3D PRINTING THE ROAD AHEAD: THE DIGITIZATION OF PRODUCTS WHEN PUBLIC SAFETY MEETS INTELLECTUAL PROPERTY RIGHTS—A NEW MODEL

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This Article addresses the threats of 3D printing to both the physical and legal world. Not only does 3D printing impact products protected by intellectual property rights, it also poses risk, threats, and challenges to many other regimes, including products governed by product liability and criminal laws, which consequently threatens public safety. 3D printing virtually possesses threats to medical devices and products, threats to legal and illegal drugs, threats to human organs, threats to the food industry, and to the transportation industry, including cars, trains, and aircrafts. Ultimately, 3D printing also threatens environmental protection, workplace protections, households, and even the government, via 3D printing's potential impact on tax revenue and regulations.

We argue that the legal realm has been caught totally unprepared to address these hazards that 3D printing presents. Long-standing traditional legislation is in many cases irrelevant and inefficient to deal with the 3D printing revolution that sanctions mass production of any product by any person. It is essential that policymakers address this new technology by developing solutions that prioritize intellectual property protection while also being cognizant of the additional threats it

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poses to society. We propose a new solution. Not only does it help handle the threat to the existing intellectual property regime, but also the threats to public safety in a variety of fields. The new model operates via a framework requiring registration, imprinting (stamping), and activity tracking in such a way that government authorities, intellectual property owners, and other stakeholders can protect their rights without severely limiting the general public's freedom to use 3D printers. The model can be adopted as a whole or only partially (i.e., imprinting and stamping). By adopting our solution, we argue that traditional legal norms can cope with the growing tug-of-war between individual users of 3D printers and intellectual property rights holders. The proposed model requires, on the one hand, amendments to intellectual property laws to accommodate the need for registration and stamping processes, but, on the other hand, once the model is implemented it allows existing laws and other safeguards regarding public safety and product control to continuously govern their regime without becoming irrelevant in the 3D printer era.

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INTRODUCTION

Moulinsart is a company that allegedly owns the rights to the works of cartoonist Georges Prosper Remi (aka Hergé), who is most famous for *The Adventures of Tintin* comic book series.[1] Like other copyright owning companies, Moulinsart is constantly monitoring for infringement of its intellectual property rights.[2] In 2013, it sent a takedown notice to Thingiverse.com[3]—a popular website that allows users to upload and share computer-aided design (CAD) models[4] of

1 *Moulinsart*, TINTIN, http://en.tintin.com/contacts/moulinsart (last visited Jan. 16, 2016).

2 Steve Henn, *As 3-D Printing Becomes More Accessible, Copyright Questions Arise*, NPR: ALL TECH CONSIDERED (Feb. 19, 2013, 3:01 AM), http://www.npr.org/blogs/alltechconsidered/2013/02/19/171912826/as-3-d-printing-become-more-accessible-copyright-questions-arise.

3 THINGIVERSE, http://www.thingiverse.com (last visited Jan. 16, 2016).

4 Ben Depoorter, *Intellectual Property Infringements & 3D Printing: Decentralized Piracy*, 65 HASTINGS L.J. 1483, 1487 (2014) (explaining that a CAD model is essentially a computerized

objects, such as toys, gadgets, and nearly anything that a 3D printer can create—ordering it to remove the 3D printing designs of Tintin's cartoon moon rocket from the website.[5] The designs were likely uploaded and shared by an anonymous fan of the cartoon to showcase the fan's artistic skills.[6]

This is only one of many examples in recent years where an intellectual property owner has taken legal action against an alleged infringement of the owner's intellectual property rights by means of 3D printing. However, we argue that the threats are much broader than the discourse on intellectual property regime and include challenges and threats to public safety, products, and governmental regulation. Threats to product safety; threats to medical products, drugs, and human organs; threats to the food industry; threats to gun control/standards; threats to the auto and aircraft industry; threats to environment protection; threats to workplace protection and to tax collection are some of these. Much of the discussion to date has appropriately focused on the effects of 3D printing technology on copyrights, patents, and trademarks. In response, scholars have proposed changes to the current intellectual property laws, with solutions ranging widely across the spectrum. At one extreme, some have argued that 3D printing should be outright banned altogether.[7] At the other extreme, some have advocated for free use of 3D printing technology by consumers within their homes coupled with limited to no intellectual property infringement liability.[8] Our model takes a different route.

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blueprint of one or more objects that can be inputted into a 3D printer to print an actual physical product).

5 *See* Henn, *supra* note 2.

6 *See MakerBot Announces Thingiverse.com Customizer Challenge Winners*, PR NEWSWIRE (Mar. 10, 2013, 6:08 PM), http://www.prnewswire.com/news-releases/makerbot-announces-thingiversecom-customizer-challenge-winners-196779891.html.

7 Olivia Sundberg, *This House Would Ban the Sale of 3D Printers to Households*, INT'L DEBATE EDUC. ASS'N (Sept. 2, 2013), http://idebate.org/debatabase/debates/science/house-would-ban-sale-3d-printers-households (showing a dead tie between banning or allowing 3D printers in households following a debate on the issues).

8 *See, e.g.*, Deven R. Desai & Gerard N. Magliocca, *Patents, Meet Napster: 3D Printing and the Digitization of Things*, 102 GEO. L.J. 1691, 1715 (2014) ("It is possible that there will be a technological solution to the infringement problems that we discuss, but if so, that is something that should emerge from the marketplace."); Rory K. Little, *Guns Don't Kill People, 3D Printing Does? Why the Technology Is a Distraction from Effective Gun Controls*, 65 HASTINGS L.J. 1505, 1509–10 (2014) (arguing that the problem to address is the criminal *use* of a product of 3D printing, not the product or technology themselves); John F. Hornick, *Inside Views: 3D Printing and Public Policy*, INTELLECTUAL PROP. WATCH (Sept. 7, 2015), http://www.ip-watch.org/2015/07/09/3d-printing-and-public-policy ("3D printing should be lightly regulated, because it enables precisely the kind of creation and progress of the useful arts and sciences that intellectual property is supposed to foster.").

Unlike prior scholarship, this Article focuses on finding a solution that delicately balances between protecting public safety and intellectual property rights on the one hand and, on the other hand, avoiding excessive restrictions on 3D printing technology. We approach this by exploring the interests of users of this technology beyond intellectual property owners, as well as the interests of other stakeholders in the technology, such as 3D printer manufacturers, government authorities, and hosting websites, including Thingiverse. The model can be adopted in parts or as a whole. We claim that the current legal norms are insufficient to address the challenges that 3D printing brings to intellectual property law, and we advocate for a new framework to resolve the tensions between these stakeholders by way of 3D printer registration and print-activity tracking.

Part I of this Article discusses the background of 3D printing generally, followed by an assessment of the challenges and threats 3D printing poses to society. Finally, Part I addresses the question of why changes to current principles of legal norms need to be made.

Part II discusses the dramatic influence of 3D printing on intellectual property laws. This Part delves deeper into the technology behind 3D printing and the subsequent impact on protected products that are defenseless against this new form of copyright, patent, and trademark infringement.

Part III dissects the various stances that proponents and critics of 3D printing technology have taken and discusses why their proposed solutions are unsatisfactory.

Finally, Part IV outlines our proposed framework for addressing 3D printing's challenges to intellectual property, and how it balances the interests between individual users of the technology and intellectual property owners.

I. CHALLENGES/THREATS TO SOCIETY: 3D PRINTING THREATENING/CHALLENGING THE VERY EXISTENCE OF LAW AND SOCIETY

Although legal principles apply to 3D printing in the same way that they apply to other technologies, 3D printing has the unique potential to upset the legal status quo.[9] 3D printing cuts across multiple areas of law

9 *See* John Hornick, *Some Thoughts on Copyright and 3D Printing*, 3D PRINTING INDUS. (Sept. 13, 2013), http://3dprintingindustry.com/2013/09/13/some-thoughts-on-copyright-and-3d-printing (defining "away from control" as "widespread personal manufacturing of copyrighted objects independent of established markets in ways that cannot be detected, prevented or controlled"); Jeroen P.J. de Jong & Erik de Bruijn, *Innovation Lessons from 3-D Printing*, 54 MIT SLOAN MGMT. REV. 43, 44 (2013) ("The use of 3-D printing makes it possible

and most types of technologies and products. Eventually, anyone will be able to privately manufacture anything with just a 3D printer, which may pose a variety of threats to society. This Part will first provide a brief explanation of how 3D printing technology works, followed by the dangers it may pose.

A. *What Is a 3D Printer?*

3D printing is a manufacturing method that involves adding multiple thin layers of one or more materials to produce three-dimensional objects. The method is implemented using a 3D printer equipped with software that controls a material depositing device that adds the various layers of materials based on topographical data provided by a CAD file.[10] Each CAD file divides the original model into slices and provides instructions, or a blueprint, to the 3D printer on how to build the final object, layer-by-layer.[11] For a simple comparison, imagine how sliced bread can be arranged to re-form the original loaf of bread by laying the slices one upon another until the loaf is rebuilt. This process is analogous to what a 3D printer does to manufacture an object; it adds materials in appropriate locations to create the volume of the object in a bottom to top manner.[12]

3D printing enables anyone to create almost any product they want by themselves.[13] Such freedom, however, may also have negative

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to build physical models, prototypes, patterns, tooling components or production parts. Design and manufacturing organizations use it for product parts in the consumer, industrial, medical and military markets.").

10 *See* Danton Bryans, Comment, *Unlocked and Loaded: Government Censorship of 3D-Printed Firearms and a Proposal for More Reasonable Regulation of 3D-Printed Goods*, 90 IND. L.J. 901, 902–03 (2015) (providing an in-depth explanation of how 3D printing works); Lucas S. Osborn, *Regulating Three-Dimensional Printing: The Converging Worlds of Bits and Atoms*, 51 SAN DIEGO L. REV. 553, 558–59 (2014) (explaining how the technology "additively" builds up multiple layers). See also SCULPTEO, http://www.sculpteo.com (last visited Jan. 16, 2016), for an example of an online firm that sells 3D printed products. 3D printing makes a physical transcription, a "materialization" of these digital data, which opens wide possibilities for creativity. This new printing method is often considered as being revolutionary as it takes a completely different logic than older conventional production methods. With the traditional industrial processes, the machines remove material, and 3D printing adds material.

