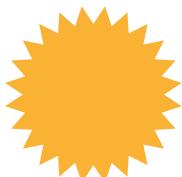




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Pirates of the 3D Realm: Strategies for IP protection from the widespread adoption of additive manufacturing by consumers

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Pirates of the 3D Realm: Strategies for IP protection from the widespread adoption of additive manufacturing by consumers

ABSTRACT

Additive manufacturing is a pillar of the 4.0 industry. As it goes for other technologies throughout history, the cost of a 3D printing machine will sink lower and lower, and the accessibility to these machines by consumers will enable them to print with a vast array of materials, thus enabling them to print whatever they would previously buy, in a physical store or from an online retailer. It will be easy to infringe on an IP right with only a cheap 3D printing machine and a digital file from which the machine can take the necessary instructions. In the first part of this paper we will analyse the brief history of 3D printing technology and we will establish a parallel pattern of adoption to the one which has seen computer becoming an everyday object owned by everyone. In the second part we will see various possible scenarios in which IP rights will clash with the widespread adoption of additive manufacturing by consumers, transforming them in prosumers. In the third and final part of this paper we will explore the various policies available or that could be easily available with simple adjustments to current laws to protect IP rights from the risks associated with the widespread adoption of additive manufacturing by consumers.

Key words: Intellectual property, additive manufacturing, 4.0 industry, disruptive technology

JEL classification: K23

Summary

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Introduction

“You wouldn’t download a car” is the first line of the famous ‘Piracy. It’s a crime’ awareness campaign. The short video was made to condemn the widespread practice of illegally downloading copyrighted material thanks to peer to peer sites such as LimeWire, Emule etc. While fifteen years ago the idea of downloading a car caused hilarity in the public opinion, today this is no more a joke to be contended with. We are making little steps in the direction of a future where you can download a file for a 3D printed car and then print it in your backyard, even if, as of today, only certain car parts can be printed¹. The argument is not limited to cars, but potentially can be extended to further and further types of objects as new technological solutions and materials for printing become feasible and easily available to the average consumer. While today 3D printing in the consumer market is restricted only to those who have at least some sort of technical competences and still face a lot of difficulties, it’s easy to imagine that in the next ten to fifteen years some companies will achieve what was achieved by personal computer’s companies in the late ‘80s and early ‘90s, especially by Microsoft and Apple, with consumer friendly interfaces². Once the interface’s problem bottleneck will be passed, the floodgates will be open for a revolution in consumerism. For example, consumers will be able to not be limited by the products line of a single producer when it comes to additional gadgets for the main product they have already bought. They will instead be able, thanks to the combination of 3D scanners, augmented reality and 3D printing technology, to 3D print a compatible Do It Yourself version of the additional gadget³. On the subject of economic feasibility, the cost of buying a 3D printer and the costs associated with raw material and electricity usage can be recouped in a few years, if it is used to print common items that are usually bought by the average consumer (such as a soap holder, a Nikon camera lens cover, a seatbelt guide, a cutting table etc...)⁴.

The excitement for such a revolution is justified, but as we need to approach the subject of this paper, some questions and doubts arise. When there will be hundreds of thousands if not millions of easy to use 3D printers, most of them, if not all, connected to the Internet, how we will manage to protect IP rights? Decentralization is a key aspect of additive manufacturing on the consumer level; hence the enforcement of IP rights will require more and more resources or a smart solution (maybe backed up by Artificial Intelligence) to efficiently prevent these difficult situations from arising. Should we put the weight of protection of IP rights on the shoulders of 3D printers’ manufacturers or should consider them as having a neutral stance on it? These questions and more will be answered in the next pages.

¹ Sher D., ‘You too could now 3D print a Lamborghini Aventador at home’, 3D Printing Media Network, available at <https://www.3dprintingmedia.network/you-too-could-now-3d-print-a-lamborghini-aventador-at-home>, Accessed on 09 October 2019;

² The need for user-friendly 3D printing machines seems to be one of the top priorities for the near future. Many make an analogy with the issues with personal computer, which usage required training in coding before they were resolved by standardised software like Microsoft word or excel. CF Garland N. P., Underwood G., Wade R. (2017) ‘Challenges of 3D Printing for Home Users’, in 19th International Conference on Engineering and Product Design Education, Oslo, Norway, 7-8 September 2017, pp. 478-484.

³ This is an example where the consumer become a prosumer, as it become capable of personalizing the standard product, already bought, with DIY modifications for adapting the product to new uses or to change broken pieces that would otherwise render the product unusable. CF Chun S., Ko H., Yoo B., (2016) ‘Prosumption perspectives on additive manufacturing: reconfiguration of consumer products with 3D printing’ in Rapid Prototyping Journal, Vol. 22, N. 4, pp. 691-705, DOI: <https://doi.org/10.1108/RPJ-01-2015-0004>

⁴ Pearce J., Petersen E. E. (2017) ‘Emergence of Home Manufacturing in the Developed World: Return on investment for Open Source 3-D Printers’, in Technologies, Vol. 7, paper N. 5, DOI: <https://doi.org/10.3390/technologies5010007>

1. A brief history

'Those who cannot remember the past are condemned to repeat it'
George Santayana

The 3D printing technology consists of an ever-evolving set of techniques for depositing 2D layers of various types of raw materials on an immobile or semi-moving platform in order to create a 3D object. 3D printing machines use a digital blueprint formatted in an .stl file, designed thanks to a CAD software (Computer Aided Design). This is the opposite of what traditional manufacturing consist of, which is the subtraction of material to create an object. To help us contextualize the advent of additive manufacturing, we will now have a brief retelling of 3D printing's history, which is also useful for seeing the parallels with the rise of personal computers.

