comparing Notions of Originality in Copyright Law. *Cardozo Arts and Entertainment Law Journal, 27*, p 375.
[100] AutÕs RT I, 28.12.2011, 5, §4(2).

To start out the EU approach on the legal protection of 3D printing, one of the most promising analogues to CAD files and 3D printed objects, which was also analysed under the U.S. approach, the computer programs, will be pursued. Computer programs were the first form of work to be granted an originality criterion with a separate directive in 1991 (now amended 2009/24/EC), which aimed to harmonise the originality criterion between member states, but at the same time complicated it, because the directive only intended to define the criteria for computer programs, dividing the overall originality criteria to mean one thing for computer programs and something else for other works.[101] This lead to a situation where different types of other works listed under literary works the same way as computer programs were to be treated differently and acquiring copyright protection for other works would be more harder.[102] Some member states had to higher their originality criterion and others needed to lower theirs, in order to comply with the requirements set by the directive.[103] The term "computer program" has been somewhat defined for the purpose of the directive under the preamble and it "/../shall include programs in any form, including those which are incorporated into hardware. This term also includes preparatory design work leading to the development of a computer program provided that the nature of the preparatory work is such that a computer program can result from it at a later stage."[104] Giving computer programs a broad definition was an unambiguous decision of the EU Commission, to avoid the term becoming out-dated. In addition to the form of expression in a source code or object code, arising from TRIPS Agreement Article 10(1) the ECJ has also stated in case *Bezpečnostní Softwarová Asociace (BSA)*, that under the Software Directive any expression in any form of a computer program which permits reproduction of that program in different computer languages, such as the source code and the object code, will be protectable subject matter. [105] The determination of originality in a computer program shall be assessed without applying a test of originality to the qualitative or aesthetic merits of the program.[106]

Computer program interfaces are defined in the Software directive, as elements of the program, which provide for interconnection between elements of software and hardware.[107] CAD files could theoretically also be considered as interfaces, because it is the basis for allowing the 3D

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[101] Mylly, U. M. (2009). Harmonizing copyright rules for computer program interface protection. *University of Louisville Law Review*, *48*, p 880.
[102] Ibid.
[103] Ibid.
[104] 2009/24/EC, *supra nota 97,* recital (7).
[105] ECJ 22.12.2010, C-393/09, *Bezpečnostní softwarová asociace (BSA),* sections 33-35.
[106] 2009/24/EC, *supra nota 97,* recital (8).
[107] 2009/24/EC, *supra nota 97,* recital (10).

printer software to utilise the information in creating the 3D printed end-result. Interfaces are explicitly excluded from copyright protection under the Software Directive. The *BSA* case dealt with the protection of graphical user interface (GUI), which is a visual medium, through which a user interacts with a computer program. [108] The main question referred to the ECJ in the course of preliminary ruling proceedings, was the question of whether GUI can be protected as the expression of a computer program, which are protected as literary works. In short, the court found GUI to be unsuitable to be considered the expression of a computer program, because it does not enable to reproduce the computer program and is merely one element of the program, which enables users to communicate with the program.[109] But the court provided, such interface could enjoy protection under Infosoc Directive, if it complies with the originality requirement of being the author's own intellectual creation.[110] In the *SAS Institute Inc. v. World Programming Limited (SAS v. WPL)* [111] ECJ analysed the possibility of protecting computer program functionalities, such as programming language or file formats used to store data, within the meaning of software program. ECJ concluded that such functionalities are incapable of gaining copyright protection as an expression of a computer program.[112] In any case, as was concluded under U.S. approach, the designer of a CAD file never usually writes the code of the computer program, thus the analogy in essence might not be the most suitable. If, in theory, we would be able to protect CAD files as computer programs and the conclusion from *SAS Institute* case that functionalities of a computer program are not protectable, could be applied to CAD files in a sense that the functionalities of a CAD file would also not be protected, would it be possible to extend the term "functionalities" to the CAD interface which interacts with 3D printer or also to encompass physical 3D printed objects which entail functional aspects.[113] The analogy to computer programs is unsuitable also for the fact that computer programs exist only in the digital form, while CAD files of 3D designs are meant to be converted into physical objects and this makes the situation very complicated. Perhaps the only solution that could be made under this section, is that computer programs do not constitute a suitable analogy to 3D printing and its characteristics, at least not based on the current interpretation. The guidelines that computer programs can offer for 3D printing technology, might not arise from the certain provisions and

[108] C- 393/09, BSA, *supra nota 105,* section 41.
[109] Ibid.
[110] Ibid, section 51.
[111] ECJ 2.05.2012, C-406/10, *SAS Institute* (*SAS*).
[112] Ibid, section 46.
[113] Though functional aspects are not granted copyright protection, it is discussed in the thesis part 2.2. that a *sui generis* right could be established to protect even such 3D printed objects, which are of a useful nature.

scope of protection granted for computer programs, rather from the way in which computer programs received an early regulation. [114]

Another category pursued under the U.S. approach, which also entailed certain similarities to 3D printing technology was architectural works. The protection of architectural works derives from the BC, Article 2(1). Under EU copyright regulations an exception regarding architecture can be found under the InfoSoc directive Article 5(3), which allows for member states to provide exceptions of limiting copyright protection for different works, including for works of architecture. France, Belgium, Italy have refrained from establishing this voluntary provision and continue to protect architectural works according to national legislation.[115] The Eiffel tower in Paris, France is no longer copyrighted, it is in the public domain now, but the lighting solution of Eiffel tower was deemed to fall under copyrights, making the photographs taken of the Eiffel tower at night subject to copyright restrictions and license agreements.[116] Thus it can be concluded, that the protection of architecture can vary in EU member states and is not fully harmonised. Photographing has already been compared to scanning in this thesis, so some analogy to architectural works can be generated on the basis of photography and 3D scanning process. If CAD files scanned from physical objects were to be treated in the same manner as photographs of architectural works, it could provide member states the opportunity to regulate this subject matter similarly to architecture and for example, ban scanning of copyrightable objects.[117] This analogy is also a long shot, but it is suitable to illustrate, that the protection of architectural works do not provide a suitable analogy to 3D printing under the EU law.

The originality criteria for photographs is the "authors own intellectual creation" criteria, and by fulfilling the originality requirement, photographs in the EU are granted the term of protection for 70 years. The originality requirement regarding CAD files would be completed, if the file was created from scratch. Almost any object irrespective of whether it is protected by copyright or not can be turned into a blueprint in the form of a CAD file.[118] This can be achieved either by creating a blueprint from a copyrighted object from scratch or through 3D scanning. Similarly as

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[114] The future regulative possibilities are further discussed under the second chapter of the thesis, computer programs are mentioned in sections 2.1. and 2.2.
[115] Schlackman, S. (2014) Do Night Photos of the Eiffel Tower Violate Copyright? Available at: http://artlawjournal.com/night-photos-eiffel-tower-violate-copyright/ (accessed 15.04.2015).
[116] Newell, B. C. (2010). Freedom of Panorama: A Comparative Look at International Restrictions on Public Photography. *Creighton Law Review*, *44*, 412.
[117] See section 2.1. of the thesis to note, that banning of scanning in general can bring about undesired effects, as it would deprive users from use of technology which can offer many opportunities which are non-infringing.
[118] Swanson, *supra nota 49,* p 487.

described under U.S. originality criteria, the questions of determining originality will relate more to creations achieved through 3D scanning technology. Works of photography and applied arts have been granted a shorter minimum period of protection for 25 years in Berne Convention Article 7 (4), due to the historical reasons that many scholars have argued against the originality aspect of such works.[119] Though it has been debated, the standard of originality still is the same as for any other works. Similarly we could assume that the originality element of a CAD file that has been created via a program, which offers a small variety of pre-designed "block libraries" of shapes and objects, could be doubted, but a solution for this issue can be found from Infopaq case. [120]

The harmonisation of EU originality criteria originates from the infamous *Infopaq* case.[121] The infopaq case concerned a preliminary ruling forwarded to CJEU by a Danish court, where the main question was about the interpretation of two concepts included in the Infosoc Directive. Firstly the Danish court was seeking to find answer in relation to the interpretation of the concept of "reproduction in part", prescribed in Article 2 and whether it could be allowed to use without the authorisation of the right holder. Infopaq is a company which by "data capture process" constructs summaries of Danish newspaper articles. Danske Dagblades Forening ("DDF") is an association of daily newspaper publishers in Denmark, which functions in order to assist its members with copyright issues. Infopaq was capturing data without consent from right holders with a data capturing method, which extracts eleven words before and after a search term. The CJEU first determined what can be considered "work" in the meaning of InfoSoc Directive and concluded based on the originality criteria defined in computer programs directive and database directive that it is the same, meaning that a work is original when it is the authors own intellectual creation.[122] Words and phrases are not protectable under copyright law, but the court decided that even eleven words can be subject to copyright protection in the meaning of InfoSoc directive, when they are the expression of the intellectual creation by the author. As previously mentioned, some CAD programs are simplified to the extent that the user merely picks pre-designed objects and rearranges them according to his needs. It could be argued,

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[119] See, for example: Sherer, M. D. (1986). Copyright and Photography: The Question of Protection.*Comm. & L.*, *8*, 31. and Baade, P. L. (1996). Photographer's Rights: Case for Sufficient Originality Test in Copyright Law. *John Marshall Law Review*, *30*, 149.
[120] ECJ 16.07.2009, C-5/08, *Infopaq International*.
[121] Rosati, E. (2010). Originality in a Work, or a Work of Originality: The effects of the infopaq decision. *J. Copyright Soc'y USA*, *58*, pp 800-802
[122] C-5/08, Infopaq, *supra nota 120,* section 37.

whether such activity comprises an element of originality,[123] because services with pre-designed block libraries usually offer basic shapes for the designer to rearrange and the basic shapes are usually not protectable by copyright, similarly to words and phrases.[124] Taking into account the outcome of Infopaq case and the analogy of block shapes to words, it would be possible to conclude that even the arrangement of such block shapes might include originality. Dasari proposes that such activities of rearranging shapes and developing a 3D design might constitute originality in the same sense as a short story incorporating "common colloquial phrases and words in a story" might be original.[125]

1.4.2. Copyrights versus design rights

In the EU, there is a strong framework and regulation for industrial design protection. Copyrights and design rights are very similar to one another, as the object of protection for both is the visual appearance of a work. In the EU a great emphasis is put on highlighting the importance of design and to support that, a harmonized Community Design system is established with Council regulation 6/2002. The harmonization is carried from the idea of creating a designer-friendly environment, in which innovation, development of and investments into new products are encouraged. [126] The Community design regulation contains a specific definition of a design, meaning: "the appearance of the whole or part of a product resulting from the features of, in particular, the lines, contours, colours, shape, texture and/or materials of the product itself and/or its ornamentations".[127] According to Margoni, this definition will easily allow for both 2D and 3D products to be protected by Community design rights.[128] A product under design regulation is "any industrial or handicraft item, including inter alia parts intended to be assembled into a complex product, packaging, get-up, graphic symbols and typographic typefaces, but excluding computer programs".[129] EU design law has been criticized as being inadequate for designers, because most of the provisions support the industry sector, rather than an individual designer, because there is even no clear definition of a designer.[130] The basis for EU design law was laid

[123] Osborn, *supra nota 41,* p 829.
[124] Dasari, *supra nota 28,* p 294.
[125] Ibid.
[126] Council Regulation (EC) No 6/2002 of 12 December 2001 on Community designs, recital (7).
[127] Ibid, Article 3, (a).
[128] Margoni, T. (2013). Not for designers: on the inadequacies of EU design law and how to fix it. *Journal of Intellectual Property, Information Technology and E-Commerce Law*, 3, p 228.
[129] 6/2002/EC, *supra nota 126,* Article 3, (b).
[130] Margoni (2013), *supra nota 128,* p 236.

down in the early 1990s, when the technology did not enable designers to play an important role and industrial design was rather a playground for big industrially based enterprises,[131] nor was 3D printing technology providing simple means for designers to utilise their design from digital to physical. The requirements for a design under Community Design Regulation are novelty and individual character, many national laws, including Estonian Industrial Design regulation, incorporate the requirement that it has to be possible to create actual products following the design, either industrially or through process of handicraft.[132] It is already possible to create actual products through 3D printing technology and although the predictions about 3D printing industry do not promote the possibility that the technology would bring along the emergence of personal home factories in the near future, it could still be possible that at some point in the future the desktop printers for home use will achieve the capacity similar to industrial printers in terms of printing speed and material quality. Then it would be possible to ascertain that the requirement of industrial production is fulfilled through using 3D printing technology.