11 *See* sources cited *supra* note 10; de Jong & de Bruijn, *supra* note 9, at 44 ("Drawing on a computer-aided design (CAD) file, the design for an object is first divided into paper-thin, cross-sectional slices, which are then each 'printed' out of liquid, powder, plastic or metal materials in sequence until the entire object is created.").

12 *See* sources cited *supra* note 10.

13 Desai & Magliocca, *supra* note 8, at 1693 (discussing the positive aspects of 3D printing: "The promise of 3D printing is that people will be free to make almost anything they want themselves, which opens the door to a new wave of innovation from the home, the start-up, and large firms").

consequences that need to be kept in mind as 3D printing technology continues to become more widely accessible.

B. *The Threats of 3D Printing*

3D printing presents a double-edged sword: while it can offer so many benefits to society, it can also cause some potentially disastrous outcomes that should not be ignored.[14] Once personal and industrial 3D printers become capable of massive production, it will be difficult to control and prevent widespread personal manufacturing of copyrighted objects, which John Hornick refers to as "away from control."[15] The following discussion will also address the threats to intellectual property laws, product safety (and therefore public safety), environmental protection, as well as the threat to other regulated fields.

Without ignoring the fact that the 3D printing revolution opens the door to new waves of progress, welfare, and solutions, we have to cope not just with the uncertainty accompanying the 3D printing era, but also with the severe threats, hazards, perils, and jeopardies that come along with it. As policymakers should prepare society before crises occur, it is important to be aware of the entire spectrum of threats and challenges. The following Section will discuss the threats and challenges of 3D printing in several areas, followed by an elaborate discussion of the threat to the different branches of intellectual property. Some of these threats have already been widely discussed (e.g., 3D printed guns) while others have hardly been mentioned in the latest harvest of scholarly writings on the topic (e.g., environmental and medical threats). These are all beyond mere uncertainty. Lawmakers face huge hurdles in the process, including coping with various stakeholders, procedures, planning, and the unpredictable nature of 3D printer

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14 *See* Lyndsey Gilpin, *The Dark Side of 3D Printing: 10 Things to Watch*, TECHREPUBLIC (Mar. 5, 2014, 4:51 AM), http://www.techrepublic.com/article/the-dark-side-of-3d-printing-10-things-to-watch (warning society against ten hazards associated with 3D printers: excessive use of energy; unhealthy air emission; reliance on plastics that cannot be recycled; black market for counterfeits of IP-protected products; gun control loopholes; product liability; moral and ethical implications of bioprinting; possibility of enabling the manufacture of illegal drugs; national security risks; and production of unsafe items that come in contact with food). See also the PBS video PBSoffbook, *Will 3D Printing Change the World?*, YOUTUBE (Feb. 28, 2013), https://www.youtube.com/watch?v=X5AZzOw7FwA.

15 Hornick, *supra* note 8 ("Legal disruption by 3D printing away from control will probably be mostly unintentional. Consumers who 3D print products may not be aware that legal rights and obligations are involved. But 3D printing away from control may become so widespread—and it may become so common to copy things with 3D scanners, widely available digital blueprints, and 3D printers—that most people and companies will not care whether their 3D printing is legal and stakeholders may throw up their hands in defeat.").

technology and its outcomes.[16] Policymakers need to take these threats seriously when considering legal solutions.[17] Our solution, which will be addressed in the next Part of the Article, may contribute to an easier and more efficient way to handle these dangers.

1. Threat to Product Safety

When produced without supervision or regulation in the home by the general consumer or small firms using peer-to-peer software, 3D printed products can be dangerous.[18] This is especially true when highly regulated products are involved, such as safety equipment, drugs, food, or cars.[19] While products made from hazardous materials, such as special plastics, are obviously dangerous, even products made from natural materials, such as bicycles and children's toys, can place the public at risk when they are not manufactured properly.[20] The ultimate question of who will be responsible, if at all, for any resulting damages is still up in the air.[21] Will it be the companies that make the printers? The owners of the printers? The sellers of materials used to print the objects? Or the users of the printers? Will insurance cover any injuries or damages?

The model suggested in this Article can help identify and control the source of 3D printed objects and, therefore, provide a means for holding those accountable who produce such products.

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16 Depoorter, *supra* note 4, at 1489–91 (explaining the hurdles that might have prevented legislators and courts from coming up with a solution policymakers can adopt).

17 *Id.* at 1489–93 (explaining uncertainties in using existing intellectual property principles in relation to 3D printing).

18 *See 12 Vital Facts About Food Safe 3D Printing*, ALL3DP (Apr. 25, 2016), https://all3dp.com/food-safe-3d-printing-material-filament-plastic ("[W]hilst fabricating kitchen utensils or drinking cups in a funky design, you may well have cause to stop and wonder; how safe is 3D printing for daily contact with food and drink?"). Risks include: bacteria buildup, chemicals in the filament, toxic particles in the printing process, not being dishwasher safe. *See id.*

19 *See generally id.*

20 *See* Jelmer Luimstra, *Is 3D Printing Always a Safe Activity?*, 3DPRINTING.COM (Mar. 11, 2014), http://3dprinting.com/news/safe-3d-printing [http://web.archive.org/web/20160504041402/http://3dprinting.com/news/safe-3d-printing] (plastic materials being used by 3D printing for making toys and utensils can be dangerous and cause severe health problems).

21 *See* Nora Freeman Engstrom, *3-D Printing and Product Liability: Identifying the Obstacles*, 162 U. PA. L. REV. ONLINE 35, 37 (2013) (examining the RESTATEMENT (SECOND AND THIRD) OF TORTS and determining that "in many instances, no one will be strictly liable for these injuries under current [product liability] doctrine"); Giulio Coraggio, *Top 3 Legal Issues of 3D Printing!*, DLA PIPER: TECHNOLOGY'S LEGAL EDGE (Sept. 7, 2015), https://www.technologyslegaledge.com/2015/09/top-3-legal-issues-of-3d-printing (because the customer is the actual manufacturer, "3D printing certainly creates situations that were previously unheard [by courts]").

2. Threat to Medical Devices, Drugs, and Human Organs

Imagine a scenario involving black market 3D printed human organs, drugs, medical equipment, and other medical products.[22] This scenario is not hypothetical; it is already happening. 3D printers are reported to be capable of printing human organs, such as artificial ears and other internal and external parts of the body.[23] Organovo, a medical laboratory and research company, has already printed liver cells in cooperation with the National Eye Institute and the National Center for Advancing Translational Sciences.[24] But shockingly, the conversation about the ethical, moral, and legal issues of such printing has only just begun.[25]

3D printing is also a great candidate for nano-molecular production due to the capacity of 3D printers to print miniature components, such as human cells and other living matter.[26] 3D printers will also be used to print medicinal drugs. Indeed, doctors (and possibly even patients themselves) will be able to print medications on their own.[27] Assembling chemical components on a molecular level by using a 3D printer will become more and more feasible.[28] Regulators at the

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22 HOD LIPSON & MELBA KURMAN, FABRICATED: THE NEW WORLD OF 3D PRINTING 218–23 (2013) (discussing black market uses of 3D printers); *see* de Jong & de Bruijn, *supra* note 9, at 44–45 (explaining that as their technologies evolved, 3D printing companies started to focus on applications of 3D printing for medical uses such as hearing aids and dental implants).

23 *See* C. Lee Ventola, *Medical Applications for 3D Printing: Current and Projected Uses*, 39 PHARMACY & THERAPEUTICS 704, 706 (2014); Macrina Cooper-White, *How 3D Printing Could End the Deadly Shortage of Donor* Organs, HUFFINGTON POST (Mar. 2, 2015), http://www.huffingtonpost.com/2015/03/01/3d-printed-organs-regenerative-medicine_n_6698606.html (providing a Q&A with Dr. Anthony Atala, director of the Wake Forest Institute for Regenerative Medicine). *See generally* Phoebe H. Li, *3D Bioprinting Technologies: Patents, Innovation and Access*, 6 L. INNOVATION & TECH. 282 (2014) (discussing research concerning and uses of 3D bioprinting technology as well as roles of biotechnology companies and governments in shaping the industry).

24 Press Release, Organovo, Organovo Announces Collaboration with National Institutes of Health (Jan. 14, 2014), http://ir.organovo.com/phoenix.zhtml?c=254194&p=irol-newsArticle&ID=2129449; *ExVive Human Liver Tissue Performance*, ORGANOVO, http://organovo.com/tissues-services/exvive3d-human-tissue-models-services-research/exvive3d-liver-tissue-performance (last visited Nov. 25, 2016).

25 Gilpin, *supra* note 14 (ethical discussion on how 3D printing will inevitably cause a lot of controversy).

26 Carrie E. Rosato, Note, *The Medical Liability Exemption: A Path to Affordable Pharmaceuticals?*, 42 FLA. ST. U. L. REV. 1067, 1085 (2015).

27 *Id.*

28 *See* Press Release, Univ. of Ill. at Urbana-Champaign, Molecule-Making Machine Simplifies Complex Chemistry (Mar. 12, 2015), http://www.eurekalert.org/pub_releases/2015-03/uoia-mms030615.php; Gilpin, *supra* note 14; Jim Keeley, *3D Printer for Small Molecules Opens Access to Customized Chemistry*, HHMI (Mar. 12, 2015), http://www.hhmi.org/news/3d-printer-small-molecules-opens-access-customized-chemistry (using what they call a "3D

Federal Drug Administration (FDA) will inevitably face the need to handle countless 3D printed medical devices.

3. Threat to Food Industry

Food manufacturing by 3D printers can also threaten public safety. Food products can look like those that we usually consume, but can actually be made from hazardous ingredients. 3D printed dishes and utensils can also contain unsafe materials or be contaminated with bacteria that could grow in the 3D printers themselves.[29] Heavy existing regulation on food would not help in the 3D digital era because 3D printed copies will be difficult to identify as opposed to regulated food products.