We can select 1984 as the starting date for the history of additive manufacturing, when Charles W. Hull invented the technique of stereolithography⁵, which definition is «*an additive manufacturing process that builds solid prototypes, patterns and products from CAD drawings. SLA enables the construction of solid plastic prototypes that are weaved from a CAD-powered laser beam gun*⁶». This was the first feasible technique for making additive manufacturing into reality as now digital models in CAD can be used to direct the 3D printer. In 1988, the Fused Deposition Modelling technology was invented by Scott Crump who promptly filed for a patent one year later⁷. This technique is the one typically used now by commercially available 3D printers for the consumer market. During the '80s and '90s additive manufacturing was reserved mostly for rapid prototyping products by manufactures, also because of the medium cost for a 3D printer which was \$20.000,00⁸. In the 2000's we have an exponential increase in usefulness for additive manufacturing, especially helping in the medical field. 3D printing was starting to seem a feasible technology for the creation of artificial human organs for transplants⁹ and in general by creating a new branch of the medical field which is 'biofabrication'¹⁰. Another field which was starting to intersect with additive manufacturing was food¹¹. During the '10s we have an explosion in interest for additive manufacturing from consumers. The cost of a basic 3D printer model sunk to an all-time low. Now an entry level 3D printer can be bought from as low as \$200,00, more complex machines going from \$700,00 up to \$3.000,00 - \$6.000,00, while, obviously, industrial 3D printers are

⁵ Hull C. W. (1984) US4575330A

⁶ Definition taken from <<https://www.techopedia.com/definition/29381/stereolithography-sla>>, Accessed on 10 October 2019

⁷ Crump S., (1989) US5121329A

⁸ CF Dickens P., Waterman N. (1994) 'Rapid Product Development in the USA, Europe and Japan', World Class Design to Manufacture, Vol. 1, N° 3, pp. 27-36, DOI: <https://doi.org/10.1108/09642369210056629>

⁹ CF Boland T. et al. (2003) 'Organ Printing: computer-aided jet-based 3D tissue engineering', in TRENDS in Biotechnology, Vol. 21, N° 4, pp. 157-161, DOI: 10.1016/S0167-7799(03)00033-7

¹⁰ For a clear understanding of the fundamentals of biofabrication see Mironov V. et al. (2009) 'Biofabrication: 21st century manufacturing paradigm' in Biofabrication, IOP Publishing Ltd, Vol. 1, N°2, pp. 1-16 DOI: <https://doi.org/10.1088/1758-5082/1/2/022001>

¹¹ CF Periard, D., Schaal, N., Schaal, M., Malone, E., Lipson, H. (2007) 'Printing food', In: Proceedings of the 18th solid freeform fabrication symposium, Austin, Texas, USA, pp. 564-574

more expensive, costing at average half a million dollars¹². There are many fairs and conventions related to additive manufacturing not targeted toward professionals, but for enthusiasts and hobbyists. There are examples of additive manufacturing in practically every field of human activity, from housebuilding¹³ to creating cheap prosthetics¹⁴, from synthetic printed food¹⁵ to guns¹⁶.

If we try to think of an analogy to the development of additive manufacturing, it is easy to associate it with the rise of personal computers. In a few decades we went from having these machines costing millions of dollars and occupying entire rooms, to having the possibility of buying them for a few hundred dollars from an online retailer. The difficulty of operating computers passed from rocket science level to hobbyist and enthusiasts' level and now computers can be operated even by kids. The same fate is happening also to 3D printers, where in the past only specialist could operate them, now there are 3D printers even for kids¹⁷. As we are entering the '20s we can certainly forecast that this decade will be characterized by a massive increase of the number of 3D printers accessible by the consumer market. The most critical breakthrough needed is a more user-friendly interface, while the lowering of the machine's cost and in general the betterment of the printing quality can be considered physiological to this as to any modern technology. The allure of having an independent household where an individual could print by himself objects that in the traditional market could have cost hundreds if not thousands of dollars for a few bucks will certainly drive for increasing consumer-level 3D printers. As it was for digital content created from personal computer and uploaded to the Internet, the consumer will become a 'prosumer' even in the field of additive manufacturing and to paraphrase a famous quote from Bill Gates, by the end of the '20s we will have '*a 3D printer in every home*'.

¹² Anonymous (2019) 'How Much do 3D Printers Cost? – Prince Ranges and Categories for 2019', TOTAL 3D PRINTING, Available at: < <https://total3dprinting.org/much-3d-printers-cost-price-ranges-categories/> > Accessed on 11 October 2019

¹³ Bendix A. (2019) 'These 3D-printed homes can be built for less than \$4,000 in just 24 hours', Business Insider, Available at < <https://www.businessinsider.com/3d-homes-that-take-24-hours-and-less-than-4000-to-print-2018-9?IR=T> >, Accessed on 11 October 2019

¹⁴ Birrel I. (2019) '3D-printed prosthetic limbs: the next revolution in medicine', The Guardian, Available at < <https://www.theguardian.com/technology/2017/feb/19/3d-printed-prosthetic-limbs-revolution-in-medicine> > Accessed on 11 October 2011

¹⁵ Montes L., Moynihan R. (2018) 'A researcher has developed a plant – based meat substitute that's made with a 3D printer', Business Insider, Available at < <https://www.businessinsider.com/this-fake-meat-is-printed-in-a-lab-using-vegetables-and-a-3d-printer-2018-11?IR=T> > Accessed on 11 October 2019

¹⁶ Hanrahan J. (2019) '3D-printed guns are back, and this time they are unstoppable', Wired, Available at < <https://www.wired.co.uk/article/3d-printed-guns-blueprints> > Accessed on 11 October 2019

¹⁷ Roberson B. (2019) 'The Best 3D Printers for Kids', Forbes, Available at < <https://www.forbes.com/sites/billroberson/2019/08/22/the-best-3d-printers-for-kids/#1158e40f370c> > Accessed on 11 October 2019

2. IP rights and additive manufacturing: two worlds ready for clashing

As we have seen in the previous section, soon we will have millions of cheap 3D printers that will be easily manageable, and which can print at a cost to rival mass manufacturers. What are then the implication for IP rights holders?