Design rights in the EU are divided into two – the Registered Community Design (RCD) and Unregistered Community Design (UCD), as the name says, the first requires a registration process prior to publishing in the OHIP registrar office and the latter does not need to be registered and exists automatically after publishing. One major difference between copyrights and design rights is the period for protection, copyrights exist automatically for a work and last for 70 years after the death of the author. The term for design protection depends on the type of design, whether it is registered or unregistered community design. Registered design period for protection is initially 5 years from the date of filing the application and the period can be renewed for one or more periods of five years for up to 25 years from the date of filing. Unregistered Community design period is a lot shorter, an unregistered design shall enjoy protection for a period of three years from the date on which the design was first made available to the public within the Community. Publishing the design in any normal course of business activity, which makes the design known to circles specialised in the sector concerned, will be sufficient, as long as the design has not been disclosed to a third person under explicit conditions or confidentially. The protection timeframes of copyright, registered and unregistered design differ quite a lot, some scholars will criticize that applying long term copyright protection to 3D designs that are capable of being utilised really fast with a 3D printer, will have a negative effect

[131] Ibid, p 226.
[132] TDKS RT I, 12.07.2014, 147, § 5 lg 1.

on follow-on creativity.[133] The design registration process is also referred to as a "deposition system", meaning that the act of registering a design does not indicate that the registered design is suitable for design protection. The evaluation of a certain design being suitable for protection will be subject to interpretation and examination by the courts in case of a dispute.[134]

In the case of copyrights and design rights, one does not exclude the other, and they can exist cumulatively for a work. Design is a key element for being successful in business and competition - it helps for the product to stand out in the variety of others. 3D printing is especially beneficial for designing new test products, as it helps to make the design from digital to physical in a matter of hours, simplifying the creation of test products and making the production process and entering to market much faster than it has been before. [135] At the same time the digital era is a stepping stone for designers, who now have to think about protecting their works more than ever, prior to publishing any of their designs and making them vulnerable for intellectual property infringements, which can be utilised into a product in a very small timeframe. Computer programs are specifically excluded from the protection of design law[136], so if CAD files are found to be similar to and treated equally with computer programs, the analogy might lead to the exclusion of CAD files from design law. 3D printing has a dual characteristic to it and CAD files can be considered as the digital representation of a 3D object through a computer program, it is definitely not a regular computer program. [137] Regardless of the exclusion from design protection, it is still possible to protect certain parts of computer programs under design regulation, for example user interface or web design, which for CAD files could end in protecting the design element and not the functional code component of the CAD file. Design law and copyright law are closely related when it comes to 3D printing, mainly for the reason that if and when the range of materials for 3D printing escalates, it will enable printing of many different utilitarian works, such as leather shoes, clothing and so on, which are generally excluded from the protection of copyrights due to their utilitarian nature and are the reason why design law was generated. In general it is possible, that the CAD files will acquire copyright protection, while 3D printed objects which are on the borderline of copyrights, but suitable for design protection, will fall under the scope of design protection. In the case of adequate design

[133] Osborn, *supra nota* 41, p 835.
[134] Afori, *supra nota 90, pp.* 870-871.
[135] Lewis, A. (2014). The Legality of 3D Printing: How Technology Is Moving Faster than the Law. *Tulane Journal of Technology and Intellectual Property*, *17*, pp. 315-316.
[136] 6/2002/EC, *supra nota 126,* Article 3 (c).
[137] Computer program analogies were analysed under U.S. and EU approach in sections 1.3.1 and 1.4.1.

regulation, it would be a clear and good solution, which would eliminate the need to expand copyright law to functional objects and would help to avoid duplicate layers of IP protection for 3D printed objects.

2. Future regulation of 3D printing

The field of 3D printing will definitely find a solution to IP problems eventually in the future, but what will the future be, is still unclear, as there are many possible routes the IP regulation can lead the industry to. In addition to designers, who desire sufficient enforcement of their copyrights for works expressed in the form of new digital mediums, there are three main actors in the industry of 3D printing, who also require a legal framework to protect them form abuse. These actors are 3D printer manufacturers, online platforms for sharing 3D designs and printing service providers, such as libraries and print shops.[138] 3D printing industry owes a great deal to the community behind it, which is at most part responsible for the rapid development of the technology, for example, the RepRap project which was licensed to the public and made 3D printing more affordable for users.[139] Due to the fact that the industry is still relatively undeveloped and only starting to become available for home use, some scholars disapprove of regulating it in an early stage, because regulation might have unforeseeable effects on the growth and innovation of the 3D printing industry.[140] The Supreme Court of U.S. has highlighted that whenever there is a need to create balance between IP protection and technical innovation, the social benefits of creativity and innovation must be treated as a priority.[141] Scholars have different approaches to the topic, some are of the opinion that 3D printing industry brings along a lot of confusion and necessity for legislative reform. Others, on the other hand believe that since the problems are so similar to music industry, which in the years has overcome the challenges through numerous litigation, the required legal framework is already in place.[142] This does not eliminate the need for regulation in the future, when the industry has reached its full capacity.

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[138] Ealey, D. (2015) How to Avoid 3D Printing a Legal Landmine. Available at: http://www.eurekamagazine.co.uk/design-engineering-features/ip-advice/how-to-avoid-3d-printing-a-legal-landmine/75838/ (accessed 15.04.2015).
[139] Bradshaw, *supra nota 3,* p 9.
[140] Finocchiaro, *supra nota* 21, pp. 489-490.
[141] Sony Corp. of Am. V. Universal Studios, Inc., 464 U.S. 417, 429-430 (1984).
[142] Twomey, *supra nota 38,* pp. 32-33.

The main possibilities, which could solve the copyright issues at whole or in part on a regulatory level, are brought out in this chapter.

2.1. Regulation under copyright law

If 3D printing regulation is incorporated under existing copyright regulations, it could be done through introducing new subject matter of 3D printing technology or through categorising and interpreting elements of 3D printing under existing categories of copyrighted subject matter. The solution for regulating and understanding 3D printing can be achieved through interpretation of the subject matter of 3D printing by the courts, but the downside of this option is that it always results in costly litigation.[143] The courts can provide clarity to the situation by interpreting the characteristics of the new technology of 3D printing under an existing category. The existing list of analogous categories of works protected by copyright, which could comprise 3D printing and its specific characteristics, may prove to be insufficient and out-dated.[144] A benefit for court interpretation is that every case is evaluated on a case-by-case basis, which helps to interpret the situation more accurately and avoids making vague generalisations, but because 3D printing is a relatively new phenomena with different complex legal aspects to it, most judges can unfortunately be incompetent to make an adequate decision on the subject matter. The disruptive nature of 3D printing technology may lead to a very strict and narrow interpretation by the courts, which could be excessively restrictive and would not comply with the views of manufacturers and users.[145] A possible concern has been expressed, that the courts could declare the CAD files and 3D printed objects to simply being a new fixed form medium, like DVDs or CDs, instead of classifying them as a new form of copyrightable work and giving them their own category.[146] If unsuitable rules are set into place, it is hard to navigate around them, thus a more beneficial way to regulate the industry for manufacturers would be to influence the process of regulation in the direction they feel would be more reasonable, which does not exclude the possibility to keep the field unregulated for an unforeseeable period of time.

Thus far, the analysis of existing copyright protected subject matter has lead to a conclusion, that there are many potential analogous categories, but none is specifically suitable for the aspects of

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[143] Swanson, *supra nota 49,* p 489.
[144] Ibid.
[145] Ibid.
[146] Ibid.

3D printing technology. Computer programs were protected as literary works, but the definition of a computer program was not very specific in order to avoid the term becoming out-dated and to allow for legal rules to follow the rapid development in technologies. The regulation of computer programs was already established prior to them becoming more widespread for home use and possibly the legal regulation played a part in the success and innovation that followed computer programs. Due to the complex nature of the whole 3D printing technology and the different steps from CAD file to the actual 3D printing process, it would be reasonable to try and regulate it more specifically, by setting up a legal framework. 3D printing regulation in the EU could be established through enforcing a new directive dedicated to protection of 3D printed objects, which encompasses both the protection of CAD files and protection of physical 3D printed objects. This would help to prevent the issue of different interpretation on member state level and would provide a framework for a unified internal market of 3D printed objects. The regulation for 3D printing should not be very restrictive and the definitions should be broad, allowing for interpretation and future development, but at the same time providing clarity and protection for designers. Although the technology is only starting to become widespread, the emerging legal issues are already somewhat defined by the scholars. At the same time practical experience with the legal aspects of the technology is lacking and new possible issues may emerge after practical experience, thus making the process of working out a suitable definition and striking a fair balance between copyright protection and development of technology hard. Because the list of literary and artistic works protected by copyright is usually non-exhaustive, allowing for other undefined works to be eligible for copyright protection, then providing a specific definition for CAD files and 3D objects is not essential, but a clear definition would improve legal certainty and provide clarity to the situation and support for courts in interpreting disputes concerning the aspects of 3D printing.

If it is decided, that 3D printing needs to be regulated and it needs to be done by expanding existing regulation, Rideout suggests possible directions to which copyright laws could be expanded. It could be either the expanded protection of CAD files or expanded protection of 3D objects in the form of *sui generis* right.[147] Copying of physical objects is simplified through 3D scanning technology, which enables the user to create CAD files containing a digital representation of a physical object in no time. Expanding control over CAD files created by scanning could be achieved through forbidding 3D scanning of objects for commercial purposes

[147] Rideout, *supra nota 40* pp 173-174.

or by criminalising the act of scanning physical objects to digital and deem it to be an unlawful format shifting. The latter would restrict people from making use of a new technology, which could also entail a lot opportunities for uses, that are non-infringing.[148] The copyright owner would then have to prove that the act of physical copying via 3D printer has taken place, because a CAD file itself is merely a representation of the object and not a copy. Excessive expanding of IP rights might lead to censorship in open-source development and the existing design platforms and could hinder future innovation in the field. The policy-making activities could be handed more to the manufacturers, but then the balance will shift for the users, who so far have been able to be involved in the development.[149]

For now, the online design sharing sites can escape liability from user infringements, by setting up a takedown-notice system under the safe-harbour provisions provided by the U.S. DMCA and in the EU under Ecommerce Directive.[150] The underlying idea is, that online hosting sites can escape liability, when they have no actual knowledge of illegal activities and provided that they react expeditiously after obtaining information of such conduct and remove or disable access to such information.[151] Provided that these conditions are met, the online hosting sites cannot be held liable. Rideout also suggests the possibility, that to improve control over CAD files, copyright could be expanded in a way of eliminating the safe-harbour provisions for online hosting sites and allowing right holders to go after the distributor of the designs.[152] This approach does not seem reasonable, as the safe-harbour provisions were put in place for a reason. It is unreasonable and impossible to expect from an online hosting site to maintain control over the activities of all the users. To improve and enable the hosting sites to have some control over the activities is exactly why safe-harbour provisions are necessary. If they were to be undermined and removed, the amount of online sharing sites for 3D designs would decrease and this could be an undesired outcome for the development of 3D printing industry.