4. Threat to Public Safety—Guns (with No Roses)

Outside of the intellectual property world, 3D printing has also entered the spotlight in a criminal context. Aside from being able to print toy guns that may infringe on a toy manufacturer's intellectual property rights, 3D printers have also proved capable of fabricating actual, functioning guns.[30] This has sparked governments around the world to evaluate the dangers of 3D printing technology, and even enact laws banning such uses of the printers.[31] While these efforts are commendable, they are only at the beginning stages, and only seek to employ punitive measures to deter certain uses of the technology—they

printer" for small molecules, scientists used a single automated process to synthesize classes of small molecules).

29 Gilpin, *supra* note 14; *see also* Osborn, *supra* note 10, at 564.

30 Georgi Kantchev, *Authorities Worry 3-D Printers May Undermine Europe's Gun Laws*, N.Y. TIMES (Oct. 17, 2013), http://www.nytimes.com/2013/10/18/business/international/european-authorities-wary-of-3-d-guns-made-on-printers.html?_r=0 (reporting on the Austrian Interior Ministry's successful testing of a gun made with a consumer-grade 3D printer).

31 *See, e.g.*, HOME OFFICE, GUIDE ON FIREARMS LICENSING LAW 22 (2016), https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/479794/Guidance_on_Firearms_Licensing_Law_Nov_2015_v16.pdf ([In the U.K, t]he manufacture, purchase, sale and possession of 3D printed firearms, ammunition or their component parts is fully captured by the provisions in section 57(1) of the Firearms Act 1968."); Josh Butler, *NSW Tightens 3D Printed Gun Legislation as Expert Warns They're Getting Cheaper, More Effective*, HUFFINGTON POST AUSTL. (July 15, 2016, 12:51 PM), http://www.huffingtonpost.com.au/2015/11/20/3d-printed-gun-laws-nsw_n_8595818.html (noting Australian State, New South Whales, has banned possession of files for 3D printing firearms); *UK Bans the Manufacture, Sale of 3D Printed Guns*, WEBPRONEWS (Dec. 6, 2013), http://www.webpronews.com/uk-bans-the-manufacture-sale-of-3d-printed-guns-2013-12 (noting the U.K. updated its Firearms Licensing Law with a clause explicitly banning 3D printed guns).

do nothing to prevent the illegal use in the first place. To this end, we claim that a revolutionary reform of current legal norms is required to rein in and prevent public misuse of the printers. Briefly, we propose a print request authorization configuration that reviews and grants or denies user print requests based on the objects to be printed. We elaborate on this more thoroughly in Part IV of this Article.

Banning the manufacture of guns by 3D printers may, of course, violate First and Second Amendment rights and therefore be unconstitutional.[32] Banning 3D printed guns may also contradict the Supreme Court's decision in *District of Columbia v. Heller*, which protected modern forms of firearms by noting that "the Second Amendment extends, prima facie, to all instruments that constitute bearable arms, even those that were not in existence at the time of the founding."[33] Nevertheless, various proposals and models for changes to federal and state regulations and legislation concerning 3D printed guns have been made and should be addressed.[34]

5. Threat to Car and Aircraft Industry—Transportation and 3D Printed Parts

Manufacturing of vehicles, such as cars and aircrafts, as well as the vehicle components, by 3D printers can similarly threaten public safety. As people begin to design and print customized parts for their own or others' vehicles, it will undoubtedly hurt the aftermarket parts industry, affecting revenue and jobs. It will also be increasingly difficult to regulate the safety of those designs.[35] The parts can appear genuine, but may be riddled with deficiencies and unsuitable for their intended purposes, which could result in many serious injuries.

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32 Josh Blackman, *The 1st Amendment, 2nd Amendment, and 3D Printed Guns*, 81 TENN. L. REV. 479 (2014) (discussing the First and Second Amendments in relation to 3D printed guns).

33 District of Columbia v. Heller, 554 U.S. 570, 582 (2008); *see also* Peter Jensen-Haxel, Comment, *3D Printers, Obsolete Firearm Supply Controls, and the Right to Build Self-Defense Weapons Under* Heller, 42 GOLDEN GATE U. L. REV. 447 (2012) (discussing the right to build weapons after *District of Columbia v. Heller*).

34 *See, e.g.*, Undetectable Firearms Modernization Act of 2013, H.R. 1474, 113th Cong. (2013) (the legislation banning 3D printed guns originally failed to pass but was reintroduced in 2015); *see* Katie Curtis, Note, *A Wiki Weapon Solution: Firearm Regulation for the Management of 3D Printing in the American Household*, 41 RUTGERS COMPUTER & TECH. L.J. 74, 81–86 (2015) (addressing the right to bear arms under the Second Amendment).

35 *See* Deven R. Desai, *The New Steam: On Digitization, Decentralization, and Disruption*, 65 HASTINGS L.J. 1469, 1474 (2014) ("As more people design cars and car parts for personal manufacture, the effect of little to no safety regulation will go up. The ability to regulate those practices will go down.").

6. Threats to Regulated Fields—Tax Collection

Many products in various other fields are also at risk. Take, for example, libraries. Many libraries have begun to offer 3D printers for free public use.[36] It is already well established that libraries may be liable if the public makes illegal copies of books.[37] Take also the 3D printing of clothing and shoes, which has begun to put the entire fashion industry on high alert as to the ramifications of people 3D printing protected clothing and shoe designs and trademarks.[38]

The 3D industrial revolution can essentially convert residential homes into modern factories. While the biggest threat is, of course, in developing countries where there is minimal protection over the workforce, developed countries are at risk as well. As these homemade factories become more prevalent and remain largely unregulated, they pose serious threats to workplace protection, labor, and employment laws.[39]

7. Threat to Environmental Protection

3D printing might also have a negative impact on environmental protection if production gets out of control. The melting of plastic with heat or lasers typically involved in the 3D printing process can be extremely harmful to the environment.[40] Additionally, a 3D printer can consume up to fifty to 100 times more electrical energy to produce an item than an injection molding apparatus.[41] The 3D printer also poses a health risk when used in the home. When heating the plastic to print small figures, the PLA filaments of the machines can emit twenty billion ultrafine particles per minute, which can settle in the lungs or the

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36 *See, e.g.*, Sarah K. Wiant, *Comment: 3D Printing*, 71 WASH. & LEE L. REV. 699, 703–05 (2014) (explaining that libraries should not be held responsible for patron copying using 3D printers which exceeds the law).

37 *See* 17 U.S.C. § 108 (2012) (stating when reproduction by libraries is acceptable or unacceptable).

38 Rose Auslander, *Time for Fashion Designers to Buckle Up for 3-D Printing*, LAW360 (Oct. 17, 2013, 4:01 PM), http://www.law360.com/articles/478826/time-for-fashion-designers-to-buckle-up-for-3-d-printing (discussing negative impacts of pirated shoe and clothing designs if 3D printing becomes the fashion industry standard).

39 Elizabeth J. Kennedy & Andrea Giampetro-Meyer, *Gearing Up for the Next Industrial Revolution: 3D Printing, Home-Based Factories, and Modes of Social Control*, 46 LOY. U. CHI. L.J. 955, 988 (2015) (discussing alternative solutions, e.g., "modes of social control" for home-based factories and laws relating to: ethical precepts, safety regulations, affinity groups, vigilant and effective media, and direct action).

40 *See* Gilpin, *supra* note 14 (referring to a study conducted by Loughborough University).

41 *See id.*

bloodstream and cause health risks, especially for sensitive individuals (e.g., those who have asthma).[42]

8. Threat to Workplace Protection

Making items at home and "away from control" can eventually render conventional manufacturers unnecessary. This will threaten the traditional retail model where products are sold in stores or on websites, similar to how photo shops disappeared when digital photography became popular and people could print their photos at home. Such a change will inevitably decrease state and federal government revenues earned from sales tax and duties.[43]

The hazardous effects of 3D printing have not yet been thoroughly studied. The discussion above reflects only the tip of the iceberg of all the risks and hazards the 3D printing revolution may invoke. To date, little thought has been given to the effect of 3D printing in many other areas of the law. Our suggested model can help handle future unpredictable outcomes and not merely the issues we presently face.

We note that, while we do appreciate the aspect concerning the *protectability* of 3D printed objects and CAD models (e.g., via copyright or patent) themselves, this Article focuses on 3D printing's challenges to intellectual property, as part of other challenges, rather than its *protectability by way* of intellectual property. It is the tug-of-war between users of the technology and intellectual property owners that is of more critical concern, and for which we propose reforms to current norms to address the balance of interests between these two conflicting groups.

In order to understand the potentially harmful effects of 3D printing on current laws, we first have to understand how 3D printers work. One of the most important insights should be how the 3D printer actually functions and more specifically, in regard to the infringement of intellectual property laws, the role of the operating system and the software that "carries" the 3D figure and operates together with the printer and materials to create or manufacture the printed product. In order to be an efficient solution, legal reforms must address the operating system and software instead of focusing merely on the printer and raw materials.

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42 *See id.*

43 Hornick, *supra* note 8 ("3D printing away from control will also challenge governments' abilities to collect income and sales taxes . . . .").

C. *The Extensive Use of 3D Printing*

1. The Accessibility of 3D Printers

While it may seem like a relatively new technology, researchers and deep-pocketed manufacturers have actually been using 3D printing for over thirty years.[44] Analogous to the popularization of computers, the introduction of 3D printers to the consumer market has been slow as the printers have traditionally been large and expensive to produce and maintain. However, recent advances in the technology have made the devices small enough to enter the home and hence to be used by everyone, everywhere, and for anything.[45] The technology works as an iterative process; layers of material are essentially deposited and hardened (e.g., via a laser sintering process) according to a specified model, such as the aforementioned Tintin rocket model, until the end product is completed.[46] Any suitable materials can be used, including metals and plastics, as long as their properties allow for them to be hardened.[47]

Unlike conventional home and office products, such as 2D printers, computers, video records, and copy machines, 3D printers are capable of using all sorts of materials to create tangible products (including human organs, guns, and even food). They can be used to not only copy products, but also derive new ones, allowing for massive production. If you want to have new Nike shoes, why bother going to the mall or shopping on the Internet? Just find the 3D model of the shoes online and print them out yourself. You want a shirt just like the one your friend has? Borrow it, scan the design, and make it yourself. You want to sell guns, human organs, engines, or medicine? Just do it yourself at home with your new 3D printer device. Are you bored with

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44 Chuck Hull invented 3D printing in the 1980s. Matthew Ponsford & Nick Glass, *'The Night I Invented 3D Printing'*, CNN (Feb. 14, 2014, 9:03 AM), http://www.cnn.com/2014/02/13/tech/innovation/the-night-i-invented-3d-printing-chuck-hall; *see also* Dana Goldberg, *The History of 3D Printing*, PRODUCT DESIGN & DEV. (Sept. 16, 2014, 9:28 AM), https://www.pddnet.com/article/2014/09/history-3d-printing.