Again, it is useful to take inspiration from the evolution and widespread adoption of personal computers. While content piracy was practiced even before personal computers and the Internet, the rise of online peer to peer sharing caused a spike in IP rights violations, mostly concerning copyrights. During the decade of the ‘2000s an arm race ensued between the so called ‘pirates’ and the entertainment industry, concerning the film industry¹⁸ and the music industry¹⁹. The copyright crisis of the ‘2000s is now partially behind us, with new models of legitimate content consumption, like streaming, and different avenues of profit (such as merchandise, tie-in videogames etc....) have helped both the Music and Film industry²⁰

Most of us who have lived through the ‘90s and the ‘2000s may remember street vendors with their rugged sheets onto which CDs with illegal copies of movies and songs were shown. These pirated copies could be bought for a fraction of the original cost. We could imagine a future in which instead of CDs, onto those same rugged sheets, USB flash drives containing CAD files with an illegally copied blueprint for a set of toys, designer furniture for your living room or anything else possible and linked to certain IP rights.

However the most trafficked highway for 3D printing piracy will be the Internet, as like the above mentioned menace of peer to peer illegal websites for the music and the movie

¹⁸ Hollywood in 2002 tried, through Californian Senator Howard Berman, to propose a bill which would in practice let copyright holders self-enforce their rights on the Internet. They would have gained the possibility of using ‘technological tools’, such as denial of service attacks, to block illegal sharing of copyrighted materials without the intervention of the competent public authority, thus becoming a sort of copyright internet vigilantes. To know more see Fazekas C. (2002) ‘Vigilantes v. Pirates: The Rumble over Peer to Peer Technology Hits the House Floor’, Duke Law & Technology Review, Vol. 1, pp. 20-31, Available at <<https://scholarship.law.duke.edu/dltr/vol1/iss1/62/>> Accessed on 12 October 2019; also see Humphrey J. S. (2003) ‘Debating over the Proposed Peer-to-Peer Piracy Prevention Act: Should Copyright Owners Be permitted to Disrupt Illegal File Trading over Peer-to-Peer Networks’, North Carolina Journal of Law & Technology, Vol. 4, Is. 2, pp. 375 – 416, Available at <<http://scholarship.law.unc.edu/ncjolt/vol4/iss2/5>> Accessed on 12 October 2019

¹⁹ We can confidently agree that the music industry was the one that was hit the hardest by the rise of peer to peer illegal content sharing. Various possibilities were explored i.e. voluntarily uploading computer viruses masked as MP3 files. It was also explored the possibility of improving online services functionality. To know more on the virus technique deterrence, see Higgins G. E., Marcum C. D., Wolfe S. E. (2008) ‘Deterrence and Digital Privacy: a Preliminary Examination of the Role of Viruses’, Social Science Computer Review, Sage Publications, Vol. 26, N° 3, pp. 317 – 333, DOI: 10.1177/0894439307309465. To know more on the improved functionality of the online services technique, see Mandel N., Sinha R. K. (2009) ‘Preventing Digital Music Piracy: The Carrot or the Stick?’ Journal of Marketing, American Marketing Association, Vol. 72, Is. 1, pp. 1 – 15, DOI: <https://doi.org/10.1509/jmkg.72.1.001>

²⁰ For the pros and cons of paid music streaming services see Aguiar L., Waldfogel J. (2015) ‘Streaming reaches flood stage: Does Spotify stimulate or depress music sales?’, Working paper 21653, National Bureau of Economic Research, Cambridge (MA), Available at <<http://www.nber.org/papers/w21653>>; for the pros and cons of film and tv series streaming services see Smith M. D., Telang R., Zhang Y. (2019) ‘I Want You Back: The Interplay Between Legal Availability and Movie Piracy’, International Journal of the Economics of Business, Vol. 26, Issue 1, pp. 199-216, DOI: 10.1080/13571516.2019.1553293

industry, this time anything that can be reliably and easily be printed on a consumer level 3D printer will be uploaded on one of those peer to peer sites. Industries which traditionally did not suffer from piracy and were more concentrated on fighting counterfeiting will soon enough face the same challenges as the Music and Film industry.

2.1 Legal loopholes

What we will be focusing on in this paragraph is what can be considered dangerous loopholes that will be critical for rights. We will not review the whole system of IP protection, as it would take another entire paper to explain its full potential²¹.