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[148] Ibid.
[149] Santoso, S. M., & Wicker, S. B. (2014). The future of three-dimensional printing: Intellectual property or intellectual confinement? *New Media & Society*, 1-18, p 14.
[150] Directive 2003/31/EC of the European Parliament and of the Council of 8 June 2000 on certain legal aspects of information society services, in particular electornic commerce, in the Internal Market (Directive on electronic commerce). OJ L 178/1, 17.7.2000.
[151] Ibid, Article 14.
[152] Rideout, *supra nota 40,* p 173-174.

2.2. *Sui generis* right

CAD files and 3D printed objects are a unique form of expression to copyright law and do not completely comply, nor fall under any of the existing categories of copyrightable subject matter and due to their complexity pose new issues and questions about the suitability under copyright protection regarding the functionalities of CAD file and the 3D printed end result. For these reasons it has been proposed that it would be reasonable to establish a *sui generis* copyright-like protection for 3D objects. Whenever a novel technology accompanied with economic benefits emerges, policymakers need to make considerations in order to provide suitable legal framework for the new technologies to operate, because the protection of such works will have impact on the technological development.[153] In the EU, *sui generis* protection has been granted for databases with the database directive.[154] Though the originality and suitability of many databases under copyrightable subject matter is doubtful, the objectives of granting databases a *sui generis* protection under copyrights include the substantial investments required from the maker of the database in order to create the database and the fact that copyrights remain the most appropriate form of IP protection for authors of databases.[155]

So far databases, which do not qualify for traditional copyright protection are the only exception of works to be granted *sui generis* protection under EU copyright law, but it has been previously suggested by scholars, that computer programs should have also been protected with a *sui generis* right. Computer software falls somewhere in between copyright and patent rights and it has been declared that copyrights provide insufficient protection, while patent law is too restrictive for innovation and development of the technology.[156] In practice, protecting computer programs as literary works within the meaning of Berne Convention can already be seen as implementing a *sui generis* right, because the traditional copyright rules have been widened and altered to comply with the distinctive technological characteristics of computer programs.[157] Taking into account the fact that no such subject matter has previously existed in the realm of copyright protection and that it incorporates digital and physical aspects both seeking copyright

[153] Mylly, *supra nota 101,* p 880.
[154] Directive 96/9/EC of the European Parliament and of the Council of 11 March 1996 on the legal protection of databases OJ L 077 , 27.03.1996.
[155] Ibid, recital (5), (7).
[156] Toeniskoetter, S. B. (2005). Protection of software intellectual property in Europe: An alternative sui generis approach. *Intellectual Property Law Bulletin*, *10*, 76.
[157] Mylly, *supra nota 101,* p 880.

protection, the *sui generis* proposals by scholars for 3D printed objects is not an entirely unexpected line of thought.

The *sui generis* right that Rideout proposes for 3D printing technology, is to establish a copyright-like protection for even those 3D printed objects that incorporate a useful article and as previously determined, would thus fall out of the scope of copyright. Rideout generates the idea on the basis of *sui generis* right granted for vessel hulls under U.S. copyright law, which resembles to industrial design protection and applies to the appearance and utilitarian function of the vessel hull.[158] Thus he proposes that the necessary practice of protecting works with a *sui generis* right under the scope of copyright exists and it could be easily broadened to encompass 3D printed objects as well.[159] Creating a *sui generis* protection for 3D printing technology would merely constitute a method of encompassing all 3D printed objects, as such, under copyright protection. It would make it very convenient for designers, as there will be no reason for obtaining industrial design protection or trademark protection to pursue their intellectual property protection, because copyrights for 3D printed objects would exist automatically. This solution could possibly decrease destructive effects of regulation to 3D printing industry, as the protection of works can create a higher incentive for designers to create and share their designs. On the other hand it could also have a negative effect on the traditional intellectual property regulations in place, because it is capable of creating multiple layers of protection by different forms of IP, for example the end result can be simultaneously protected by copyright and design right, which can end in over protecting of works that is also unreasonable and not the purpose of setting the *sui generis* protection. Michael Weinberg expressed concerns that such *sui generis* copyright-like protection for functional objects will create a patent-like protection, without the novelty requirement and strict period of protection.[160]

The possible application of a *sui generis* protection for 3D printed objects raises some questions, for example what would be the objectives of setting *sui generis* right for 3D printed objects. Is it reasonable merely because of the fact that the technology is very complex or because no interpretation of the elements of 3D printing technology under existing categories seems suitable. For some, protecting 3D printed objects with a *sui generis* right could seem as preferring one form of expression, namely 3D printing technology, to other forms of expression. Another issue

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[158] Rideout, *supra nota 40,* p 175.
[159] Ibid.
[160] Ibid.

is, whether 3D printed objects acquire copyright protection easier than other types of works due to the *sui generis* right? For example, if one creates an original work with utilitarian purpose and 3D prints the object, he acquires copyright protection for the object regardless of the functionalities, while one creating the same kind of object without using 3D printing technology, does not. For databases, the *sui generis* right granting them copyright protection, was about creating an incentive to substantially invest in the creation of databases. Looking at 3D printing, even though the argument of investment protection seems not that suitable, perhaps ensuring designers their protection of copyrights and thus promoting the creation of 3D designs will end up creating an incentive for manufacturers to invest in developing new and improved 3D printers. But this investment is not directed to creating a work, which is copyrightable, rather an investment into the technology, so the context for the argument of investment protection is not suitable comparing to the substantial investments defined under database directive. The discussion of possible *sui generis* protection for computer programs was brought about due to lack of sufficient and suitable form of IP protection. Regarding 3D printed objects this could be the case, as for now there is a lack of suitable analogue in copyright law. But as computer programs were still protected under copyright without creating a separate *sui generis* right, it is also possible to conclude, that copyright is capable of encompassing very different type of works, including works of digital creation. The author is of the opinion that such expansion of copyright law to protect functional objects and the basic principles of copyright should initially be left untouched. The enactment of legislative changes regarding 3D printing technology should be postponed as long as possible, to allow the revolutionary technology to mature and develop.[161] In addition to hard regulation there are other opportunities to guide the industry, one possible measure to achieve a better solution for protecting 3D printed objects, is licensing under permissive licenses, such as Creative Commons licenses, which will be looked at in a separate section.

[161] Susson, M. A. (2013). Watch the World'Burn': Copyright, Micropatent and the Emergence of 3D Printing. *Micropatent and the Emergence of 3D Printing, forthcoming.* Available at: http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2253109 (accessed: 15.04.2015), p 48.

2.3. Self-regulation

A better alternative for such a novel and developing technology would be to rely on community self-regulation and continue on the path that has already proven to be effective. Leading specialists in IP and 3D printing recommend that 3D printing industry should regulate itself, rather than let others regulate it for them.[162] In addition to self-regulation there also exist self-monitoring and co-regulation, which differ in small aspects, but sometimes refer to the same thing. Self-monitoring in essence means that the state makes the rules and regulations and an industry self-monitoring system controls the compliance to the rules.[163] There is no clear definition for self-regulation, but it can be considered as an alternative to regulation by the state or as a supplement to national legislation.[164] Self-regulation across the world has emerged in different industries and on different grounds and considering that 3D printing is still in an uncertain position and at a developing stage, it is the perfect industry for self-regulation.[165] Ideally, the necessary rules are established by different parties on the market, such as industry-relevant private groups, organisations and users, as they know the industry best and are familiar with the specific characteristics, issues and needs.[166] An important element of self-regulation is that the participation of the industry-relevant groups is voluntary and they are interested of complying with the rules they set upon themselves, because they are fully responsible for monitoring compliance with the regulations.[167] Self-regulation is carried by the idea of freedom of contract and only sanctions provided by civil law apply to misconduct, no sanctions by the state can be imposed, as the state is not responsible for establishing the regulations.[168]

Regulated self-regulation, also known as co-regulation, encompasses elements of classic public authority regulation and self-regulation.[169] Government organisations will provide a legal framework for self-regulation by the self-regulatory bodies of the industry and under this form of self-regulation the state is entitled and obliged to monitor the activities and propose sanctions

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[162] Flick, C. B. (2013). Copyright and 3D Printing: Everything Old is New Again. Available at: http://3dprintingindustry.com/2013/10/02/copyright-3d-printing-everything-old-new/# (accessed 15.04.2015).
[163] Palzer, Carmen. (2003) European Provisions for the Establishment of Co-Regulation Frameworks. *Media Law & Policy*, 13 (1), p 7.
[164] Dombalagian, O. H. (2006). Self and Self-Regulation: Resolving the SRO Identity Crisis. *Brook. J. Corp. Fin. & Com. L.*, *1*, p 318.
[165] Rodriquez, S. Self-Regulation as a regulatory strategy: The Italian legal Framework. *Utrecht Law Review* 2007/3 (2), p 140.
[166] Palzer, *supra nota 163,* p 8.
[167] Ibid.
[168] Ibid.
[169] Ibid.

when necessary.[170] Co-regulation is the form of self-regulation used in the EU, where it is seen as a combination of legislative and regulatory actions with actions taken by the interest groups related to the industry, which are carried by knowledge and practical experiences of the industry specific characteristics.[171] The scope of co-regulation should be used in cases, where co-regulation: "/../ clearly adds value and serves the general interest."[172] There are two approaches to co-regulation, first is the "initial approach", which is lead by the public authority, establishing the framework of rules to be followed by the actors on the market. The second is "bottom to top" approach, for which the government takes the set of rules applied by the actors on the market and establishes them as mandatory rules for others to follow.[173] The "bottom to top" approach seems the most reasonable way for the implementation of regulations for 3D printing industry, as it would allow to take into account the industry specific characteristics and needs, before transforming them into mandatory regulations. Again, the timing of this process can be debatable, as it is not reasonable to regulate the field in an early stadium and it should be seen rather as an evolution that will peak with implementing regulations.

3D printing is largely usable for educational purposes, which means that most probably schools and libraries will take on the leading role in connecting the new revolutionary technology of 3D printing with the community of people interested in creating and learning to use the technology, for whom the prices of 3D printers remain too expensive to buy for home use. In the U.S. about 250 locations of libraries have gained access to 3D printing technology and the number is on the rise, thus creating the need to start thinking about policies.[174] Just recently the Library of the town Narva in Estonia also opened up a MakerLab with 3D printers.[175] One library in the U.S. has proposed to solve the issue of liability from 3D printing related copyright or other IP infringements by posting a legal notice above the 3D printers, warning the users to refrain from conflicting with governing IP laws.[176] It shows that libraries are also starting to timely prepare for the emerging legal challenges and possible liabilities arising from copyright and other IP infringements of the users and the best method to do that is self-regulation among library

[170] Ibid.
[171] Ibid, p 10.
[172] Ibid, p 11.
[173] Ibid, pp 10-11.
[174] Wapner, C. (2015) OITP Perspectives. Progress in the Making: 3D Printing Policy Considerations through the Library Lens, pp 1-2.
[175] Lille, M. (2015) Avatakse esimene Eesti raamatukogu innovatsioonilabor MakerLab. Available at: http://www.narva.ee/ee/calendars/view/3292 (accessed: 22.04.2015)
[176] Wapner, C. (2015) *supra nota 174,* pp. 19-20.

associations.[177] Same sort of liability question will arise for print shops that enable customers to print out 3D objects for a fee and they will also need some kind of policy to keep them safe from abuse.