45 *See* Posie Aagaard & Michael A. Kolitsky, *3-D Printing, Copyright, and Fair Use: What Should We Know?*, *in* TOO MUCH IS NOT ENOUGH!, CHARLESTON CONFERENCE PROCEEDINGS 2013, at 470 (Beth R. Bernhardt et al. eds., 2014) ("Over the past few years, 3-D printing has rapidly become more affordable and accessible."); *A Brief History of 3D Printing*, T. ROWE PRICE ASSOCS., INC., http://individual.troweprice.com/staticFiles/Retail/Shared/PDFs/3D_Printing_Infographic_FINAL.pdf (last visited Oct. 9, 2016).

46 *See* E. Sachs et al., *Three-Dimensional Printing: Rapid Tooling and Prototypes Directly from a CAD Model*, 39 CIRP ANNALS–MANUFACTURING TECH. 201 (1990).

47 *See id.*

your furniture or old paintings, or need a replacement part for your car? Design, print, and replace them all yourself.[48]

The printer cannot function without operating software, which will be discussed below. This software should be closely tied to the legal solution we are proposing.

2. The Computer-Aided Design (CAD) Models

Constructed to somewhat resemble the miniature industrial machines,[49] 3D printers include mechanical components, electronic hardware, as well as software, but an inseparable feature of 3D printers is that CAD models are fed to and used by the software to generally control the printer in order to actually craft the final product, layer-by-layer.[50] CAD models are essentially three-dimensional computer representations of the real world objects to be printed.[51] They can be designed using computer drawing software or, alternatively, rendered via 3D scanners—devices that employ lights and cameras to capture and generate 3D models of actual objects[52]—that instruct the printer how to create the corresponding physical object.[53]

Since the time 3D printing was introduced to the consumer market, numerous CAD models have been created and shared around the web.[54] Thingiverse is but one of the mediums that users have been using to share their models.[55] Shapeways.com is another player in the CAD model distribution business.[56] In addition to allowing users to upload and share CAD models, Shapeways also provides 3D printing

48 *See generally id.*

49 *Cubify Cube, a 3D Printer That Looks like a Home Appliance*, COOLTHINGS (Jan. 18, 2013), http://www.coolthings.com/cubify-cube-3d-printer.

50 Sachs et al., *supra* note 46.

51 *See id.*

52 *How It Works: Step by Step*, SHAPEGRABBER, http://www.shapegrabber.com/solutions-how-it-works.shtml (last visited Oct. 9, 2016).

53 Brian Rideout, *Printing the Impossible Triangle: The Copyright Implications of Three-Dimensional Printing*, 5 J. BUS. ENTREPRENEURSHIP & L. 161, 163 (2011); Sachs et al., *supra* note 46.

54 *See, e.g.*, Dale Nicholls, *Where to Find Free 3D CAD Models for 3D Printing*, 3D PRINTING SYS. (Feb. 8, 2013), http://3dprintingsystems.com/where-to-find-free-3d-cad-models-for-3d-printing (providing a list with URLs of some of the most popular online collections of objects, such as Thingiverse, GrapCAD, Google's 3D Warehouse, Parts Libraries, Trace Parts Online, and 3DTin).

55 THINGIVERSE, *supra* note 3.

56 *About Us*, SHAPEWAYS, http://www.shapeways.com/about?li=footer (last visited Oct. 9, 2016).

services. Instead of purchasing their own printers, individuals can have their products printed using Shapeways's 3D printers.[57]

Given that users can print nearly anything with a 3D printer (as long as they have access to the appropriate CAD models),[58] some believe that the technology will soon revolutionize the manufacturing world.[59] Concentrated and large manufacturing facilities, which have been the driving force of modern mass production, face a real risk of becoming a thing of the past—it cannot be emphasized enough that 3D printing has the potential of putting the power of manufacturing into the hands of the consumer.[60]

II. NOTHING CAN ESCAPE THE FLOOD—NOT COPYRIGHTS, PATENTS, OR TRADEMARKS

A. *Potential Loss for the Industry*

Analysts predict that "[b]y 2018, 3D printing will result in the loss of at least $100 billion per year in intellectual property globally. . . . [a]t least one major western manufacturer will claim to have had intellectual property (IP) stolen for a mainstream product by thieves using 3D printers."[61] These predictions may reflect the copying, self-manufacturing, or reserved manufacturing (which have already become easily accessible and available for purchase on many websites), as well as

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57 *How Shapeways 3D Printing Works*, SHAPEWAYS, http://www.shapeways.com/how-shapeways-works?li=footer (last visited Oct. 9, 2016).

58 Sachs et al., *supra* note 46.

59 *See, e.g.*, Desai & Magliocca, *supra* note 8, at 1697 ("3D printing will unleash the power of digitized things on manufacturers."); Rick Smith, *7 Ways 3D Printing Is Already Disrupting Global Manufacturing*, FORBES (June 29, 2015, 7:55 AM), http://www.forbes.com/sites/ricksmith/2015/06/29/7-ways-3d-printing-is-already-disrupting-global-manufacturing/#409078f4158b (explaining the seven ways 3D printing has already impacted the manufacturing world with its current use).

60 *See* Richard A. D'Aveni, *3-D Printing Will Change the World*, HARV. BUS. REV. (Mar. 2013), https://hbr.org/2013/03/3-d-printing-will-change-the-world# (theorizing that as 3D technology becomes more available and its prices drop, goods will be manufactured closer at their point of purchase or consumption: the household); Desai & Magliocca, *supra* note 8, at 1697.

61 Press Release, Gartner, Inc., Gartner Reveals Top Predictions for IT Organizations and Users for 2014 and Beyond (Oct. 8, 2013), http://www.gartner.com/newsroom/id/2603215. Surprisingly, more thieves using 3D printers will likely reside in western markets rather than in Asia by 2015. *Id.* ("The plummeting costs of 3D printers, scanners and 3D modeling technology, combined with improving capabilities, makes the technology for IP theft more accessible to would-be criminals. Importantly, 3D printers do not have to produce a finished good in order to enable IP theft. The ability to make a wax mold from a scanned object, for instance, can enable the thief to produce large quantities of items that exactly replicate the original.").

IP-protected products that will never be purchased. The phenomenon is not new. The digitalization era of the entertainment sector in the mid-to-late 1990s followed by active digital piracy through peer-to-peer downloading of content, which still lingers today, led to significant revenue loss in the entertainment sector.[62]

As music, films, books, and photos have all become digitized, the nineteenth century manufacturing model has crumbled, leaving the industries dramatically changed.[63] The process of decentralizing digital piracy significantly damaged the industry, resulting in a decline in sales.[64] Entertainment stakeholders tenaciously fought against illegal file sharing and downloading with little result.[65] 3D printing will probably produce an even worse outcome. Like music, movies, and other entertainment products, downloading CAD models that yield patent infringing products will be difficult to detect.[66] Most people using 3D printers will realize that the probability of being caught is small.[67] Firms will externalize the risk to end-users by making them sign intellectual property memberships and indemnification clauses.[68]

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62 Stan J. Liebowitz, *File Sharing: Creative Destruction or Just Plain Destruction?*, 49 J.L. & ECON. 1, 14–17 (2006) (offering empirical evidence that file sharing harms revenues in the industry); *see also* Rafael Rob & Joel Waldfogel, *Piracy on the High C's: Music Downloading, Sale Displacement, and Social Welfare in a Sample of College Students*, 49 J.L. & ECON. 29, 29–30 (2006) (discussing that piracy downloading reduces individuals' purchases in their survey by about ten percent).

63 LIPSON & KURMAN, *supra* note 22 (discussing customized, on demand manufacturing and cloud manufacturing, arguing that cloud manufacture used by many users will eradicate centralized mass manufacturing).

64 *See* Aagaard & Kolitsky, *supra* note 45, at 470 ("[W]ith the ease and affordability of copying physical objects come concerns about ownership of materials."); Depoorter, *supra* note 4, at 1493 n.50 (citing Liebowitz, *supra* note 62, at 14–17 (presenting empirical evidence that filing sharing reduced the recording industry's revenues)); Desai & Magliocca, *supra* note 8, at 1693 ("Once music, film, and books were digitized, those industries were transformed.").

65 Depoorter, *supra* note 4, at 1493–94.

66 *Id.* at 1496 ("Like music and movie downloading on peer-to-peer networks, most infringement will be difficult to detect.").

67 *Id.* at 1496–97 ("Because the rights holders' resources to pursue IP violations are limited, as the number of infringers increases, each individual infringer's chance of being caught decreases. This, in turn, will likely lower inhibitions against producing counterfeit items on 3D printers even further.").

68 For example, see the terms and conditions posted on Sculpteo's website under Article 10–Intellectual Property. *Terms and Conditions of Sculpteo*, SCULPTEO, http://www.sculpteo.com/en/terms (last visited Jan. 22, 2016) ("ii. All CUSTOMERS who send SCULPTEO an image, drawing or design (the "IMAGE") guarantee that they are the author or holder of all intellectual property rights for this IMAGE and that they have not infringed any intellectual property rights by sending this IMAGE. The CUSTOMER undertakes to indemnify SCULPTEO against any claims by third parties. The CUSTOMER will retain ownership of the IMAGE sent to SCULPTEO. The CUSTOMER grants SCULPTEO a licen[s]e for the single use of their IMAGE to carry out their order. . . . v. Any reproduction, exploitation or use, whether in France or abroad, of all or part of the "http://www.sculpteo.com" website and/or any OBJECT for professional use (on whatever basis, even partially) or duplication on any media,

3D printing may result in widespread copying of not only consumer products but, perhaps more importantly from an intellectual property perspective, also IP-protected products and their components. Companies that conventionally purchased replacement parts may begin making or repairing the parts themselves. Laws will become old fashioned, traditional, inadequate, or worse yet, completely irrelevant.