These exceptions were created in a time in which 3D printing was not calculated. The basis for them can be found in the Agreement for Trade Related Intellectual Property Rights (TRIPS²²), which influenced most modern IP laws and regulations around the world. In article 16 of the aforementioned agreement, trademark protection is limited to its use in the «*course of trade*²³». So, for example, what if someone 3D prints some object which usually bare the trademark just for its personal usage, without printing more than one copy. Obviously, the individual does not find itself acting in the course of trade. This is not a problem at the moment as 3D printers are not so widely used. This become a problem when the number of 3D printers in circulation reaches a critical mass and people start to put 3D printed trademarks of certain companies in whatever they want. This will indeed cause a devaluation of certain trademarks which have thrived in the artificial scarcity and in the exclusiveness of their products. Trademarks traditionally served as a way the indicate the quality and the origin of product, but their use in a post 3D printing world could shift to just signalling of a consumer's affinity with certain company²⁴. This would not happen if we change the current limitations on trademark law.

For copyright protection, article 13 provides that: «*Members shall confine imitations or exceptions to exclusive rights to certain special cases which do not conflict with a normal exploitation of the work and do not unreasonably prejudice the legitimate interests of the right holder*²⁵». Many countries have consequently put in a place an exception for 'private use'. Most countries in the world have private copy exception. In the European Union, the only Member States that do not have a provision in place for this exception are: Cyprus, Luxemburg, Ireland and Malta. But this exception is counteracted by the existence of private copy levies. This is a sort of taxation of every electronic device with storage capacity to compensate those who lose profit from individuals making private copies of their copyrighted

²¹ For a wide spectrum analysis on 3D printing and IP rights see Birtchnell T. et al. (2018) '3D Printing and Intellectual Property Futures', Intellectual Property Office, Newport (UK) pp. 88; also see Bradshaw S., Bowyer A., Haufe, P. (2010), 'The Intellectual Property Implications of Low-Cost 3D printing', ScriptEd, vol. 7, n°1, pp. 5-31, DOI <https://doi.org/10.2966/scrip.070110.5>; also see Tran J. (2015) 'The Law and 3D Printing', The John Marshall Journal of Information Technology & Privacy Law, Vol. 31, Issue 4, Art. 2, pp. 505-519, Available at <http://repository.jmls.edu/jitpl/vol31/iss4/2>

²² TRIPS: Agreement on Trade-Related Aspects of Intellectual Property Rights, Apr. 15, 1994, Marrakesh Agreement Establishing the World Trade Organization, Annex 1C, 1869 U.N.T.S. 299, 33 I.L.M. 1197 (1994)

²³ Id. Art 13

²⁴ CF Grace J. (2014) 'The End of Post-Sale Confusion: How Consumer 3D Printing will Diminish the Function of Trademarks', Harvard Journal of Law & Technology, Vol. 28, N° 1, pp. 263 - 287

²⁵ Id. Art 16

material. Of the many countries which provide a private copy exception, only 74 provide a private copy levy and of those countries only 38 have an effective system in place to collect and distribute the resulting revenue²⁶. While this system partially recoups the losses, this is only limited to the content creation sector. A future private copy levy on 3D printers and all the related material and products would comprehend almost any commodity sector, therefore the levy weight on 3D printers' sales would be unbearable or the resulting revenue would be too little to compensate the real losses of companies.

For patent protection, in article 30 of the TRIPS we find that «*Members may provide limited exceptions to the exclusive rights conferred by a patent, provided that such exceptions do not unreasonably conflict with a normal exploitation of the patent and do not unreasonably prejudice the legitimate interests of the patent owner, taking account of the legitimate interests of third parties*²⁷». Patent law exceptions vary from country to country, but there are some common trends, one of which is 'private and/or non-commercial use'²⁸. Again, while this exception may have been rational in the past, as it would have been difficult for most consumer to replicate a patented object, the features of 3D printing could in the near future put this exception to its final testing. 3D printing will also stretch the limits of individuals privately repairing patented objects with 3D printed spare parts. In the US for example, consumers which tamper with patented objects are confronted by the doctrine of 'repair and reconstruction'. The consumer has the right to repair the patented object to maintain it during its useful life but not to an extent to which the object is practically recreated when it would have been worn out and spent²⁹. Therefore, we will see an increase in consumer 3D printing the unpatented spare parts they need to repair the patented object, cutting the profits of the patent owners.

All these exceptions and limitations to IP rights were made in a time where the issues of the widespread adoption of 3D printing were not evident nor it was possible to think that one person would have been able to print in the privacy of its house most of the objects needed for its day to day life. The prevention of a new crisis similar to the one suffered by the Music and Film industry must start from international agreements such as TRIPS, as it would then trickle down to supra national organizations such as the EU and then to single nations. Companies need to be active and fast in lobbying for adjustments to the current system of exceptions and limits to IP because as more time passes, people will become more accustomed to printing in autonomy whatever they desire and then it will be difficult if not impossible to limit the damages. As a common motto dictate: 'it is better to prevent than to cure'.

²⁶ Oron G. (2017) 'New CISAC study Highlights how private copying schemes can generate important revenues for creators', CISAC blog, Available at < <https://www.cisac.org/Newsroom/Articles/New-CISAC-study-highlights-how-private-copying-schemes-can-generate-important-revenues-for-creators> > Accessed on 10 November 2019

²⁷ TRIPS Art 30

²⁸ < https://www.wipo.int/patents/en/topics/exceptions_limitations.html > Accessed on 10 November 2019

²⁹ CF Wilbanks K. B. (2013) 'The Challenges of 3D Printing to the Repair-Reconstruction Doctrine in Patent Law', George Mason Law Review, Vol. 20 N°4, pp. 1147-1181

2.2 A song of merchandise and designer furniture

During the ‘80s through the ‘2000s toys related to cartoon series such as the Transformers and Pokémon were all the rage. However, during the ‘2010s we have seen an explosion in toys related to very successful live films and tv series which spawned a myriad of related toys and collectables. An example could be the Disney’s Marvel cinematic universe of superheroes. The 22 films of Marvel’s cinematic universe have grossed a total of \$19.9 billion alone³⁰. Obviously, with great cinematic success comes great merchandise profits. Profitable licensing with toy manufacturers such as Hasbro³¹ and Lego³² is making all the parties involved very high profits. While the toys related to cartoon series such as those mentioned above were more directed to kids, this time the adult audience is also part of the possible pool of costumers.