At first glance, self-regulating 3D printing industry seems like the best possible solution, and first attempts of self-regulating the field are starting to emerge. The regulations could at first be in the form of industry standards, which will later evolve into mandatory rules, if and when the industry is ready. The timing of all regulative processes should be taken into consideration, as it would be unreasonable to regulate the field too early and create a restrictive environment, first a period for experimenting would be useful. In the rapid development of technologies, traditional copyrights will need a helping hand in enforcing the digital copyrights. 3D printing and the formation from digital to physical will complicate the situation even further, but so far Creative Commons licenses have been used widely and open-source licensing tools could be seen as a valuable instrument for 3D printing industry, that is capable of changing the world. CC licenses will be looked at in a separate section.

2.4. Industry standards

For 3D printing technology, an industry standard to harmonise the quality of prints would be necessary, because for now there are inconsistencies among 3D printers in terms of print quality, speed and other aspects. Industry standard are necessary for an industry, especially one that deals with complicated technology, at the same time considerations need to be made in relation to restricting the innovation of the industry in such an early stage of development. Industry standards are capable of creating confidence for both manufacturers and customers.

In the UK a report has been conducted on the policy issues of 3D printing industry and it includes an evaluation of industry standards and suggestions for policy makers, which for the purpose of this thesis are suitable to be treated as universal guidelines, which could be used and applied in the course of regulating 3D printing on the EU or U.S. level. The need for industry standards for 3D printing has been recognised, in 2013 the National Institute of Standards and Technology of U.S. already awarded grants to initiate the process of forming an industry

[177] Ibid.

standard.[178] Main goal of implementing industry wide standards is to support innovation, as well as to regulate markets and build consumer confidence.[179] In the 3D printing industry, standards could be set for 3D printers, 3D printing materials, 3D printing software and systems that convert the designs from CAD files to STL file format, which is readable for the 3D printer. To make sure history does not repeat itself, it is suggested that manufacturers should take a proactive role in pursuing to balance the IP rights of creators and users.[180] For now the printers have not been completely reliable in terms of print quality, but industry standards could require compliance with a certain level of quality and give the consumer the necessary information and confidence. Setting of industry standards can bring the industry substantial economic benefits and facilitate the growth in the mass-market for 3D printing.[181]

An industry standard could also be adopted in the form of implementing an industry-wide DRM standard. It is too early to evaluate or predict, whether such industry standards could bring along positive or negative effects for 3D printing industry. On the one hand, a set of rules as a common industry standard will make information public and easily accessible, which would simplify the creation of new printers or materials for the manufacturers. On the other hand scholars have predicted, that the compliance with high industry standards will make it hard for smaller manufacturers to even enter the market and concerns have expressed, that in case an industry-wide DRM measure, resembling the content scrambling system (CSS) which was implemented for DVDs, is introduced for 3D printing, then many 3D printer manufacturers would not be able to comply with the industry standard, would end manufacturing and it would hinder the future development of the industry. The issue for manufacturers could be, that in order to enable their printer to read the designs implemented with DRM measures, they need to pay extensive license fees, which they do not have capital for. This would remove many smaller manufacturers from the market, or stop new manufacturers from entering it. The concern is justified, as the creation of user-friendly and secure DRM-like technology will definitely be expensive.[182] DRM measures for 3D printing are more specifically described in part 2.6. of the thesis.

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[178] Maxey, K (2013) Additive Manufacturing Industry Needs Standards. Available at: http://www.engineering.com/3DPrinting/3DPrintingArticles/ArticleID/6364/Additive-Manufacturing-Industry-Needs-Standards.aspx (accessed 15.04.2015).

[179] Sissons, A., & Thompson, S. (2012). Three Dimensional Policy. *Why Britain Needs a Policy Framework for 3D Printing, The Work Foundation, Big Innovation Center, Lancaster University*, p 26.

[180] Flick, C. B. (2013). Copyright and 3D Printing: Everything Old is New Again. Available at: http://3dprintingindustry.com/2013/10/02/copyright-3d-printing-everything-old-new/# (accessed 15.04.2015).

[181] Sissons, Thompson, *supra nota 179,* p 26.

[182] Ganley, P. (2004). Digital copyright and the new creative dynamics. *International Journal of Law and Information Technology*, *12*(3), p 298.

Travis Hessman, an associate editor to IndustryWeek, specialised to examining trends in manufacturing is of the opinion that: "Giving 3-D printing companies certifiable evidence, hard numbers and proof for the quality, strength and durability of their parts, is all the industry needs to grow in the traditional market – to make the "hybrid factory" a reality."[183] This adequately sums up the need of setting industry standards for 3D printing. Still the fact that 3D printing is a potentially disruptive technology, which is in the process of developing, makes it very sensitive for early regulation even through industry standards and thus it would be reasonable to set broad standards in the beginning, leaving room for experimenting and changes.[184] It is important that the development of industry standards would not be lead by only one or two leading companies, rather it would be best to include different parties on the market, including manufacturers of printers, software developers, designers of things and customers.[185]

2.5. Creative Commons Licenses

The 3D printing industry has a strong community behind it, interested in developing the industry and sharing designs. Leading site for 3D printing designs is Thingiverse,[186] which is owned by MakerBot Industries, one of the biggest manufacturers of 3D printers. Users can upload their own creations to the site, download other free designs and there is a possibility to leave feedback about the design.[187] The feedback includes all kinds of practical suggestions by users who have already tried to print out the design. Thingiverse suggests that all designs be licensed under Creative Commons (CC) license,[188] which is especially suitable for CAD files, as they are often modified and re-shared,[189] and due to that objects on Thingiverse contain information about where they derived from and about other objects that have derived from that design, creating an "/../ ecosystem of creation, design and innovation".[190] The consistent usage of CC licenses so far can be seen as efforts made by the community to self-regulate the 3D printing industry by

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[183] Hessman, T. (2013). Setting some standards for 3-D printing. Available at: http://www.industryweek.com/blog/setting-some-standards-3-d-printing (accessed 15.04.2015).
[184] Sissons, Thompson (2012), *supra nota 179,* p 27.
[185] Ibid.
[186] Thingiverse. Available at: www.thingiverse.com (accessed: 08.04.2015).
[187] Thingiverse. http://www.thingiverse.com/about (accessed: 08.04.2015).
[188] Ibid.
[189] Santoso, S. M., Horne, B. D., & Wicker, S. B. (2014) Destroying by Creating: Exploring the Creative Destruction of 3D Printing Through Intellectual Property. Available at: http://www.truststc.org/education/reu/13/Papers/HorneB_Paper.pdf (13.09.2014).
[190] Weinberg (2013), *supra nota 1,* p 20.

promoting certain user-behaviour and trying to mould the mentality of users to the desired direction. CC licenses are a great tool for digital copyright, as faith in traditional copyrights in the era of rapidly changing technologies is starting to fade.[191] Santoso and Wicker find CC licenses to be particularly suitable for 3D printing technology, as the designs are commonly modified and re-shared. Though some fair use provisions may exist in copyright law, allowing in some cases making copies for non-commercial private use – making copies of such 3D objects protected by intellectual property rights is prohibited without a prior explicit permission from the rights holder. [192] Under US Copyright law it is the authors exclusive right to do and to authorize the preparation of derivative works. [193] EU law does not define derivative works in any of its directives and leaves the interpretation to the member states, which has lead to a lot of differences from state to state, which needs to be harmonized. [194]

CC licenses represent the "*some rights reserved*" principle of modern copyright and they enable the licensor to choose the way they want their work to be used by others. [195] Copyright owners choosing to distribute their work under CC licenses voluntarily disclaim part of the protection which would have attached under copyright law.[196] As it is debated by some scholars that strict long term of copyright is crucial to follow-on creativity, the CC licenses allow easier access to knowledge and culture for everyone.[197] CC license project started out in the early 2001 and due to the simplicity of CC licenses and their ability to provide successful means for creating, modifying and distributing of copyrighted works for free on the Internet,[198] they have become very popular and rapid increase in open sharing has lead to 882 mln licensed works under CC licenses by the year 2014.[199] All CC licenses consist of three layers, first is the legal code, second is human readable license text and third machine readable license. Commons Deed, the human

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[191] Flick, *supra nota 180.*
[192] Isbjornssund, K., & Vedeshin, A. (2013). *U.S. Patent Application 13/973,816*. p0099.
[193] 17 U.S.C. § 106 (2).
[194] Margoni, *supra nota 128,* p 26.
[195] Moilanen, J., Daly, A., Lobato, R., & Allen, D. (2015). Cultures of Sharing in 3d Printing: What Can We Learn from the Licence Choices of Thingiverse Users? *Journal of Peer Production*. Available at: http://peerproduction.net/issues/issue-6-disruption-and-the-law/peer-reviewed-articles/cultures-of-sharing-in-thingiverse-what-can-we-learn-from-the-licence-choices-of-thingiverse-users/ (accessed: 15.04.2015). See also: Creative Commons (2014) About the Licenses. Available at: http://creativecommons.org/licenses/ (accessed 15.04.2015).
[196] Goss, A. K. (2007). Codifying a Commons: Copyright, Copyleft, and the Creative Commons Project. *Chicago-Kent Law Review, 82*, pp. 964-965.
[197] Creative Commons. (2014) State of the Commons. Available at: https://stateof.creativecommons.org/?utm_campaign=2014fund&utm_source=carousel&utm_medium=web (accessed: 15.04.2015).
[198] Koscik, M., & Savelka, J. (2013). Dangers of over-Enthusiasm in Licensing under Creative Commons. *Masaryk University Journal of Law and Technology*, *7*, p 202.
[199] Creative Commons. (2014) State of the Commons, *supra nota 197*

readable version of the license text, is handy for licensors, as most of them are creative persons without any specific legal knowledge, an explanation of main principles of the license in a simple language is essential.[200] Creative Commons currently offers six types of licenses, which all contain the attribution element. Attribution is one of the reasons CC licenses have proven to be so popular - creators are willing to grant free access to their works in exchange of status rewards.[201] The six license types are: (1) Attribution (CC BY), (2) Attribution ShareAlike (CC BY-SA), (3) Attribution NoDerivs (CC BY-ND, (4) Attribution NonCommercial (CC BY-NC), (5) Attribution NonCommercial ShareAlike (CC BY NC-SA) and (6) Attribution NonCommercial NoDerivs (CC BY-NC-ND)[202]. In addition to those, Creative Commons also offers licenses for the purpose of granting works to public domain, for that CC0 license can be used, which functions on the principle of "all rights granted".[203] According to a study, Thingiverse users most commonly use the Attribution or equally Attribution ShareAlike licenses for published works, but the study also revealed that many works are left unpublished.[204] To conclude from that, users are either still experimenting with the online sharing platform or are simply afraid of publishing their works for intellectual property concerns.[205] The use of CC licenses in the 3D printing industry has not been entirely without any implications, the main incident was in 2012, when Thingiverse suddenly changed the terms and conditions for all of the users to the extent that it would allow Thingiverse to use the uploaded designs for their own commercial purposes and gain moral rights over the designs. This incident was called Occupy Thingiverse and it upset the users of the site and lead to many of them taking action in order to protect their designs by removing them from Thingiverse and uploading onto another similar sharing site called GitHub.[206]