Aggressive enforcement may actually undermine public support for patent rights.[69] If enforcement is too coercive, people may feel that the underlying legal rules are undue and unjust.[70] Mass infringement can lead to arbitrary enforcement without actual effect.[71] Indeed, imposing on a college student and a single mother a six-figure damage award did not halt the phenomena of illegal downloading of music but only led to more negative publicity on the part of the record companies.[72]

B. *3D Printer and Intellectual Property Infringement*

1. 3D Printer Use and Copyright Infringement

The U.S. Constitution gives Congress the power to form a copyright system and to enact legislation that "promote[s] the Progress of Science and useful Arts, by securing for limited Times to Authors . . . the exclusive Right to their respective Writings."[73] Copyright infringement is defined by statute as: "Anyone who violates any of the exclusive rights of the copyright owner as provided by sections 106 through 122 or of the author as provided in section 106A(a) . . . is an infringer of the copyright or right of the author, as the case may be."[74] Since a copyright is "the right to exclude others" from reproducing, preparing derivative works, distributing, performing, displaying, or using the work covered by copyright, sufficient measures

website, free, paid or commercial blogs, is forbidden unless prior consent has been given by SCULPTEO and constitutes a counterfeiting offence punishable under articles L335-2 and following of the French Intellectual Property Code.").

69 Depoorter, *supra* note 4, at 1501 ("[E]xcessive deterrence may undermine the political support for the underlying protected rights.").

70 *Id.* at 1499.

71 *See id.* at 1499–1501 (warning against coercive approaches to enforcement in relation to 3D printing, given the many benefits of the technology); Ben Depoorter et al., *Copyright Backlash*, 84 S. CAL. L. REV. 1251, 1255–56 (2011) ("[D]eterrence-based approach[es] will prove futile and even counterproductive to the goals of copyright holders.").

72 Depoorter, *supra* note 4, at 1499.

73 U.S. CONST. art. I, § 8, cl. 8.

74 17 U.S.C. § 501(a) (2012).

should be taken to allow copyright owners to enforce their rights against infringers.[75]

a. 3D Printed Objects Infringement

According to the statute, as long as the decorative aspect of an item is separate from the item's utilitarian aspects, the author of that item may obtain a copyright.[76] In the 3D printing context, whenever copies of copyrighted items are printed using 3D printers, the copies may thus infringe on the protected creative designs.[77] A copyright owner can therefore bring a claim of direct infringement against anyone who reproduces the protected designs.[78] For example, going back to Moulinsart's aforementioned Tintin rocket, 3D printing a copy of that rocket would amount to copyright infringement.

b. CAD Model Sharing Is Infringement

In the case of CAD models, if a particular CAD model is copyrighted, sharing of the model over the Internet would be no different from sharing copyrighted music and movies, both of which are protected by copyright law.[79] The biggest targets that copyright owners will need to monitor are hosting sites, such as Thingiverse, as the majority of model sharing will likely take place on such sites.

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75 *Id.* § 106.

76 The 1976 Copyright Act defines pictorial, graphic, and sculptural works. 17 U.S.C. § 101 ("'Pictorial, graphic, and sculptural works' include two-dimensional and three-dimensional works of fine, graphic, and applied art, photographs, prints and art reproductions, maps, globes, charts, diagrams, models, and technical drawings, including architectural plans. Such works shall include works of artistic craftsmanship insofar as their form but not their mechanical or utilitarian aspects are concerned; the design of a useful article, as defined in this section, shall be considered a pictorial, graphic, or sculptural work only if, and only to the extent that, such design incorporates pictorial, graphic, or sculptural features that can be identified separately from, and are capable of existing independently of, the utilitarian aspects of the article."). When a work's utilitarian and design features are so intertwined that they are unable to be physically separated, courts consider whether there is conceptual separability between its form and function. *See* Carol Barnhart Inc. v. Econ. Cover Corp., 773 F.2d 411 (2d Cir. 1985).

77 For a thorough discussion of copyright issues regarding 3D printing see Rideout, *supra* note 53, at 163–64; Haritha Dasari, Note, *Assessing Copyright Protection and Infringement Issues Involved with 3D Printing and Scanning*, 41 AIPLA Q.J. 279 (2013); and Edward Lee, *Digital Originality*, 14 VAND. J. ENT. & TECH. L. 919 (2012).

78 *See supra* note 77.

79 *See* Metro-Goldwyn-Mayer Studios, Inc. v. Grokster, Ltd., 545 U.S. 913 (2005) (ruling that distributors of peer-to-peer file sharing software infringed the copyrights of the songwriters, music publishers, and motion picture studios who brought the action); UMG Recordings, Inc. v. MP3.com, Inc., 92 F. Supp. 2d 349 (S.D.N.Y. 2000) (ruling in favor of musical recording copyright holders and against an Internet company that made MP3 files of the recordings available to its subscribers).

The Digital Millennium Copyright Act (DMCA)[80] has allowed copyright holders over the past decade to compel Internet site operators to act whenever copyright infringing content is found on their sites. As demonstrated in the Moulinsart example above, it appears to extend copyright owners the means to enforce their rights even in the 3D printing context;[81] they can force Internet sites to block access to infringing material and can pursue individuals who print infringing items.[82] The DMCA also provides a convenient safe harbor provision to such site operators—essentially, freedom from infringement liability in exchange for compliance with the notice, and subject, of course, to the condition that it was actually an independent actor or user who uploaded the infringing material and not the site itself.[83] This is reasonable because there are legitimate reasons for giving sites like Thingiverse the benefit of the doubt and keeping them in business as long as they comply with the law.[84]

But not all authors of works take the extra step of creating and copyrighting corresponding CAD models. For centuries, authors have created works and designs without the use of computers. While these works *can* be modeled using computers (and authors nowadays can

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80 Digital Millennium Copyright Act, Pub. L. No. 105-304, 112 Stat. 2860 (1998). Essentially, this was the United States implementation of the World Intellectual Property Organization (WIPO) treaties, which heightened penalties for copyright infringement over the Internet. *See* WIPO Copyright Treaty, Dec. 20, 1996, 36 I.L.M. 65; WIPO Performances and Phonograms Treaty, Dec. 20, 1996, 36 I.L.M. 76.

81 Henn, *supra* note 2 (noting Moulinsart served Thingiverse with a DMCA takedown notice to remove printing designs of Tintin's cartoon moon rocket).

82 *Id.*

83 "[17 U.S.C. § 512(c) (2012)] limits the liability of qualifying service providers for claims of direct, vicarious, and contributory infringement for storage at the direction of a user of material that resides on a system or network controlled or operated by or for the service provider." Perfect 10, Inc. v. CCBill L.L.C., 488 F.3d 1102, 1117 (9th Cir. 2007). To be eligible for the safe harbor, a service provider must adopt and reasonably implement, and "inform[] subscribers and account holders of the service provider's system or network of, a policy that provides for the termination in appropriate circumstances of subscribers and account holders of the service provider's system or network who are repeat infringers." 17 U.S.C. § 512(i). While the statute does not define what is considered "reasonably implemented," the court in *Perfect 10, Inc. v. CCBill L.L.C.* held that "a service provider 'implements' a policy if it has a working notification system, a procedure for dealing with DMCA-compliant notifications, and if it does not actively prevent copyright owners from collecting information needed to issue such notifications." 488 F.3d at 1109. Thus, as long as a service provider receives notices and responds to them, and does not actively prevent copyright owners from collecting information required to issue notifications, then it will have complied.

84 H.R. REP. NO. 105-551, pt. 2, at 58 (1998) ("[The Safe Harbor provision] is intended to promote the development of information location tools generally . . . by establishing a safe harbor from copyright infringement liability for information location tool providers if they comply with the notice and take-down procedures and other requirements . . . . The knowledge or awareness standard should not be applied in a manner which would create a disincentive to the development of directories which involve human intervention.").

easily generate such models using 3D scanners), some authors may choose not to. Yet does that mean their works should not nevertheless be protected? Should third parties be prohibited from generating corresponding CAD models and sharing them on the Internet? Scholarly literature appears to be silent on this, and we claim that reform is necessary to provide copyright owners the legal means to force takedowns of CAD models corresponding to their works.

To this end, we advocate changes to the underlying principle of the DMCA to give copyright owners the power to identify and pursue those who share such models on the Internet, and to bring legal action against them.

2. 3D Printer Use and Patent Infringement

The U.S. Constitution also gives Congress the power to form a patent system and to enact legislation that "promote[s] the Progress of Science and useful Arts, by securing for limited Times to . . . Inventors the exclusive Right to their respective . . . Discoveries."[85] New technological advances typically pose challenges to innovation, but "[t]he nation . . . [often] benefit[s] from the adaptability of the patent system to new technologies."[86] 3D printing is yet another technology that will hard press patent principles to adapt. Since a patent is merely "the right to exclude others" from making, using, selling, or otherwise practicing the invention,[87] sufficient measures should be taken to allow patent owners to enforce their rights against infringers. The 3D printing technology puts the Do It Yourself (DIY) emerging community at a new risk of running afoul and infringing upon patent law.[88]

Patent infringement is defined by the legislature in an explicit statute.[89] The law also differentiates between direct and indirect

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85 U.S. CONST. art. I, § 8, cl. 8.

86 *In re* Schrader, 22 F.3d 290, 297 (Fed. Cir. 1994) (Newman, J., dissenting).

87 35 U.S.C. § 154(a) (2012).

88 Davis Doherty, Note, *Downloading Infringement: Patent Law as a Roadblock to the 3D Printing Revolution*, 26 HARV. J.L. & TECH. 353, 359–60 (2012) (explaining that the patent infringement by DIY users of 3D can be independent, direct, or indirect).