Another example not related to a single franchise is the phenomenon of the Funko Pop vinyl dolls. The company producing them has concluded many profitable licensing agreements with many famous franchises, creating a business valued today at almost \$700 million³³ marketed mostly to adults.

We can look at the miniature strategy based role-playing market, in which one of the most prominent actors is Game Workshop, with its worldwide recognized brand for creating games such as Warhammer and Warhammer 40K. During the last year, the company has seen a soar in its share’s value³⁴ and the future ahead seems bright, for the time being. Most of its profits are made by selling miniatures of the soldiers needed to role-play as a commander of such armies and by selling the manuals for the hundreds of rules needed to play these games. A quick visit to the official Game Workshop’s website will reveal that this is not a cheap hobby to maintain as the cost for the models of soldier and vehicles can rapidly bring the total spending into the \$1,000 if not more.

As hundreds of millions if not billions of dollars are to be made from all these different kinds of toys, one has to ask what are the risks related between the widespread adoption of consumer grade 3D printers and this billion dollars’ worth market that encompass a wide spectrum of age.

3D printing piracy could become a sweet temptation for the consumer eager to save some money while at the same time still having the latest Christmas toy or to replenish the ranks of their sci-fi role-playing game. There are those who could object that the current or

³⁰ Shieber J. (2019) ‘Avengers: Endgame becomes the first film to break \$1 billion in an opening weekend’, Techcrunch.com, Available at < <https://techcrunch.com/2019/04/28/avengers-endgame-becomes-the-first-film-to-break-1-billion-in-an-opening-weekend/> >, Accessed on 27 October 2019

³¹ Whitten S. (2019) ‘Hasbro stands to make millions from Marvel’s Phase 4 slate’, CNBC.com, Available at < <https://www.cnbc.com/2019/07/23/hasbro-stands-to-make-millions-from-marvels-phase-4-slate.html> > Accessed on 27 October 2019

³² Wood Z. (2019) ‘Lego bounces back with Avengers and Lego Movies sequel toys’, TheGuardian.com, Available at < <https://www.theguardian.com/lifeandstyle/2019/sep/03/lego-bounces-back-with-avengers-and-lego-movie-sequel-toys> >, Accessed on 28 October 2019

³³ Tait A. (2019) ‘How aggressively cute toys for adults became a \$686 million business’, Vox.com, Available at < <https://www.vox.com/the-goods/2019/8/13/20798910/funko-pop-vinyl-figurines-collectibles> > Accessed on 30 October 2019

³⁴ Crux J. (2019) ‘Why Game Workshop’s shares are marching on again today’, Sharesmagazine.co.uk, Available at < <https://www.sharesmagazine.co.uk/news/shares/why-games-workshops-shares-are-marching-on-again-today> >, Accessed on 01 11 19

near next gen 3D printers for the mass market will not be capable of printing to the resolution and quality of the traditional industry. But we can easily respond that not always the best product's quality wins the day. A clear example of such situation can be viewed in the format war between the JVC's VHS and the Sony's Betamax cassettes³⁵.

Derivative works have also been helping the movie and tv industry recoup the losses sustained by piracy with derivative works such as the previously mentioned Funko Pop, themed Lego sets and miniatures. But there are also other ways of recouping losses like selling gadgets such as keychains, mugs, pins, replicas of weapons used in the shows etc... One of the biggest tv series of all times, Game of Thrones, is also the show which suffered the most from piracy³⁶. Therefore, merchandise can be considerate as a way to partially recoup that part of the revenue which is lost to piracy. On the one hand, if people start to 3D print the action figures or other paraphernalia from their favourite shows, there would be another piracy front to manage for the Film and TV Series industry.

Another worrying scenario involves the possible disruption brought by 3D printing in the market for spare parts and designer items, such as lamps, libraries etc...

Today many companies find their strength and main business in making unique designs of everyday objects like Alessi and Kartell. Imagine then that these designers' objects can be easily scanned and reproduced by a 3D printer. One could start from an empty little apartment and a 3D printer and in a few days transform it in a modern luxurious apartment with the latest designer chair and dining table. They will not be made of mahogany or any other luxury material, but they would still retain the functionality and design of the original furniture. There are already websites that offer both free and pay for download blueprints of designer furniture, such as Cgtrader.com³⁷.

Finally, the spare parts market will be revolutionized by the widespread adoption of 3D printing as the consumer will become a prosumer³⁸. Today many retailers rely on the fact that the consumer cannot find replacement parts for their furniture, cars, kitchen appliances etc... They will need to adapt to a future where the consumer will be able to print itself the spare parts needed for their objects or they will face big profit losses.