Even though there exists a human readable version of the licenses, the process of choosing the most suitable license for a creation can still be a relatively difficult task, as the evaluation depends on the suitability for copyright protection of the work, because licenses are initially meant for content, which clearly falls under the scope of copyright,[207] but physical objects differ

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[200] Creative Commons (2014) About the Licenses. Available at: http://creativecommons.org/licenses/ (accessed 15.04.2015).
[201] Katz, Z. (2006) Pitfalls of Open Licensing: An Analysis of Creative Commons Licensing". *IDEA*, *49*, p 396.
[202] Creative Commons (2014) About the Licenses, *supra nota 200.*
[203] Ibid.
[204] Moilanen, *et al*, *supra nota 195.*
[205] Ibid.
[206] Ibid.
[207] Weinberg, M. (2015) 3 Steps For Licensing Your 3D Printed Stuff. White paper from Public Knowledge's Institute for Emerging Innovation, p 1.

from computer program codes or other literary works and photographs, which make licensing of 3D printed objects complicated. Problems may arise in situations, when the licensed 3D printed object falls under non-copyrightable objects, which are of useful nature.[208] According to Michael Weinberg, licensing of non-copyrightable objects, which may contain useful articles, has two benefits. First the usage conditions granted with licenses for non-copyrightable objects prior to any expansions or changes in copyright legislation will remain the same, regardless of how 3D printing is regulated and there is no factual downside to licensing of non-copyrightable objects under permissive licenses, as long as the licensor understands that the license does not give them control over non-copyrightable parts of the creation.[209] Secondly, the licensing of non-copyrightable objects by the licensor show their intent of including the work into an "/../ ever-expanding and evolving network of creativity".[210] Another requirement for licensing is the licensors right to license the work under a CC license.[211]

Creative Commons licenses provide a substitute copyright system to hard copyright regulation. They provide the right holder an opportunity to decide on how their designs are shared and also provide an environment for innovation and development. As was previously stated, legislators need to be careful about enforcing restrictive laws on such a novel and immature technology. For now, it could be sufficient to keep the field unregulated in relation to CAD files and 3D objects and let the community pursue on the same route, which is extensive use of CC licenses and hope for the best, that everyone inside the community will behave according to the mentality of open-sharing.

2.6. Digital rights management and 3D printing

Because 3D printing technology is making its way to home use, DRM-like services are already being developed for the industry. Though the theft of intellectual property has not yet reached its predicted volumes, many designers may feel reluctant to publish their designs online due to the fear of being subject to infringement. 3D printing industry is constantly being compared to the digitalisation of music and movies and the comparison is appropriate due to the similar nature of legal problems arising, only the underlying difference being the fact that in 3D printing the

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208 Weinberg (2013), *supra nota 1,* p 20.
209 Weinberg (2015), *supra nota 207,* p 1.
210 Ibid.
211 Ibid.

subject of digitalisation are physical things. When music and movies first started becoming more vulnerable to intellectual property infringement due to new copying tools, such as digital audio tapes, video tapes and digital file sharing, it put the industry into a totally new situation. To fight IP theft, DRM tools were introduced. By now DRM does not have a good reputation and no service in essence wants to define its purpose as a strict DRM measure. But for the sake of this analysis, the author refers to the possible "DRM-like" measures for 3D printing as "DRM" solutions. The first initiatives regarding 3D printing DRM also refer to self-regulation of the field by industry. [212]

3D printing industry has evolved on the open collaboration between users, file and information sharing and there can be no arguing that it has supported and lead the technology to where it is now. The number of 3D printing enthusiasts is on the rise and there would be no incentive for a home user to buy a printer, if they could not experiment with, for example, free design files downloaded from the Internet. People can buy 3D printed objects for a fee from Shapeways, which is a marketplace for designs, but their concept is that the company will print the item for the customer, so the customer does not see the original design file, but just gets the opportunity to order an item produced with the new and exiting technology of 3D printing.[213] Though most copyright issues have moved to the digital sphere, the traditional infringement cases will continue, thus providing a certain position for DRM technologies and the anti-circumvention provisions included in copyright laws.[214] Sharing 3D designs for free is the mentality for now, but after the technology has made a leap forward regarding materials, speed and quality, things will probably change and DRM or DRM-like services and measures might become necessary. A patented method related to 3D printing and DRM will be handled as the basis for the description of the possible functional solutions for the future to shine light on the emerging DRM-like services and the service is compared to the potential negative impacts of DRM to 3D printing brought out by scholars. Scholars have predicted that applying DRM measures to 3D printing technology will be ineffective, due to the fact that it has previously proven to have limited success. At the same time, it is acknowledged that the DRM measures have had some success in enforcing copyrights for e-books, films and music.[215] The author of this thesis proposes a contradicting argument, that DRM measures for 3D printing can prove to be effective, but the

[212] Santoso *et al*. (2014), Destroying by Creating, *supra nota 189*.
[213] www.shapeways.com
[214] Kramarsky, S. M. (2001). Copyright enforcement in the internet age: The law and technology of digital rights management. The *DePaul-LCA Journal of Art and Entertainment Law*, *11*, p 17.
[215] Santoso, Wicker (2014). The future of three-dimensional printing, *supra nota 149, pp 13-14.*

DRM measures need to be customised, taking into consideration the special characteristics of the technology and industry.

2.6.1. Legal framework of DRM

Legislation in support of DRM was first established in 1996 with the WIPO Copyright Treaty, which obliges Member States to enforce laws to forbid DRM circumvention. Following the WCT the Digital Millennium Copyright Act serves the purpose of banning the circumvention of DRM in the US. Under EU legislation the prohibitions of anti-circumvention of DRM are included in computer programs directive and in the InfoSoc directive, for harmonising the legal protection against circumvention of effective technological measures in the internal market. [216] Article 6(1) of the InfoSoc directive requires Member States to provide adequate legal protection against circumvention of any effective technological measures, which the person concerned carries out in the knowledge, or with reasonable grounds to know, that he or she is pursuing that objective.

DRM, as such, became an unappreciated term after the Napster era, but the industry is moving towards new and effective solutions such as Spotify and iTunes or Netflix streaming for music and movies. A similar streaming business model could be used to achieve secured 3D printing. Opponents of DRM are afraid that DRM lockdown will hinder innovation and creativity, because copyrights are constantly being expanded to new mediums to cover almost all forms of creative works and together with strong DRM measures, a restrictive environment is created for the customer[217]. The expansion of copyright laws and usage of DRM measures might lead to a situation where the subject matter becomes overprotected and overregulated.[218] Digitalisation of things has lead to a situation where fair use of previously unregulated content is now being regulated and restricted with strict DRM measures, providing the fair use doctrine incompatible for creations of digital technologies.[219]

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[216] 2001/29/EC, *supra nota ,* recital 47.
[217] Khan, S. M. (2008). Copyright, Data Protection, and Privacy with Digital Rights Management and Trusted Systems: Negotiating a Compromise between Proprietors and Users *Journal of Law and Policy for the Information Society*, *5*, 614.
[218] Ibid, p 604.
[219] Ibid, p 611.

Researches show that according to consumers piracy and IP theft are inevitable and have an innovation prospering and free marketing effect.[220] This is exactly the same argument brought out under the application of copyright protection to fashion design. Inconveniences accompanying the implementation of DRM measures such as limitation of downloads or in the case of 3D printing the restriction on the number of prints, might discourage the customer from legitimately buying the design or product.[221]

2.6.2. Digital Rights Management as a Service

DRM has traditionally been in the form of built-in restrictive technological measures in physical devices, delimiting access controls, restricting copying, embedding identifications into the content and also might encompass surveillance of activities.[222] DRM measures are created to monitor and control the usage of protected content by users. In addition to monitoring, the underlying idea is to grant the individual user the right to use a copyrighted work for a fee and at the same time prevent the user from making any copies of the content and from removing the content from the DRM controlled system.[223] DRM has most commonly been implemented for DVDs, CDs and e-books, to limit the use and prevent intellectual property infringement. With the emergence of cloud-based services, DRM measures are also moving from being built-into physical devices to the cloud.

Some new startup companies are already pursuing towards a novel business model and copyright protection in 3D printing technology through a cloud-based service, for example 3DPrinterOS and Authentise. 3DPrinterOS is working out a platform, which would function as a universal operating system for hundreds, or possibly all of the 3D printers on the market. 3DprinterOS service is a cloud based operating system, allowing users to upload their designs onto a secure cloud, where the owner of a design can share the design with recipients and the service enables secure streaming straight to a 3D printer. People at 3DPrinterOS are of the opinion that understandable, multifunctional software will support the development of 3D printing

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[220] Sudler, H. (2013). Effectiveness of anti-piracy technology: Finding appropriate solutions for evolving online piracy. *Business Horizons*, *56*(2), 153.
[221] Ibid.
[222] Khan, *supra nota 217,* p 604.
[223] Grimmelmann, J. (2005). Regulation by software. *Yale Law Journal*, pp 1751-1752.

industry.[224] One of the main issue for customers in using 3D printers is the complex nature of the software that accompanies it. Different printers frequently work on different software and some printers even have their own autonomous software. It is inconvenient for a user to adapt to a new software and as they can be quite complicated, then for people who possibly need to work with many different printers, a universal system is more convenient. What adds further universality to 3DPrinterOS, is the fact that it works with Windows, Mac, Linux and Raspberry PI, covering all of the major operating systems on the market.[225] The integration of different printers onto one software is comparable to what Microsoft did with the personal computers 30 years ago by creating a universal operating system. [226] 3DPrinterOS is the first of its kind on the market and many 3D printer manufacturers have already teamed up with them by sending their 3D printers for integration with the 3DPrinterOS service platform. The list of integrated printers currently includes many of the most popular models from biggest manufacturers on the market, for example, different models of MakerBot, Ultimaker, RepRap, BEETHEFIRST, WanHao, Xplorer, etc. [227] 3DPrinterOS has not yet introduced a DRM-like service, but the existence of secure streaming of a 3D design to a 3D printer will make integrating a DRM platform very easy.