89 *See* 35 U.S.C. § 271 ("(a) Except as otherwise provided in this title, whoever without authority makes, uses, offers to sell, or sells any patented invention, within the United States or imports into the United States any patented invention during the term of the patent therefor, infringes the patent. (b) Whoever actively induces infringement of a patent shall be liable as an infringer. (c) Whoever offers to sell or sells within the United States or imports into the United States a component of a patented machine, manufacture, combination or composition, or a material or apparatus for use in practicing a patented process, constituting a material part of the invention, knowing the same to be especially made or especially adapted for use in an

infringement.[90] *Direct* infringement occurs upon unauthorized use of a patented invention, either by making, using, selling, offering for sale, or importing the invention.[91]

Indirect infringement involves a particular state of mind and generally includes "aiding and abetting" direct infringement by another.[92] In particular, *active inducement* of infringement under Section (b) involves encouraging infringing activity by another with "knowledge that the induced acts constitute patent infringement,"[93] and *contributory infringement* under Section (c) involves the provision of material components to another to incorporate into an infringing product with the knowledge "that the combination for which [the] component was especially designed was both patented and infringing."[94] In essence, indirect infringement liability requires that direct infringement actually occur, i.e., by one's making, offering for sale, selling, or using a patented invention.[95]

a. 3D Printed Objects Infringe

One issue with 3D printing is that physical, infringing products can be fabricated using printers.[96] Patents, e.g., design patents, may be infringed here.[97] The design patent, in particular, protects the way a product looks and, more particularly, the ornamental features of the product,[98] making them prime targets for digitization via 3D printing. For example, a pig-shaped barbeque grill, a faucet, and a chair are all

infringement of such patent, and not a staple article or commodity of commerce suitable for substantial noninfringing use, shall be liable as a contributory infringer.").

90 Section (a) defines what constitutes direct infringement, and Sections (b) and (c) define what constitutes indirect infringement. Daniel Harris Brean, *Asserting Patents to Combat Infringement via 3D Printing: It's No "Use"*, 23 FORDHAM INTELL. PROP. MEDIA & ENT. L.J. 771, 784 (2013) (citing BMC Res., Inc. v. Paymentech, L.P., 498 F.3d 1373, 1378–79 (Fed. Cir. 2007)).

91 *See* Global-Tech Appliances, Inc. v. SEB S.A., 563 U.S. 754, 760, 761 n.2 (2011).

92 *Id.* at 764.

93 *Id.* at 766.

94 *Id.* at 763 (quoting Aro Mfg. Co. v. Convertible Top Replacement Co., 377 U.S. 476, 488 (1964)).

95 Akamai Techs., Inc. v. Limelight Networks, Inc., 692 F.3d 1301, 1306 (Fed. Cir. 2012) (en banc) ("[W]e hold that all the steps of a claimed method must be performed in order to find induced infringement, but that it is not necessary to prove that all the steps were committed by a single entity.").

96 *See, e.g.*, *What Is Thingiverse?*, THINGIVERSE, http://www.thingiverse.com/about (last visited Dec. 27, 2016) ("Thingiverse is a thriving design community for discovering, making, and sharing 3D printable things.").

97 Elizabeth D. Ferrill et al., *3D Printing: Practical Patent Pointers*, FINNEGAN (Sept. 2, 2014), http://www.finnegan.com/3DPrinting_PracticalPatentPointers.

98 *See* 35 U.S.C. § 171 (2012).

protectable designs that, if digitized using a 3D scanner to render corresponding CAD models, can be printed with a 3D printer.

The actual printout of a product encompassing protected designs may infringe patent rights. When a 3D printer user renders the actual physical object that is protected by a patent, the use of the 3D printer to *reproduce* that product infringes on the patent.[99] Additionally, *use* of the printed product may also violate the patent.

b. CAD Model Use and Infringement

Another issue with 3D printing is the CAD models themselves. The models do not constitute the actual patented product, so *use* thereof may not constitute direct infringement. However, it may amount to indirect infringement and, more particularly, contributory infringement.[100] Based on contributory infringement law, whether or not use of a CAD model would constitute infringement rests on whether a CAD model is considered a "component" of a patented product that constitutes a "material part of the invention" per § 271(c).[101] The closest case law appears to answer this in the negative.[102] If courts find models to be immaterial and separate from the patented product, then contributory infringement is an *in*effective means for patent owners to pursue infringers who upload models that can be used to render infringing products.[103] Thus, the only means remaining is a claim of direct infringement, but that can prove difficult since targeting

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99 Desai & Magliocca, *supra* note 8, at 1705–06 (providing an example of the Academy of Motion Picture Arts and Sciences suing to prevent the Oscar statuette from being reproduced even with chocolate).

100 A contributory infringer is defined by the Patent Act as:

> Whoever offers to sell or sells within the United States or imports into the United States a component of a patented machine, manufacture, combination or composition, or a material or apparatus for use in practicing a patented process, constituting a material part of the invention, knowing the same to be especially made or especially adapted for use in an infringement of such patent, and not a staple article or commodity of commerce suitable for substantial noninfringing use . . . .

35 U.S.C. § 271(c).

101 Brean, *supra* note 90, at 796.

102 *See* Microsoft Corp. v. AT&T Corp., 550 U.S. 437, 450 (2007) ("A blueprint may contain precise instructions for the construction and combination of the components of a patented device, but it is not itself a combinable component of that device."); Cardiac Pacemakers, Inc. v. St. Jude Med., Inc., 576 F.3d 1348, 1364 (Fed. Cir. 2009) (reading § 271(f) to exclude method or process patents).

103 *See* Brean, *supra* note 90, at 800 ("In view of the statutory text, Microsoft, and Cardiac Pacemakers, § 271(c) compels at least the same narrow meaning of 'component' as excluding mere abstract instructions. Accordingly, CAD files should not be considered 'components' of subsequently printed objects and, as such, a theory of infringement by a CAD file distributor under § 271(c) is likely to fail.").

individual infringers is often economically infeasible.[104] This has raised concerns among some scholars who have proposed to give patent owners the right to sue hosting sites (such as Thingiverse),[105] thus complicating the tug-of-war between 3D printer users and intellectual property owners.

We suggest that a transformation of the existing patent framework would resolve this issue. In particular, we advocate adopting a system that tracks 3D printing activities and issues alerts to both 3D printer users as well as patent owners whenever the potential for patent infringement exists. Moreover, while the DMCA may provide an avenue of relief to copyright owners in the face of infringement vis-à-vis 3D printing, it does not appear to offer anything to patent owners wishing to protect their rights by taking down models that correspond to patented products.[106] Therefore, we additionally propose introducing into the patent system a legal mechanism similar to the DMCA that allows patent owners the ability to curb the sharing of CAD models corresponding to their patented products.

3. 3D Printer Use and Trademark Infringement

Finally, the Lanham Act states that a trademark "includes any word, name, symbol, or device, or any combination thereof."[107] As the Supreme Court has intimated, "almost anything at all that is capable of carrying meaning" may be a trademark; the Lanham Act is not "restrictive."[108] So as long as the claimed mark is distinctive (i.e., it identifies the source) and nonfunctional, it is protectable. Thus, protection has been afforded to the Coke bottle, Nike symbol, and more.[109] Since a patent excludes others from making, using, selling, or otherwise practicing an invention,[110] sufficient measures should be taken to allow trademark owners to similarly enforce their rights against infringers as well.

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104 The cost of legal enforcement against each individual user generally outweighs the amount of relief that would be obtained from such a piffling infringer.

105 *See, e.g.*, Brean, *supra* note 90, at 804.

106 *See supra* notes 84–95 and accompanying text.

107 15 U.S.C. § 1127 (2012).

108 Qualitex Co. v. Jacobson Prods. Co., 514 U.S. 159, 162 (1995).

109 *See* Ted Ryan, *The Story of the Coca-Cola Bottle*, COCA-COLA CO. (Feb. 26, 2015), http://www.coca-colacompany.com/stories/the-story-of-the-coca-cola-bottle; *Can I Use Nike Trademarks, Images, Logos or Advertising?*, NIKE, INC., http://help-us.nikeinc.com/app/answers/detail/a_id/1071/~/can-i-use-nike-trademarks,-images,-logos-or-advertising%3F (last visited Nov. 26, 2016).

110 35 U.S.C. § 154(a) (2012).

Trademark infringement is also defined by statute. Section 32(1) of the Lanham Act protects trademark owners against the use in commerce of "any reproduction, counterfeit, copy, or colorable imitation of a registered mark in connection with the sale, offering for sale, distribution, or advertising of any goods or services on or in connection with which such use is likely to cause confusion, or to cause mistake, or to deceive."[111]

While CAD models may infringe copyrights and patents, it is unlikely that they infringe trademarks. Nevertheless, the sale of actual 3D printed objects that include the use of trademarks might also raise trademark issues by infringing on the rights of the trademark owners.[112]

As with patents, pursuing individual users is currently the only means for trademark owners to enforce their rights, which is difficult to do for economic reasons. In line with our proposal for patents, we, therefore, propose adopting a framework that tracks 3D printing activities and issues alerts to both 3D printer users as well as trademark owners whenever the potential for trademark infringement exists. Moreover, as with our proposal for reform to the patent framework, we also propose introducing into the trademark system a legal mechanism similar to the DMCA to allow trademark owners the ability to curb the sharing of CAD models using their trademarks.

The threat to all branches of intellectual property law is an immediate one. This, however, is not the only threat that 3D printing brings to the table. The following discussion will address other threats, including those to social and legal institutes outside of intellectual property. The model we are suggesting may help mitigate all sorts of threats involved with 3D printing.

III. CURRENT STANCES ON AND PROPOSALS PERTAINING TO 3D PRINTING, AND WHY THEY ARE INSUFFICIENT

As with any new technology, 3D printing has amassed a large amount of support and opposition. This Part explores the positions and proposals of some of the proponents and antagonists of the technology.

111 15 U.S.C. § 1114.