³⁵ Sony's Betamax ultimately lost the format war, even if it was technically superior to the VHS. As the main function of toys and miniatures can be satisfied with products of the lesser aesthetic quality, the risk to lose a big part of the market to individuals who just print pirated versions is a risk that must be recognized. To know more on the format wars and consumer's choices see St. Claire A. F. (2008) 'Costumer selection within competitive consumable commodity markets: an investigation of the video cassette, DVD, high definition video markets', Thesis, Massachusetts Institute of Technology, URI: <<http://hdl.handle.net/1721.1/45298>>

³⁶ Hooton C. (2017) 'Game of Thrones is the most torrented TV show six years running', independent.co.uk, Available at <<https://www.independent.co.uk/arts-entertainment/tv/news/game-of-thrones-torrents-streaming-2017-watch-online-hbo-season-7-a8133036.html>>, Accessed on 10 November 2019

³⁷ See <<https://www.cgtrader.com/free-3d-print-models/furniture>> Accessed on 10 November 2019

³⁸ CF Halassi S., Kirtali N., Semeijn J. (2019) 'From consumer to prosumer: a supply chain revolution in 3D printing', International Journal of Physical Distribution & Logistics Management, Vol. 49, n° 2, pp. 200 – 216, DOI: <https://doi.org/10.1108/IJPDLM-03-2018-0139>

3. Strategies for the future

In this third and last part, we will survey various policies that companies, mostly in tandem with legislators, can deploy in order to safeguard and prevent the systemic violation of their IP rights caused by an uncontrolled and exponential adoption of 3D printing technology by consumer *en masse*.

This part will be divided into the three players usually involved in piracy. First, we will take a look into what can be adopted to prevent the rise of online platforms for file sharing, which we can consider the middleman. Then, we will see what can be done to block the end user of a 3D printer from printing IP infringing objects, even if the machine is offline. Finally, we will try to make sense of what could prevent creators from using CAD software or 3D scanners to then upload it on the Internet or directly print the objects, even in the privacy of their home.

One thing to keep clear in mind while we navigate the strategies available or easily available to companies, is that we must avoid risking to stop altogether the adoption of 3D printers by consumers, which could also be a new potential market for companies, if it is exploited with the right business strategy. Thus, to avoid putting a dent into the march of technological progress, we should not put all the weight of IP protection either on the 3D printers' manufacturers and the online blueprints' distributors or to alienate the potential interest of consumer in purchasing one of these printers and to use it not only for something like a one trick funny prop. We will nonetheless also review these risky strategies which are to be taken into consideration only in extreme cases, a sort of *extrema ratio* of IP protection. It is also advisable to use these strategies in combination as to reduce to a minimum the case of 3D printing piracy.

3.1 Blame it on the middleman: online file sharing platforms and liability

Today one of the main platforms from which we can download blueprints for 3D printed objects is Thingiverse³⁹. Thingiverse was created by MakerBot, a company founded in 2009 which sells consumer grade 3D printers, as a sort of vertical integration of the hardware with a platform for its content, i.e. blueprints for 3D printed objects created by 3D printers' users. Stratasys, on the other hand, before those acquisitions only dealt with professional grade 3D printers. The Thingiverse's website contains tens of thousands of files for 3D printed objects, from simple statues to spare parts for kitchen's utensils. It is interesting how, to prevent incurring in responsibility possible IP related lawsuits, the site has IP policy, which redirect you to the MakerBot's website for managing possible infringements and disputes. It also clearly displays the contact information for addressing their specifically designated copyright's lawyer. Thingiverse goes one step further, addressing not only copyright issues but also having a dedicated info box for disputes that relate to IP rights but that do not relate to copyright⁴⁰.

³⁹ <<https://www.thingiverse.com/>> Accessed on 03 11 19

⁴⁰ To know more visit <<https://www.thingiverse.com/legal/>> and <<https://www.makerbot.com/legal/ip-policy>> Accessed on 03 11 19

Being prepared to most of the issues that will most probably arise from managing a website which host blueprints for 3D printed objects is a smart move, especially after the 2011's copyright dispute with The Netherlands based 3D artist Ulrich Schwanitz. He figured out how to create a 3D printed version of the Penrose's 'Impossible Triangle' which, if viewed from a certain angle, would retain the optical illusion properties of its 2D original counterpart, which design was in the public domain. Then, another 3D printing expert, Arthur Tchoukanov, reversed engineered the 3D model from a photo and posted the reconstructed model on Thingiverse. Mr Schwanitz filed a DMCA's takedown and Thingiverse, fearing a second liability under such law, compelled with the order. Have the dispute gone further, it would have been the first case in court concerning an uncertain copyright in an uncertain field of a new disruptive technology, potentially influencing the decades to come.

Based on less shaky ground was the DMCA's notice takedown from Game's Workshop, the same year as the Penrose 'Impossible Triangle' case. In this case, Thomas Valenty decided to create two figurines, a mech robot and a tank, inspired by the 40K Warhammer universe and he uploaded the 3D printable file onto Thingiverse. A few weeks later Game Workshop filed a DMCA takedown notice to Thingiverse which promptly took down Valenty's models⁴¹. Again, the simple implication of a long and costly legal battle has been enough to prevent an online platform from hosting dubiously IP rights infringing material.

Another company which is proactive in preventing disputes from reaching tribunal is Shapeways, a company that does not only host a platform for 3D printing blueprints, but also offer various services of 3D printing and modelling directly for businesses. Shapeways' content disputes resolution is very detailed and, in many ways, can be considered an example to follow for other online platforms and companies that deal with 3D printing⁴².