What relates to copyright protection more, is a startup called Authentise, which aims to accomplish intellectual property protection through a DRM-like service. Authentise is a California based startup, also thinking ahead of its time and trying to offer DRM for CAD files, which act as blueprints for 3D printer to utilise. Their emphasis is solely on the protection of IP rights. Following the example of music and movie industry, Authentise is aiming for a solution, which also incorporates data streaming straight to 3D printer. The client or downloader would not acquire the CAD file, meaning that there is no option of downloading the file or even the opportunity to see the file. The file data will be sent directly to the printer and kept secure. They offer a pay-per-print system, according to the number of prints predetermined by the designer. The default choice will remain one print per one purchase. If a printer fails, then it is possible for a client to reinitiate the print if the printer failed before 90% was completed. [228] The streaming model is offered under the business model of software as a service. The future of this solution

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[224] Sevenson, B. 3DPrinterOS, One Secure 3D Printer Operating System to Rule Them All. Available at: http://3dprint.com/6479/3dprinteros/ (accessed: 05.03.2015).
[225] Biggs, J (2014). Engineers Build a 3D Printing OS for All Printers Everywhere. Available at: http://techcrunch.com/2014/08/22/engineers-build-a-3d-printing-os-for-all-printers-everywhere/ (accessed: 10.03.2015),
[226] Sevenson, *supra nota 224.*
[227] 3DPrinterOS. Supported printers. Available at: http://www.3dprinteros.com/tools/supported-printers/ (accessed: 10.03.2015).
[228] Authentise. API Integration. Available at: http://authentise.com/api (accessed: 01.03.2015).

will probably lead to being transformed into a storefront similar to iTunes or Spotify for physibles, where people can buy designs. Obviously it will not make piracy impossible. If someone wants to perform an IP theft and has necessary skills, he probably can succeed, but the underlying idea is to show people that it is possible to behave in accordance with the law and a platform for buying designs offers easy access to designs, which are predicted to be not that expensive. [229] Another possible way to provide DRM to 3D models is to secretly include watermarks to 3D objects, which would make it possible to track down the copyright owner. Watermarks could be used to acquire a deterrent effect, insofar as some IP thieves would fail to act in fear of getting caught. [230]

2.6.3. Future solutions of DRM

The patented method taken as an example is possibly ahead of its time, because the consumer 3D printing is only starting to become widespread, as the printers are getting cheaper and more reachable and may soon become as widespread as 2D printers. The emerging issues relating to IP rights are similar to 2D printing, but may be even more severe with 3D printers. With 2D printers the main issue is breach of copyright, but 3D objects are capable of infringing more IP forms than only copyrights - including industrial design, 3D trademarks and patents, which have not been dealt with in this thesis, because the emphasis is on copyrights. [231]

The first thing essential for a 3D printing DRM-like service is the existence of a databank of objects, which would allow rights holders to make their copyrightable materials available for 3D printing against payment or for free. Right holders would get to choose the settings and license choices prior to publishing their designs. The system might incorporate a source of 3D objects, either in the form of: "/../ an online shop for 3D models, an online databank of 3D objects, 3D modelling service or other online services, or simply 3D scanning device."[232] The method for DRM and 3D printing should include a restricted rights database, which could determine whether a mechanical reproduction of a 3D object, or of at least one part of the said 3D object, is

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[229] Hillen, B (2013). Authentise startup protects 3D printer blueprints by streaming data. Available at: http://www.slashgear.com/authentise-startup-protects-3d-printer-blueprints-by-streaming-data-28295306/ (accessed: 03.03.2015).

[230] Fabbaloo. Authentise: 3D printing IP protection rises. Available at: http://www.engineering.com/3DPrinting/3DPrintingArticles/ArticleID/7312/Authentise-3D-Printing-IP-Protection-Rises.aspx (accessed: 03.03.2015).

[231] Isbjornssund, Vedeshin, *supra nota 192,* p0005.

[232] Ibid*,* p0019.

restricted by law or by rights of third person.[233] The restricted rights database is meant to incorporate a 3D intellectual property rights database, but might also include a list of objects restricted by other laws than copyright law, such as weapons, firearms or their parts, explosives etc.[234] As there have been many considerations about 3D printed guns and how the 3D printing technology will make it very easy to gain access to guns, this is a very smart solution.[235] Another application suitable and necessary for a DRM solution dealing with 3D printers would be a 3D objects similarity check module. The module would check the 3D object prior to printing and determine, whether "at least a portion" of the 3D object matches any of the objects listed in the restricted rights database.[236] If at least the portion of the object matches an existing object the restricted rights, the printer will prevent from printing the object, thus making copyright infringement harder and more inconvenient. If the object does not match the restricted rights database objects, it is possible to print it out without further complications.[237] The scanning of the object to detect shapes and parts of weapons and illegal objects and further on restricting the possibility to print them is also a DRM-like measure, but can be considered a less restrictive approach of DRM, as the purpose of declining print is conditional to the object being illegal under other regulations, than copyright law.[238] This detection process is comparable to currency detector system incorporated into Xerox copying machines, which includes many different pre-selected monetary note patterns and which is capable of detecting currency and in order to prevent currency counterfeiting, does not allow to photocopy them.[239]

The users own online creation relates to the situation, when the user creates a CAD file either trough computer program or by modifying an existing model or alternatively by using a 3D scanner and at the same time having both computer and 3D printer connected to the Internet. In this case there are two possible ways for similarity check, either through an online database or via the locally installed hardware. If the object turns back a match after the similarity check from the restricted rights database, the printer will either prevent printing, if it is an object restricted by law, such as guns or will offer a license, if such opportunity exists. If the user rejects the license, then printing process will not take place. If the object is without restrictions, printing will

[233] Ibid, p0010.
[234] Ibid, p0011.
[235] See, for example, Simon, M. (2013). When Copyright Can Kill: How 3D Printers Are Breaking the Barriers Between "Intellectual" Property and the Physical World. In *Pace Intellectual Property, Sports & Entertainment Law Forum* (Vol. 3, No. 1, p. 60).
[236] Isbjornssund, Vedeshin, *supra nota 192,* p0019-p0022.
[237] Ibid, p0019-p0022.
[238] Sissons, Thompson, *supra nota 181,* p 26.
[239] Fan, Z. (1996). *U.S. Patent No. 5,533,144*. Washington, DC: U.S. Patent and Trademark Office.

continue without restrictions. [240] The users own offline creation relates to the situation when the user is not connected to the Internet and creates the CAD model himself either with a computer program, by modifying an existing model or via scanning. For an offline creation to be similarity checked, a local database should be installed on the 3D printer, which stores a database of restricted designs and objects. Only objects not restricted by the database will be allowed to print. If an object has a match in the database, the printer will decline printing until it has been connected to the Internet and after network connection is established, the system will provide an opportunity for the user to purchase a license for the object, if there is one available online. For offline printing a maximum time limit or print limit could be established, after which the printer would not allow printing before it has been reconnected to Internet and updated. [241] The vast majority of people who could have access to 3D technology will most probably have access to the Internet as well, so this use case is unlikely, but in some cases possible, for example when network is down.

For a rights holder, the usage of the platform will start by opening an account and registering the designs through different authentication processes. As one embodiment, the rights holder could open up a storefront for his designs inside the service for visiting customers. The next step for a user would be to determine the parts or whole of the 3D model for which copying shall be limited. The protection level can be chosen according to the needs of the rights holder and it can either be free of charge or for a license fee. After uploading the design, the service will categorize the design based on the distinctive features of it, and stores the collected data to a restricted rights database. The system automatically determines the eligibility of a design for copyright protection by filtering out elements that are not copyrightable, such as basic shapes and forms. To evaluate the uploaded 3D object, users can give feedback to the design in terms of its quality or printability. The 3D printing community so far has functioned essentially on the open source principle and community spirit. Since the amount of enthusiasts has not been very high, feedback about the experience with a particular design is valuable to others. Printers have different characteristics, which can determine the end result and as experimenting can be time consuming and bothersome, it will be useful to know the personal experiences of other users prior to the printing process. Complaints about the originality of the elements of a design could also be confronted under the feedback tool. As a result of the feedback process, in case the

[240] Isbjornssund, Vedeshin, *supra nota 192,* p0092-p0100.
[241] Ibid, p0085-p0090.

feedback to the design is negative, the unsuitable designs will be eliminated from the database.[242] To create an incentive for designers to upload their designs it is essential that the service provider intends to safeguard the designs. A bad example was the Occupy Thingiverse incident in 2012, which already was previously described.[243] According to the terms and conditions of, for example, 3DPrinterOS, the user retains the ownership of the files and intellectual property and the terms do not grant any rights to the service provider. 3DprinterOS also excludes themselves from any liability, including from responsibility for the functionality, printability, quality, accuracy or legality of the files. [244]

For a customer from a third-party shopping site, there is also a registration process, which will be subject to the third-party service terms and conditions. If third-party service is integrated to the system of future DRM-like service, it will be done through network, using application programming interfaces. Under this option the concept of authorisation through 3D printer ID is brought up. The service can detect a printer ID code, if one exists, if there is no ID, the service will provide a unique ID to the 3D printer, which can be used as an additional method of verifying the existence of authorisation to reproduce objects using the particular 3D printer. [245] The customer will choose a 3D object for printing and depending on what model the third-party service uses, the customer is either allowed to download the file or not. If it is allowed, then customer can pay and then download the entire model to a local computer or device and if the object has passed the comparison check and is not included in the restricted rights database, the printing process can proceed automatically. If the object finds a match from the database, it might offer a license to the customer. [246] If streaming method is used, then the 3D model is streamed securely to the 3D printer and it also goes through a comparison check. During streaming the printing process is being monitored. On the example of 3DPrinterOS it is possible to describe how the process monitoring is conducted. 3DPirnterOS currently monitors Internet speed during the printing process and also suggests to attach a camera onto the 3D printer, so it would be possible to get live coverage of the process or playback afterwards. Monitoring of Internet speed is necessary because it enables to control, whether Internet speed at the time of printing was sufficient for successful streaming and printing and eliminates any false claims by

[242] Ibid, p0057-p0066.
[243] See page
[244] 3DPrinterOS. Terms and Conditions. Your Files and Privacy. Available at: http://www.3dprinteros.com/terms-of-use/ (accessed at 16.02.2015).
[245] Isbjornssund, Vedeshin, *supra nota 192,* p0068-p0083.
[246] Ibid, p0078-p0081.

users trying to avoid the pay-per-print restriction to one print. So the whole process is being monitored precisely and recorded to ensure the success of the 3D project. The elements of a future DRM service seem to be reasonable and capable of providing efficient protection of copyrights. In addition to copyrights the similarity check module also enables to detect illegal objects and prevent users from 3D printing such items.

2.6.4. Legal issues related to DRM and 3D printing

DRM methods have proven to be ineffective in the past and many scholars have expressed concerns about applying and enforcing DRM measures in general, but it is also discussed, which effects the DRM technology could have to 3D printing industry. As potential negative effects that DRM measures can pose to the development of 3D printing technology it is brought out that DRM measures will deprive users from choice. For DRM to be successful, the specific measures need to be integrated at all levels which are part of the process of receiving the end result – CAD files, 3D printers, 3D scanners and the final physical 3D object. This version of extensive DRM to all devices and files may be very expensive and decelerate the development of the industry. [247] The main aspects in which the user will be deprived from choice are considered to be decreased choice of 3D printers on the market; decreased choice of designs and objects to make for the users; unintended problems arising alongside the introduction of DRM measures. These issues will be compared to the possible future DRM solution, in order to determine, whether the solution is capable of solving any of these issues or manages to overcome the issues.

The feared effects of implementing an industry wide DRM solution were briefly considered in an earlier part of the thesis in relation to the decrease of printer manufacturers due to a strict industry standard and extensive licensing fees to enter the market. The concern is justified, as the creation of user-friendly and secure DRM-like technology will definitely be expensive,[248] but to relieve that concern, one argument is that many manufacturers are interested in, for example, the 3DPrinterOS universal cloud-based operating system and have already allowed the integration of their printers into it. Given that a cloud-based DRM solution would eliminate the costly implementation of physical DRM systems into printers, it could also save a lot of money and yet provide an effective solution. 3DPrinterOS platform could become the universal software for all

[247] Santoso, Wicker (2014), *supra nota 149, p 13.*
[248] Ganley (2004), *supra nota 182,* p 298.

printers and in the future some or many manufacturers could choose the platform as their main software and stop wasting time and money on developing their own individual software, which would again differ from the software designed for other printers and cause inconveniencies for the users. The user-friendly and printer neutral nature of the 3DPrinterOS software for the users is a key argument for manufacturers in deciding to co-operate with 3DPrinterOS. Perhaps the introduction of a new and universal platform for 3D printing could even higher the incentive to create new printers, since there already exists a functioning software, which is familiar to the users. Though this kind of monopoly over printers could create competition law issues, these will be left untouched in this thesis.