112 Depoorter, *supra* note 4, at 1487–88.

A. *Proponents of 3D Printing and the Advantages Thereof*

Turning first to the proponents, they argue that 3D printing will usher in a new era of technology innovations, which will improve society's welfare in many ways, as anyone can become a creator, inventor, or manufacturer. 3D printing opens the door to a new wave of innovation being done from home, which can be carried out by individuals, start-ups, or large firms.[113]

Individuals, firms, and enterprises of all sizes can enjoy the benefits of 3D printers. In the past, the difficulty of creating high quality counterfeits enabled the value of the licenses of intellectual property to remain relatively high, but 3D printing is now challenging this model. Lowering manufacturing costs will benefit society in general by making products more affordable.[114]

Supporters of the technology tout the tremendous potential benefits that 3D printing will bring to mankind—with 3D printers, anyone can manufacture nearly anything in the comfort of his own home.[115] Proponents have also maintained that 3D printing is nothing like Napster—the peer-to-peer file-sharing program that was shut down by the Ninth Circuit in *A&M Records, Inc. v. Napster, Inc.* in 2001.[116] No 3D printer manufacturer could thus be found to be armed with the knowledge that CAD models are being used illegally, and so the sale and use of 3D printers should ensue. This line of reasoning is consistent with the Supreme Court's holding in *Sony Corp. of America v. Universal City Studios, Inc.*, where the Supreme Court exempted Sony from copyright infringement liability since the VCRs that it manufactured and sold were capable of substantial non-infringing uses.[117]

In the academic arena, scholars supporting 3D printing have justified its existence by stressing its ability to unleash the creative powers of the public.[118] Professors Desai and Magliocca, in particular,

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113 Desai & Magliocca, *supra* note 8, at 1693.

114 *Id.* ("Once music, film, and books were digitized . . . [p]roduction costs fell. Distribution became fast, cheap, and on-demand."). 3D printing may follow the same path.

115 *See* MICHAEL WEINBERG, PUB. KNOWLEDGE, WHAT'S THE DEAL WITH COPYRIGHT AND 3D PRINTING? 1 (Jan. 2013), https://www.publicknowledge.org/files/What's%20the%20Deal%20with%20Copyright_%20Final%20version2.pdf ("3D printing provides an opportunity to change the way we think about the world around us. . . . 3D printers allow everyone to become creators of things.").

116 A&M Records, Inc. v. Napster, Inc., 239 F.3d 1004 (9th Cir. 2001) (holding that Napster may be held liable as a contributory infringer, since it was armed with knowledge of infringing activity, and induced, caused, or materially contributed to the infringing conduct of its users).

117 Sony Corp. of Am. v. Universal City Studios, Inc., 464 U.S. 417, 456 (1984).

118 Desai & Magliocca, *supra* note 8, at 1693 ("[P]eople will be free to make almost anything they want themselves, which opens the door to a new wave of innovation from the home . . . ."); WEINBERG, *supra* note 115, at 1 ("3D printers allow everyone to become creators of things.").

have argued that 3D printing makes it cheaper and faster to manufacture products, allowing people to be free to make almost anything they desire, opening the door to massive, never-before-seen innovation from the home.[119] To pave the way for unprecedented innovation, they even proposed that Congress consider exempting intellectual property infringement for 3D printing in the home, contending that the success of the technology will hinge on whether consumers are free from the fear of being sued.[120] Some supporters of the technology have also proposed that Congress enact a patent version of the DMCA (i.e., a DMPA), where distributing websites that host infringing CAD models can be forced by patent owners to take them down.[121] These proposals, however, do not come without opposition.

B. *Opponents of 3D Printing*

Opponents of 3D printing have argued that as 3D printers become widespread, peer-to-peer services will be flooded with CAD models, posing a similar threat to designers and manufacturers as Napster did to the entertainment industry.[122] Furthermore, some scholars have insisted that 3D printing will affect patent owners' abilities to obtain economically feasible relief for patent infringement, contending that if CAD distributing websites merely host and share CAD models but are not found to be *willfully blind* to the patents, then patent holders will generally have no recourse.[123] The only available suits then will be direct infringement suits against individuals (currently too difficult to identify and locate) who not only download the CAD models, but who also print the actual products, leaving an entire class of immune distributors free to do as they please.[124]

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119 *See* Desai & Magliocca, *supra* note 8, at 1693.

120 *Id.* at 1716 (contending that even though the chances for individuals to be sued are low, the threat could still have a "chilling effect" on people who do not want to engage in illegal conduct).

121 *See, e.g.*, *id.* at 1714; Doherty, *supra* note 88, at 365.

122 *See, e.g.*, Marshall Burns & James Howison, *Digital Manufacturing—Napster Fabbing: Internet Delivery of Physical Products*, 7 RAPID PROTOTYPING J. 194, 194–96 (2001) ("[3D Printing] will be to designers, engineers, and manufacturers what MP3 has been to musicians and record companies.").

123 *See, e.g.*, Brean, *supra* note 90, at 787.

124 *Id.* at 789. Patentees are helpless against CAD distributers under 35 U.S.C. § 154 because a CAD file is not a component of the patented product, creation and distribution of a CAD file is not a use of the product, and the sale of a CAD file is not a sale of the patented invention. *Id.* at 804.

Some opponents have additionally proposed making certain actors liable for patent infringement.[125] They argue that the language of § 271 of the U.S. patent law should be expanded to allow patent holders to sue CAD distributing websites directly for patent infringement.[126] At one extreme, participants in a 3D printing conference have even pondered banning the technology.[127] Additionally, from a public safety standpoint, 3D printers have been used to print illegal weapons, spurring Philadelphia and the U.K. to institute bans on 3D printing of guns.[128]

The most glaring issue with the aforementioned proposals is not that they contrast with one another, but that they are *imbalanced*. They focus either on intellectual property owners' rights or users' rights and make little to no effort in striking a better balance between the competing interests of these two groups. In the next Section, we outline the details of our proposed reform to the current *ineffective* legal norms that seek to address this imbalance.

C. *Problems with Current Stances and Proposals of Proponents and Antagonists of the Technology*

The scholarly positions explored in the previous Section can be mapped to conflicting portions of Article 27 of the United Nation's Universal Declaration of Human Rights.[129] While the first part of Article 27 states that "[e]veryone has the right freely to participate in the cultural life of the community, to enjoy the arts and to share in scientific advancement and its benefits," its latter part states that "[e]veryone has the right to the protection of the moral and material interests resulting from any scientific, literary or artistic production of which he is the author."[130] Proponents of 3D printing appear to identify with the former

125 *See, e.g.*, *id.* at 813 (arguing that CAD file distributors should be placed on notice of the patent infringement in order to strengthen a claim of active inducement of infringement).

126 *See id.* at 804 ("Given the great weight of judicial authority precluding 3D printing infringement theories, the best solution [for patentees helpless to combat a large class of infringement] would be a legislative one expanding the language of § 271 to account for modern commercial realities.").

127 *See* Sundberg, *supra* note 7 (following a debate, a large number of voters were in favor of banning 3D printing in households).

128 *See First Ban in the Country: 3D-Printed Guns Now Illegal in Philadelphia*, RT (Nov. 27, 2013, 8:30 AM), http://rt.com/usa/philly-gun-ban-johnson-280; *see also* Sara Sollors, *3D Printed Guns Are Now Banned in the UK—Will the U.S. Be Next?*, MIC (Dec. 7, 2013), http://mic.com/articles/76043/3d-printed-guns-are-now-banned-in-the-uk-will-the-u-s-be-next.

129 G.A. Res. 217 (III) A, Universal Declaration of Human Rights (Dec. 10, 1948) (declaration consisting of thirty articles delineating the basic fundamental human rights).

130 *Id.*

part of Article 27, opting to protect individuals from infringement liability, whereas the opponents appear to find solace in the latter part of the Article, opting to better assist intellectual property owners in enforcing their rights and being duly compensated.

But there are problems with what these groups are proposing—quite possibly, the drafters of Article 27 included both of these parts because they recognized that the best way to encompass the rights and interests of authors/creators and of everyday users is to balance them all in a single "equation." We claim that Article 27 is a good model to keep in focus and to reference when reforming the current legal norms. We argue that no single group should be afforded more rights than the other, but rather that there should be a controlled balance between the two.

In one aspect, even if individual users are "innocent" (or it is economically infeasible to pursue them for infringement), exempting them from infringement liability will undermine the protections afforded by intellectual property law and challenge why we have intellectual property laws at all. In another aspect, amending the patent law to render CAD model sharing websites liable for *indirect* infringement is bad for business and economic growth as these sites provide useful mediums for advertisements and for building consumer communities.[131] Lawmakers realized this when they included the safe harbor provisions in the DMCA.[132]

Furthermore, as for public safety, we commend the efforts by various government authorities to penalize people for printing dangerous weapons, but we do not believe that these punitive measures will actually prevent criminal acts from occurring since users can still print illegal weapons and simply hide them from the authorities. We claim that a legal framework that makes printing weapons nearly impossible is required to truly address public safety. Moreover, as to those who support a complete ban on 3D printing, we disagree. Banning such a useful technology will hurt societal advancement, given the benefits that it promises to deliver.[133]

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131 H.R. REP. NO. 105-551, pt. 2, at 58 (1998).

132 *Id.* ("[The Safe Harbor] provision is intended to promote the development of information location tools generally, and Internet directories such as Yahoo!'s in particular, by establishing a safe harbor from copyright infringement liability for information location tool providers if they comply with the notice and take-down procedures and other requirements of new subsection (d).").

133 *See* Desai & Magliocca, *supra* note 8, at 1694 (for example, "rapid, unpredictable experimentation; faster learning; and increased knowledge growth").

IV. PROPOSED MODEL TO CURRENT LEGAL NORMS

The analysis in Part III makes it clear that favoring any one group (either users or stakeholders) would unnecessarily offset the balance of their competing interests. As to whether such a balance can be struck, we conclude that it can and outline our proposed reforms to current legal frameworks in the following Sections. Additionally, we discuss how these changes will offer a better means to ensure the "equation" is not disproportionate.

A. *Preliminary Reforms*

First, to address the need for policymakers to control the 3D printing process in order to avoid the public safety threats mentioned in Part I and for stakeholders, including intellectual property owners to protect their rights in the context of file sharing CAD models, certain changes to the norms should be made. As we briefly mentioned in Part I of this Article, for copyrights, reforms should be made to ensure that copyright owners who do not possess intellectual property protection of CAD models corresponding to their works are nevertheless given the means to prevent others from uploading and sharing such models. Essentially, government authorities (such as the FDA in relation to drugs and foods) should be unequivocally allowed to leverage the DMCA's notice-and-takedown provision[134] to stop infringers.