Until someone resists the DMCA takedown notice, this is a perfectly viable option for companies to prevent potential IP infringing 3D printing files from being present on online platforms. Even suing those online platforms to put them down and close this easy gateway for pirated files can be considered as long as this strategy is supported by what happened in the past. Again, using the music industry crisis of the early '2000s, we can learn how to respond to online platforms hosting files which infringe on IP rights. In *A&M Records, Inc. v. Napster Inc.*⁴³ case, Napster, one of the first successful peer to peer websites, was delivered the final blow as it was considered liable for contributory and vicarious infringement in regard to the pirated versions of films and song that were circulating on the site. The same fate happened to another online peer to peer platform, LimeWire. In *Arista Records LLC v. Lime Group LLC*⁴⁴ LimeWire was found liable of contributory infringement and after a few months went out of business. The demise of LimeWire is debated whereas it has produced a significant slowdown for online music piracy⁴⁵ or not⁴⁶. Therefore, even in the remote case in

⁴¹ Thompson C. (2012) '3D printing's forthcoming legal morass', Wired.co.uk, Available at <<https://www.wired.co.uk/article/3d-printing-copyright>> Accessed on 11 November 2019

⁴² See <https://www.shapeways.com/legal/content_policy> Accessed on 11 November 2019

⁴³ 239 F.3d 1004 (2001)

⁴⁴ 715 F. Supp. 2d 481 (S.D.N.Y. 2010)

⁴⁵ See Sandoval G. (2011) 'Study: LimeWire demise slows music piracy', cnet.com, Available at <<https://www.cnet.com/news/study-limewire-demise-slows-music-piracy/>> Accessed on 13 November 2019

which a court will rule in favour of online file sharing platforms, the risks and the costs of getting into a lawsuit could help companies to reduce the number of websites which hosts pirated blueprints of their goods.

Platforms for downloading 3D printing models should therefore be required to not only have a mechanism in place for resolving copyright disputes, but also to have one for IP in general. While on the front of copyright both in the United States⁴⁷ and in the European Union⁴⁸ there are laws and directives that could serve copyrights' owners in defending their IP rights against online platform hosting pirated versions of their works, the ground on which patents', trademarks', patented designs' owners is shakier. Thus, if we think that hitting the middleman could prevent IP rights infringement from happening at all this is but a mere mirage. A combination of IP protection strategies should always be on the mind of companies, especially in the new technological landscape that the widespread adoption of 3D printing will create.

3.2 Consumers and digital rights managements (DRMs): a battle of wits

The constant tension between companies trying to raise their profits and consumers trying to enjoy content and products and the lowest cost possible has always been present. Since the days of pirated music cassettes, content piracy has always attracted many customers, because of the cost of the original ones or just because they wanted to save some money. Systems and methods for protecting IP rights have always been unpopular in the eyes of the consumer, but they are nonetheless a necessity. Here are some possible solutions.

There is the possibility of spontaneously equipping every new consumer grade 3D printer with a 'black box'. Lawmakers could also draft a law that would render mandatory the instalment of a black box. The black box would register every object that was printed on the 3D printer and would be sealed, with high fines if the user tries to tamper with it. The downsides of using such type protection are the possible risks for Privacy, the higher costs of the 3D printers which could slow the diffusion of these machines and the difficulty in enforcing IP rights on the individual consumer's level.

A slightly different solution could be the mandatory installation on each new 3D printer of an anti-piracy software which should regularly have access to the Internet for updates, blocking the printing process of any blueprint files which appear to be infringing an IP right. Another version of this type of protection could require constant access to the Internet, without which it would lock-down the 3D printer until Internet access is given again. Obviously, such solution would cut off that part of the market made of people who would use the 3D printer in remote areas to supply items or spare parts as a mean of not spending

⁴⁶ Faughnder R. (2015) 'Music piracy is down but still very much in play', Los Angeles Times, Available at < <https://www.latimes.com/business/la-et-ct-state-of-stealing-music-20150620-story.html> > Accessed on 14 November 2019; also see Brown K. C., Mitchell D. M., Scott C.P. (2018) 'Did the RIAA's Prosecution of Music Piracy Impact Music Sales?', Atlantic Economic Journal, Vo. 46 Issue 1, pp. 59-71, DOI: <https://doi.org/10.1007/s11293-017-9567-1>

⁴⁷ US, 105th United States Congress, Digital Millennium Copyright Act, 112 Stat. 2860 (1998)

⁴⁸ See the European directive which recently got into effect on online copyright protection. The directive, on article EU Parliament and Council, Directive 2019/790, 17 of April 2019, Available at < <https://eur-lex.europa.eu/eli/dir/2019/790/oj> >

resources for the costly logistic of getting them delivered in such remote places⁴⁹. As for the previous solution, this would increase the total cost for operating the 3D printer as the software would need constant updates to resist the constant assault of those who wish to crack it. If there is not a mandatory installation law, directive or regulation, it could nonetheless be paired with an anti-virus which is more than ever needed today for any smart device, especially if the device in question has a lot of fragile parts which could break if the 3D printer is hacked⁵⁰. The first virus directly targeting 3D printers has been found in 2010⁵¹. This could decrease or hide the cost for the constant updating of the software in the eyes of the public.

Another solution to discourage individuals from using pirated .stl files could be companies launching a massive lawsuit campaign against individual infringers. This happened in the past, specifically in the Music industry with the RIAA, which starting from 2003 until 2009, launched an all-out assault on individual copyright infringers, using bots to scan the Internet, find the perpetrators and sue them. But bots are prone to errors and suing customers is not a popular move and business minded action, and certainly the Music industry antagonized part of its end users⁵². But while the Music Industry acted when the idea of peer to peer music sharing was already embedded in the mindset of consumer, maybe an early action by interested companies could prevent bad publicity that resulted from RIAA lawsuits.