Another feared effect is, that users will have a more narrow choice of free designs and objects to make, when DRM measures are implemented. The 3D printing industry has developed on the open source principle for long, and it has had benefits to the users. But there will come a time, when 3D printing will move on from the incubation stadium, the printers will become more dependable and the quality and speed of print will get better. The need for a supportive open source community will slowly fade away and new business models will prevail. Firstly the author is of the opinion, that if a DRM-like service such as 3DPrinterOS is introduced, it does not necessarily mean that the free online sharing sites will become extinct. Maybe in the long run, but not immediately, as sharing of designs has become the mentality among 3D printing community. The positive effect of a service including a restricted rights database of designs is to show that it is possible to buy good quality designs without breaching copyright. For designers the certainty, that there is a secure environment for their design, where it will be kept safe and they get fair remuneration in return for the creative work they have done, will create a higher incentive for designing and publishing new, innovative and good quality 3D designs. The users will have a choice, on the one hand to print free designs, from which the end result may turn out satisfactory, but there is no guarantee that the design is not infringing copyrights and to pursue printing with the custom software used for their printer type. On the other hand, many users will possibly choose to pay for designs for which there is a guarantee that the design is of good quality.

The issue of unintended problems, related to DRM measures, has repeatedly occurred with previous attempts in setting up a new DRM measure. The example that Santoso and Wicker have built their concern on, is a situation when Sony produced a copy preventing scheme on compact disks (CDs), which posed a risk on the users computers falling under attack by viruses and the

system also sent data about users behaviour back to Sony.[249] What is really important behind this example, is that the DRM measures were in the form of a software and installed secretly without informing the user or asking consent, the details of introducing such a DRM measure were not discussed publicly. The Sony code had modified Windows in a way that it was impossible to tell that the DRM system even existed and the rootkit also made the computers vulnerable for hackers and virus attacks. [250] This undoubtedly shines negative light on DRM measures, but the technology has advanced over the period of time and the user consent is a prerequisite for installing any program. Surely, the security of a program or software is essential and no such security gaps should be left in, but in the cyber sphere users are constantly facing different threats of security and if one wants to completely avoid them, one should stay offline.

For these concerns some solutions already exist, that could ensure both the user and the service provider the success of the printing process. For example, 3DPrinterOS suggests all customers to install a camera above the printer platform and connect it to the computer, so that live coverage and playbacks are possible to see, when and why did the printing process fail. If the failure is not evoked due to the behaviour of the user, then another attempt for print should be given. To eliminate the possible concern, that the speed of Internet connection was not sufficient, 3DPrinterOS also measures the Internet speed during the printing process. Also, the same concern could be eliminated by first buffering the whole object to the printer and then printing it out. [251]

As the main conclusion of this chapter it should be noted that a platform integrating different printers and operating systems and acting as a universal operating system to make printing easier, which also embodies the aim of copyright protection could possibly be an effective solution to help enforcing the copyrights of the designers. Looking at the predicted issues that could relate to 3D printing and DRM, some of them have justified grounds, but the possible future technological solution could in most part overcome the issues and provide a more secure environment for both the designers and customers of the service. Lessons from previous DRM services and their downfalls need to be taken into account and as success is already following the

[249] Santoso, Wicker (2014) *supra nota 149,* p 13.
[250] Shneier, B. (2005) Sony's DRM Rootkit: The Real Story. Available at: https://www.schneier.com/blog/archives/2005/11/sonys_drm_rootk.html (accessed: 05.03.2015).
[251] Isbjornssund, Vedeshin, *supra nota 192,* p0099.

business model of Spotify and iTunes, it encourages the streaming model to be applied to 3D printing technology as well.

Conclusion

3D printing is without a doubt a potentially disruptive technology, which is capable of enabling the copying of physibles. It is a complex technology becoming more widespread for home use, as prices for desktop printers have been decreasing after the patents on the technology have ended. 3D printing poses different threats to traditional intellectual property regulations, which were drafted long before mass copying of physibles was possible. 3D printing has two main characteristics, which make the intellectual property issues complicated. First the 3D design, which is created in the form of a CAD file, that is a digital representation of the 3D object and conveys information for the 3D printer to utilise. Second phase consists of 3D printer interpreting the information included in a CAD file and layer-by-layer printing out the physical object. The intellectual property rights in those two creations can be different and it could be hard for copyright to encompass the entire 3D printing process. Firstly, an overview of existing legislation in the context of 3D printing and copyrights was given in the first chapter.

The most important international copyright treaties were analysed in the first chapter. BC being the oldest copyright treaty, gives the list of protected works, which include different forms of work relative to topography, geography, architecture and science. Even three-dimensional works are explicitly mentioned, but since BC was last revised in 1971 and last amended in 1979 and a patent for 3D printing technology was granted in 1977, it is safe to say that this definition of a three-dimensional work does not indicate for it to be applied specifically to 3D printed objects. Architects can make use of 3D printing technology and the creation process of an architectural drawing and a digital 3D design can be made in the same CAD program, also enabling architects to print out the physical architectural model. This makes it possible to ascertain, that in case creations of 3D printing relate to architecture, they can be protected by copyright under BC. WCT and TRIPS were both enacted with the purpose of granting computer programs copyright protection within the meaning of BC. The technological developments in the domain of computer software were seen as possibly having enormous economic benefits and thus explicit protection was deemed necessary to encourage further innovation. Computer programs are often

considered to be the best possible category of analogous works to 3D printing and they were more precisely analysed under sections of U.S. and EU approach.
The topic of 3D printing has been dealt with more extensively under the U.S. copyright legislation and thus scholars have conducted an understanding of categories, which could be analogous to 3D printing. Though there have been legal researches, there is no clear understanding as to what poses a harder question for being suitable to copyright protection, the CAD files or physical 3D printed objects. Scholarly opinions have divided roughly into two, some considering the protection of CAD files posing the main difficulties in acquiring copyright protection and others giving same considerations to 3D printed objects. The author of the thesis is of the opinion that such contradiction in opinions might have emerged due to insufficient understanding of the technology. 3D printing is very complex and the dual characteristic combining both digital and physical aspects will make the copyrightability issue undoubtedly problematic.

The analogous categories suggested by scholars include architectural plans and blueprints. A similar aspect to 3D printing is, that both processes will begin with a drawing, for architecture it could be either digital or physical, and the drawings will be utilised into a physical object. For architecture, the copyright protection encompasses both architectural plans and extends to the building. The main difference from 3D printing derives from the timeframe of utilisation, which can vary in years and the fact that architectural plans contain information for humans, while CAD files contain information for a 3D printer to utilise and this has been considered an underlying difference that makes the comparison unsuitable. In the EU the protection of architectural works is not completely harmonised, allowing for member states to protect architectural works according to national legislation and does not provide a uniform solution or analogy for 3D printing. Under U.S. approach “other technical drawings” were granted an exception under copyrights, regardless of the fact that they are not traditionally considered to be creative, because they convey information about a functional item. The copyright protection for technical drawings is different from architectural plans and blueprints, because the copyright protection applies only for the technical drawings. Equating technical drawings to CAD files might be an undesirable form of protection to right holders, because they would like to acquire copyrights for both CAD file and 3D printed object. The reason this analogue was deemed unsuitable is also due to the aspect that technical drawings convey information for a person and CAD files to 3d printers.

Computer programs were at first considered to be the most promising analogue to 3D printing, because the format was also digital, as is for CAD files. In the U.S. it is possible to protect the computer program with a dual-protection, by protecting the code as literary work and the outputs as audio-visual work. The two-dimensional protection gives hope, that it could be applied to 3D printing technology to encompass CAD files and 3D printed objects. The analogy soon lead to an understanding that they are not perfectly compatible, because when equating CAD files to computer programs, CAD files would also be protected as literary works, but since CAD files are not computer programs in the traditional sense, meaning that the author of a CAD file never usually writes nor even sees the code component of the program, the analogy is inadequate. Under EU copyrights the computer programs also do not provide any clarity in terms of being a suitable analogue to 3D printing, rather the comparison will be accompanied with more confusion. Turning from the conclusion of computer programs being an incompatible analogue, computer-generated works were assessed. Authorship of computer generated works is granted to the person who created the work and not to the programmer, but this analogy might also have a downfall as it arises new question, whether the code component created in the course of creating a CAD file is contributable to the programmer or to the author of the computer-generated works. This question can be as hard to evaluate, as is the copyrightability question of CAD files, thus there is no use of adopting the analogy to computer-generated works. Though many analyses for finding analogous subject matter to 3D printing technology have been conducted, the underlying conclusion remains, that many categories are somewhat similar to 3D printing characteristics, but there is no perfectly compatible analogue. In the

A key element for a work to gain copyright protection is the originality requirement, which in the U.S. derives from the Feist case. To determine originality in a work a two-step test needs to be conducted. The current two-step test requires from a work to be independently created and to be created with a modicum of creativity. As the test may not be sufficient to analyse originality in digital creations, Edward Lee has proposed a modification to the two-step test by adding a third element of looking at the “creation process”. For 3D printing it would mean, that the creation process to be analysed would be the creation process of a CAD file, which can either be created from scratch, by modifying an existing design or by scanning, thus the creation process helps to evaluate originality through determining the creation process. Though it is not certain yet, whether courts will adopt a new test to determine originality in digital creations, this three-step test can prove to be of help to the courts. In the EU originality has been clearly defined for computer programs, databases and photographs and recently harmonised for other types of works

with the Infopaq case and the originality criteria for the work is that it has to be "author's own intellectual creation". Naturally the questions of originality will most commonly arise in the context of 3D scanning, which could be compared to photographing copyrighted objects.

The idea of copyright is that no useful features of a work are protectable by copyright. Under U.S. Copyright Act useful articles are clearly excluded from the scope of copyright protection and a separability test is in place to evaluate the physical and conceptual separability of design features from the utilitarian aspects. This is also U.S. version of industrial design protection. CAD files usually host content, which may fall out of the scope of copyright protection and CAD files also contain a code component, which carries the function of sending the design to a 3D printer and may create the question of whether the design part of the file is separable from the functionalities. Scholars have concluded that if CAD files were to be treated as architectural plans or technical drawings, they would be able to undergo the separability test. Dolinsky is of the opinion that regardless of how CAD files are regulated, they are still capable of being physically and conceptually separable. In the EU no such thing as a "useful article" is defined, but an effective framework for industrial design protection is established, allowing for the appearance of functional objects to be protected under registered or unregistered community design. Under U.S. approach the usefulness of a CAD file was analysed, but under EU this is not the question. Industrial design protection rather applies for 3D printed objects, which could require design protection, while CAD files could fall under copyright protection.

As the main conclusion it could be said, that though many categories of copyrightable subject matter might be analogous and in some aspects seem to be sufficient, in reality none of the existing categories are completely suitable for encompassing the entire process of 3D printing. Only thing that could be obtained from generating such analogies are the methods of how different subject matters have been regulated. Because of that the second chapter focused on different measures, which could be applied to achieve the regulative solution for 3D printing. It has been proposed a lot, that regulation for 3D printing could be achieved through expanding copyright laws either to CAD files or 3D objects. In case of expanded copyright protection for CAD files, one option would be to prevent the act of scanning in order to gain better control over CAD files. This would not be a suitable option, because it would deprive users from benefits of a technology that also entails non-infringing uses. Another measure would be to eliminate safe-harbour provisions that have been established to protect hosting sites, but this is also not a reasonable choice. Another possibility is to allow for courts to interpret the emerging issues on a

case-by-case basis, but this can lead to a restrictive interpretation by the courts and as the technology is complex and immature, the judges may provide incompetent decisions.

In case of expanded copyright protection for 3D printing it has been suggested that it should be done in the form of a *sui generis* right. Previously the idea of establishing a *sui generis* right has emerged in case of new technologies or in case a subject matter falls somewhere in between two or more forms of intellectual property protection. In the EU, *sui generis* right has been established for databases, which are not creative in the traditional sense, but have required substantial investment from the maker of the database. Another aspect of establishing a *sui generis* right is that copyrights have remained the most suitable form of IP for databases. Protecting computer programs under copyright law has often considered to be a mistake and it has been suggested by scholars, that computer programs should have been protected with a *sui generis* right instead. At the same time, the fact that computer programs were protected by copyright shows that copyrights are capable of encompassing different types of work and the practice indicates to an informal *sui generis* right. A *sui generis* right for 3D printing technology is suggested to be a copyright-like protection for 3D printed objects, even to those, which are of a useful nature. The author analysed the possible objectifications of granting 3D printed objects the *sui generis* right. Firstly, it could merely constitute a convenient method of encompassing the 3D printing technology under copyright protection, but on the other hand, it could entail questions of whether results in unfair treatment of forms of expression, by preferring 3D printing to other forms of expression and granting copyrights more easily for works created by 3D printing. Secondly, a similar argument of substantial investments related to databases would not be suitable under 3D printing *sui generis* right. The author is of the opinion that such expansion of copyright law might be unreasonable and the basic principles of copyright could initially be left untouched and rather the use of other regulative measures, such as self-regulation would be more beneficial.

Self-regulating by the industry specific interest groups could be seen as the best form of regulation for 3D printing. In addition to right holders there are 3D printer manufacturers, online sharing platforms and print shops or libraries, which are also in need of IP policies. As the technology is still developing an unfamiliar to many, including to legislators, it would be best to leave policy-making activities in the hands of those who know the industry. The industry-relevant private groups need to participate voluntarily in the process of self-regulation. First attempts to self regulate the possible emerging issues are already been concluded, for example in

the U.S. by libraries, which will probably facilitate as the connectors of interested people and novel 3D printing technology. Another form of self-regulation that could be used to achieve some certainty in the industry is the setting of industry standards. For 3D printing industry standards can be established for 3D printers, printing materials and to software and systems. The standards should be broad, leaving room for experiment and developments.

A useful tool for digital copyright is open licensing, which for 3D printing is being used in the form of CC licenses. Thingiverse and other platforms suggest all works be licensed under CC licenses, which are suitable for 3D designs, because they are often modified and re-shared. An important benefit of CC licenses is that they are very easily understandable for everyone without requiring any legal knowledge. Applying strict copyright terms on 3D designs is unappreciated among scholars, as they are of the opinion that it would be crucial to follow-on creativity, which is very important for 3D printing technology. It should be noted that licensing under CC licenses does not grant the copyright owner the right to control objects, which are non-copyrightable. Licensing of non-copyrightable objects is fine, as long as the licensor understands what they are licensing and it is also without implications to further regulation of copyrights for 3D printing, because the usage conditions granted with the license will remain the same regardless of which regulations will be applied. The act of licensing is beneficial because it indicates the right holders' intent to allow use of their work in turn of attribution. Major legal issues of 3D printing have been avoided so far and perhaps the continuous use of CC licenses plays a part in that. The promotion of using CC licenses can also be seen as efforts to self-regulate the industry to mould the mentality of users in a certain direction. In an ideal world, CC licenses would suffice for 3D printing copyright, but unfortunately there is always someone who does not want to behave according to custom.

For digitised content, such as music and movies, DRM measures have been introduced to fight IP infringements in the digital sphere. Strict DRM measures have previously proven to have limited success, until new business models, such as Netflix and iTunes were introduced. The idea of DRM is to monitor and control the use of content by the users and to restrict them from making copies of it. At first, DRM tools were built-in to hardware, but now the emergence of cloud-based services leads the first initiatives of 3D printing DRM to the cloud. The author introduced the existing initiatives opted to provide a DRM-like service for 3D printing and described future solutions of DRM for 3D printing. The future solution should encompass elements of restricted rights database and similarity check module, which will enable to detect

objects, which are protected by someone's copyrights or objects, which are restricted by other laws, such as guns. There are possible scenarios of online and offline use and scenarios of use by different parties. All of these elements indicate the possibility of providing 3D printing an adequate and effective DRM solution as a service.

The hypothesis of this thesis was that the existing measures for enforcing copyright protection needs to be reviewed in order to comply with the complex nature of 3D printing technology. Based on an analysis of existing copyright regulation in relation to 3D printing a conclusion can be made, that the existing copyright regulations are not capable of encompassing the entire process of 3D printing. Some analogies are compatible at parts, but none is fully suitable and it could even be possible that CAD files can be protected under copyrights and the physical 3D printed objects under design rights. In terms of existing regulation, it definitely needs to be reviewed, before introducing the subject matter of 3D printing under copyright regulation. Because no such subject matter has been regulated before, the different alternatives also need to be carefully considered and reviewed, the possible outcomes of implementing regulative measures should be evaluated, to achieve an efficient regulative solution for 3D printing. Perhaps to refrain from interfering with the innovation and technological development, the industry should rather be left unregulated for as long as possible, to allow for it to mature and develop. Applying strict DRM and copyright protection cumulatively can lead to overregulating the industry and might end in decreasing innovation, which is why a DRM-like solution should consider the industry specific characteristics to provide a suitable solution. The world of 3D printing is exciting and is capable of offering endless opportunities to different fields of use, if we only allow.

Kokkuvõte

Magistritöö eesmärgiks on uurida revolutsioonilist 3D printimise tehnoloogiat ja sellega kaasnevaid autorõiguslikke küsimusi. 3D printimine võimaldab muuta digitaalselt konstrueeritud joonise väga lühikese ajaga füüsiliseks objektiks ning ühtlasi on võimalik 3D skanneerimise abil teha koopiaid füüsilistest objektidest. 3D printimine on kahefaasiline tehnoloogia, mis saab alguse disainerist, kes arvutiprogrammi abil kujundab CAD (Computer Aided Design) faili, mis on kui tehniline joonis, milles sisalduva info järgi 3D printer füüsilise objekti kiht-kihi haaval välja prindib. 3D printimise tehnoloogia ei ole iseenesest uus, sest leiutati see juba 1970ndatel aastatel, kuid erinevate patentide tõttu ei olnud tehnoloogia varasemalt laialdaselt kättesaadav ning on alles nüüd tegemas debüüti ja laialdasemalt koduseks kasutamiseks levimas. Kuna autoriõiguse regulatsioonid on koostatud ajal, mil füüsiliste esemete kopeerimine oli praktiliselt võimatu või ei olnud nii lihsustatud, siis ei ole eksisteeriva seadusandluse alt kindlasti võimalik leida spetsiifilisi termineid või sätteid, mis kohalduksid 3D printimisele. Seetõttu on töös esmalt uuritud olemasolevat autoriõiguse regulatsiooni, mida oleks võimalik tõlgendada 3D printimisele sobivalt või millega 3D printimist võrdsustada.

Esialgu on 3D printimise ja sellega kaasnevate õiguslike probleemidega suurem kokkupuude esinenud Ameerikas ning seetõttu on seal antud teemat sügavamalt uuritud, mis võimaldab koostada hetke arusaama 3D printimise õiguslikust seisukohast just Ameerika näitel. Ameerika õigusteadlased on pakkunud välja erinevaid autorõigustega kaitstavate objektide kategooriaid, mis võimaldaks enda alla hõlmata ka 3D printimise ja selle erinevad faasid, mille hulgas on potentsiaalsete analoogidena välja pakutud arhitektuurilisi jooniseid ja plaane, tehnilisi jooniseid, retsepte, arvutiprogramme ja arvutiprogrammide poolt loodud teoseid. Ükski nimetatud kategooriatest ei ole piisavalt laiaülbaline, et olla täiuslikult sobilik 3D printimise tehnoloogiale. Lisaks sobiva definitsiooni puudumisele on autoriõigusliku kaitse saamiseks vajalik teose originaalsuse kriteeriumidele vastamine ning teatavasti ei ole autoriõigustega kaitstavad kasulikud objektid. Töös on 3D printimise tehnoloogiat uuritud nii originaalsuse kui ka funktsionaalsuse kontekstis. Euroopa Liidu lähenemise all on käsitletud Ameerika õigusteadlaste poolt pakutud kategooriatele samaväärseid analooge, kuid ka EL'i autorõiguste regulatsioon ei ole piisavalt sobilik nii uue tehnoloogia väljunditega tegelemiseks. ELi lähenemise suureks plussiks on hästi toimiv tööstusdisaini regulatsioon, mis võimaldab ka funktsionaalsete objektide väljanägemise kaitse.

Palju on vaieldud 3D printimise, kui uue ja revolutsioonilise tehnoloogia, reguleerimise vajaduse üle. Liiga varajane või piiritletud regulatsioon võib mõjuda rängalt tehnoloogia arengule, samas on juba ette näha võimalikke tekkivaid õiguslikke probleeme, mis muudavad regulatsiooni varem või hiljem vajalikuks. Töös on käsitletud erinevaid võimalusi ja meetmeid, mida võiks rakendada, saavutamaks 3D printimisele adekvaatset regulatiivset lahendust. Võimalikuks peetakse autoriõiguste kaitseala laiendamist sellisel viisil, et see võimaldaks hõlmata 3D printimisele iseloomulikke tunnuseid, mis tähendaks et kaitset tuleks laiendada kas 3D objektidele või CAD failidele. Teine regulatiivne võimalus oleks sarnaselt andmebaaside kaitsele EL'is rakendada ka 3D objektidele *sui generis* õigust, kuid ka sellel on oma head ja vead. Kuna siiani on 3D printimise kogukonnal õnnestunud suuremas osas vältida tavapäraseid autoriõiguslikke probleeme, on välja pakutud, et parim võimalus olekski lubada 3D printimise kogukonnal jätkata eneseregulatsiooni teel, mis siiani on üsna tulemuslik olnud. Erinevatest eneseregulatsiooni vormidest võivad vajaduse korral välja kasvada ka kohustuslikud reeglid. 3D disainide puhul on laialdaselt levinud Creative Commons (CC) litsentside kasutamine, mis annab autorile võimaluse valida, kuidas ta soovib oma töö kasutamist lubada ning CC litsentse on vaadeldud ka kui kasulikku abimeest 3D printimise ja üldisemalt digitaalsete autoriõiguste tagamiseks. Tavapäraselt leidub kogukonnas siiski keegi, kes keeldub tavaks saanud käitumismudeli järgi talitamast ning seetõttu on pakutud välja ka 3D printimise puhul kohaldada digitaalsete õiguste kaitse tehnilisi meetmeid (DRM – Digital Rights Management), sarnaselt näiteks e-raamatutele kohaldatavatele tehnilistele meetmetele. Esimesed initsiatiivid 3D printimise DRM lahenduste pakkumisest on juba ilmnenud ning võimalikku tuleviku lahendust on töös patendil põhineva info põhjal ka kirjeldatud. Järeldusena on leitud, et eksisteerivaid meetmeid tuleks põhjalikult üle vaadata ja kaaluda, enne kui asutakse regulatiivseid meetmeid 3D printimisele kohaldama.

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