An example of a digital rights management method which is already viable is the one patented by Secure3DP+, a joint venture between ISF Incubator (a start-up branch of Intellectual Ventures) and NTUitive, a company of the Nanyang Technological University of Singapore. The patent concerns «*Methods and systems for a manufacturing control system include but are not limited to identifying at least one object data file configured to produce an object by a manufacturing machine; confirming that an authorization code is associated with the object data file, the authorization code configured to be received by the manufacturing machine, the manufacturing machine adapted to receive the authorization code; and enabling the manufacturing machine to interface with the object data file only if the authorization code*

⁴⁹ The solution could be presented as 3D printers with a SIM integrated to provide internet connection. We could alternatively just use other offline IP rights protection for 3D printers sold for only a particular purpose. But we shouldn't limit 3D printers' production only on online as we would lose a big part of the 3D printing potential. In fact, additive manufacturing will have a great impact not only in developed countries but also in the developing ones where internet connection is weak or absent. To know more see Ibrahim A. M. S. et al. (2015) 'Three-Dimensional Printing in Developing Countries', Plastic and Reconstructive Surgery Global Open, Vol. 3, Issue 7, e443, DOI: 10.1097/GOX.0000000000000298. Also see Schonwetter T., Van Wiele B. (2018) 3D Printing: Enabler of Social Entrepreneurship in Africa? The Roles of FabLabs and Low-Cost 3D Printers, Working Paper 18, operAIR African Innovation Research, Available at <<http://idsd102019.pbworks.com/w/file/fetch/131552409/3D%20printer.pdf>>, Accessed on 11 November 2019

⁵⁰ Virus which can damage physical objects by infecting their software are nothing new. The most famous one is Stuxnet. This virus infected computers at the uranium enrichment plants in Iran severely damaging the machines responsible for the whole operation. This resulted in a setback of Iran's nuclear program by several years. It is not impossible to think that in the future someone who tries to download an .stl file will download both a blueprint for a pirated version of an object and a virus. The virus could then cause the overheating of the machines or other complications that would result in a fatal damage for the 3D printer.

⁵¹ The virus was mostly unharful and was used as a proof of concept more than with a malicious intent. See <<https://www.shapeways.com/blog/archives/408-3d-printing-virus-for-stl-file-type.html>>

⁵² Not everyone is against this tactic, see Sag M. (2006) 'Twelve-Year-Olds, Grandmothers, and Other Good Targets for the Recording Industry's File Sharing Litigations', Northwestern Journal of Technology and Intellectual Property', Vol. 4, n° 2, pp. 133 - 155

meets one or more predetermined condition⁵³». This is clearly the creation of someone who understood the disruptive potential of 3D printing and is trying to gain a decisive advantage on the competition in the DRM's field once the brakes for the exponential expansion of the additive manufacturing's market.

3.3 Copycats and scanners

Pirated versions of blueprint .stl files do not appear from thin air. There must be someone redoing a physical object with the aid of CAD software or 3D scanning it. Blocking 3D piracy at its source is the ultimate win for companies. But, sadly, it is a mere mirage. Unless we are willing to violate several privacy laws and at the cost of constant surveillance, not much can be done to avoid the creation of pirated blueprints. We could require each and every device and machine involved in the process of 3D scanning and printing to be equipped with DRMs add-ons or software, but usually those who are up to piracy of content and in this case physical objects, are necessarily tech savvy enough to go around these DRMs in few weeks or days. Therefore, the best strategy for protecting IP in the 3D printing era is to target the middleman and the end user.

⁵³ US8286236B2

Conclusion

It is difficult to predict the future, even the one which is nearer to us. We have a few certainties that we can extract from this paper. One is the fact that 3D printing will enter the homes of a great number of consumers, giving them a potential weapon for constantly infringing IP rights and rendering the enforcement of such rights a nightmare both for companies and for the legal system. Another is the fact that, as history tends to repeat itself: We should learn from the copyright crisis of the ‘2000s. For the next crisis to happen, which this time will involve all sorts of IP rights, the only thing which is not yet present, but that will surely arrive in the next decade, is a cheap and easy way to use device for printing. The aforementioned strategies for protecting IP are obviously still on the paper, as right now the only one actively used is the one concerning targeting the middleman. Nonetheless, companies, having the advantage of the experience made by Music and Film industry, should be able to prepare and diversify their IP protection strategy against the widespread adoption of 3D printing that will surely happen in the ‘20s. Lawmakers and companies should cooperate to rejuvenate the IP protection legal framework. This legal revolution should start from international conventions and then trickle down to supra national organizations such as the European Union and then finally arrive to national legislations.

3D printing will revolutionize almost any sector of human activity, causing a social and economic paradigm shift. It will eliminate most of the supply chain, it will allow for in-depth personalization of mass-produced goods, it will lower the difficulty of managing the assembly line and the operational costs⁵⁴. There are some negative effects, such as the risks for IP rights, which is the theme of this paper. But there are other things worth mentioning, such as the creation of 3D printed non traceable guns, or the use of 3D printers for other criminal purposes. As for every tool and technology in the history of the mankind, 3D printing will be whatever those who use it make it to be.

To conclude, it is a great possibility for both companies and consumers, and its negative effects should be limited or otherwise contained to allow a new industrial revolution to flourish and display its full beneficial effects.

⁵⁴ CF Banning G. (2014) ‘3D Printing: New Economic Paradigms and Strategic Shifts’ Global Policy, Vol. 5, Issue 1, pp. 70 – 75, DOI: <https://doi.org/10.1111/1758-5899.12119>