Second, for patents and trademarks, provisions similar to the DMCA should be adapted to also allow patent and trademark owners to force takedowns of CAD models that correspond to their protected products and marks. The adoption should allow relevant authorities to act accordingly in order to prevent risks. These provisions can be termed the Digital Millennium Patent Act (DMPA), the Digital Millennium Trademark Act (DMTA), the Digital Millennium Health Authority Act (DMHA), and so on.[135] In this way, patent and trademark owners, as well as other stakeholders, and the public will be protected not only in terms of rights for their designs or marks, but also in terms of exclusion of others from sharing corresponding CAD models that may include severe and immediate risks to the public. This should

134 17 U.S.C. § 512(c)(3)(A) (2012) (listing the elements of notification).

135 *See, e.g.*, Desai & Magliocca, *supra* note 8, at 1714 (suggesting a Digital Millennium Patent and Trademark Act to impose notice and takedown rules on sites hosting 3D printing software); Doherty, *supra* note 88, at 365–69 (discussing the DMCA's notice-and-takedown and safe harbor provisions that would be applicable to a hypothetical Digital Millennium Patent Act).

discourage individual users from creating and/or sharing infringing or problematic models in the first place.

B. *General Substantive Reforms*

The foregoing delineated only preliminary changes that should be made mainly to the existing intellectual property framework. On a more substantive scale, we propose a revolutionary reform that addresses the interests of all the various players involved in 3D printing (even including 3D printer manufacturers and government authorities) explored in Part I, taking into consideration the propositions of the scholars discussed in Part III. Rather than merely letting intellectual property laws slowly become irrelevant or, alternatively, slowly adapt to the issues brought upon them by 3D printing, we propose proactive and immediate reforms to the legal norms to be followed by a technological solution. We claim that it is important to ensure that the public and intellectual property owners, as well as other stakeholders, have the ability to protect their rights in real world products and/or corresponding CAD models, and that sufficient measures are available to them to identify and halt infringement of these rights. At the same time, this should not be done at the expense of near free use of 3D printing technology. Moreover, intellectual property owners should not be allowed to go after websites like Thingiverse and Shapeways—they are legitimate and useful sites,[136] and as long as they comply with the DMCA, they should be left relatively immune to liability.

The three core elements of our proposed reform are as follows. *First*, registration of 3D printers should be required. *Second*, 3D printers should be manufactured to contain an imprinting/stamping sign that enables the tracking of its products. Optionally, 3D printers can be manufactured to be inoperable unless the printers are connected to the Internet. *Additionally*, a website with an Authorization and Tracking System that users must log onto to obtain approval for all 3D print requests should be implemented.[137] *Third*, a repository should be provisioned to receive and store CAD models uploaded by intellectual property owners—these can be matched with models uploaded by users during 3D print requests to identify whether infringing models are being used. The following Sections provide further details on each of these elements. The model can be used as a whole or just partially. For

136 H.R. REP. NO. 105-551, pt. 2, at 58 (1998).

137 *See* ABHIJIT BELAPURKAR ET AL., DISTRIBUTED SYSTEMS SECURITY: ISSUES, PROCESSES AND SOLUTIONS 284–90 (2009) (describing authorization systems and implementation methodology).

example, policymakers can decide to avoid registrations and still use a stamping process or labeling in order to identify the source.

1. 3D Printer Registration, Imprinting/Stamping, and Internet Connection Requirement

Requiring 3D printer users to register their printers, or perhaps having them secure legal permits for operating and/or purchasing the printers, is a logical and reasonable approach to protect intellectual property owners against widespread dissemination. This is similar to how individuals are required to register their vehicles, houses (albeit done more likely for property and tax reasons), firearms, and even register their businesses and their patents. The difference here, however, is that because both public safety and intellectual property rights (which fall under federal instead of state jurisdiction) are involved, the registration system should be similar to patent registration, implemented at the federal level. Given that 3D printers can potentially be used to mass produce dangerous products, establishing registration rules is not too onerous on individual users—it merely allows a governing entity to keep track of all 3D printers and users. Further, for reasons that will be apparent in the next Section of the Article, 3D printer manufacturers should be required by law to make their printers inoperable (e.g., via software) unless the printers are connected to the Internet.

The control over the 3D printed products will enable the relevant authority or stakeholders at risk to use the existing laws to observe their rights on the one hand and public safety on the other hand. In this way, current laws will not become inadequate and irrelevant.

It might be argued that the Supreme Court's decision in *Sony* imposes a hurdle to our model, given that the *Sony* Court suggested that manufacturers are generally not liable for the infringement activities of end users.[138] That is, in the context of 3D printers, some might contend that manufacturers should remain relatively blameless for infringement resulting from the use of 3D printers they put on the market. Given that our model does not impose any such liability on the printer manufacturers, however, we claim that it is not too much of a burden to have them subjected to minor regulatory standards (i.e., to render their printers inoperative unless connected to the Internet), as part of the reform of legal norms.

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138 Sony Corp. of Am. v. Universal City Studios, Inc., 464 U.S. 417, 442 (1984).

2. Imprinting/Stamping and Authentication Website

Along with user and/or printer registration and the optional Internet connection requirement, we additionally (or alternatively) propose enacting legal provisions that establish a 3D printing imprinting or stamping (imprinting or labeling) technology as a mandatory request. This is not unlike what is typically required for various products on the market, particularly foods, beverages, health products, drugs, and many other products, which carry different forms of labeling. The other move we innovatively suggest is to create a community "entity" (whether run and/or funded by government entities or other stakeholders) that operates a web Authentication System. The system can, generally speaking, be configured to authenticate 3D printing user requests over the Internet (which is why 3D printers should be rendered inoperable unless connected to the Internet). The system can include mechanisms, such as recognition software or actual people for reviewing CAD models that users wish to print. It should also be configured to grant or deny requests based on the review. For example, it would deny a request if the object to be printed is or resembles a gun or another dangerous weapon. This provides for a means to monitor the 3D printing activities of the public and to ultimately restrict their ability to print certain things (e.g., weapons or illegal drugs). More importantly, this solution will help the public to identify and be aware of products that do not contain the printing (stamp).

3. Repository for IP-Protected CAD Models

The proposed Authentication System should also be tied to a database for storing IP-protected CAD models. This allows intellectual property owners and relevant authorities to upload CAD models of their IP-protected products so that the system can identify whether any of these CAD models are being requested by users in order to authenticate or deny the print requests. The system can thus advantageously recognize when a user is requesting to print an infringing product, can keep track of those requests, and can notify the appropriate rights holders whenever potentially infringing activity occurs. As a result, stakeholders can be alerted when their CAD models, or substantially similar ones from 3D scans, are being used, which will allow them to directly target the individual infringers by looking up their user registration information. This would serve as a preventive step to deter most people from using the printer in an illegal way that infringes the rights of others.

C. *The Advantages of Our Proposed Model*

The proposed model carries some significant advantages.

First, from an intellectual property perspective, widespread infringement of intellectual property rights can be contained since users are notified and prohibited from printing products that are likely to infringe others' rights. In this context, it gives stakeholders and intellectual property owners the means to monitor, track, and protest such infringement.

Second, known hazardous or dangerous products (e.g., drugs or guns) can be banned from public printing, since the CAD models for such products can be easily loaded into the authentication system and used to screen print requests for these items. To this end, the authentication requirement provides authorities with a regulatory framework for controlling the public from self-manufacturing potentially dangerous products. As new dangerous products come into existence, such as newly developed drugs, governments can likewise easily control or prohibit users from manufacturing them with 3D printers by simply adding the corresponding CAD models to the "ban" list.

Third, the massive important legislation on products liabilities and public safety can still be used.

In summary, while the proposal does not restrict public printing of certain customized items, such as customer vehicle parts, food, or other products that can vary based on design, it nevertheless provides a robust first attempt at a first aid solution to the issue of 3D printing becoming "away from control."[139]

D. *The Drawbacks of Our Proposed Model*

No legal framework is perfect, and we do not suggest that our proposed reforms are any different. Here, we address some likely drawbacks of our approach, and why they are actually non-issues.

One criticism of the proposed system may be the loss of 3D printer's user privacy that may result from the monitoring and tracking of user activities—the print request and print trail will have to pass through the Internet, and perhaps stored remotely on some Internet server. We argue, however, that this is not detrimental—

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139 *See* Hornick, *supra* note 9 (defining "away from control" as "widespread personal manufacturing of copyrighted objects independent of established markets in ways that cannot be detected, prevented or controlled").

communications with the system can be implemented using secure communication protocols (e.g., the Hypertext Transfer Protocol Secure (HTTPS)).[140] Additionally, the integrity and confidentiality of data stored on the server can be restricted. Moreover, succumbing to a simple monitoring mechanism is an inconsequential trade-off considering that users can still relatively freely enjoy the technology.

Another drawback is that not all stakeholders will benefit from the system, particularly those who merely manufacture products and do not produce the corresponding CAD models. Without these models, intellectual property owners will not benefit from the tracking feature—they may not be able to identify users who are sharing and using CAD models (perhaps models obtained by 3D scanning the actual products produced by the intellectual property owners) that can be used to create infringing end products. We contend, however, that it would only be a matter of time before intellectual property owners recognize the benefits of the system and realize that they, too, can 3D scan their products themselves to arrive at corresponding CAD models—these can then be easily uploaded to the repository for monitoring and tracking purposes.

Yet another concern is that, as with any computing device or system, the proposed Internet connection requirement and the Authentication System are subject to hacking.[141] For example, hackers may tinker with the software in the 3D printers to bypass the authentication feature and then use the printers without being connected to the Internet or without having their print requests authorized. As another example, hackers may hack the Authentication website and fool it into approving all their print requests. While this will likely be an ever-lasting limitation in computer-based systems, most people are not tech-savvy enough to hack the system, and thus, the vast majority of users would likely not engage in such activity. Plus, security measures can also be implemented to protect the integrity of the website. Moreover, additional legal provisions making it illegal to bypass authentication procedures, similar to those in the DMCA—making it illegal to bypass digital rights management and protective measures in the copyright context—should suffice.

The main concern of our proposal, however, is freedom of expression under the First Amendment of the U.S. Constitution. That is, some may argue, that the model trespasses the public's freedom of speech.[142] However, registration and mandatory imprinting or labeling

140 R. Fielding et al., *Hypertext Transfer Protocol–HTTP/1.1*, INTERNET SOC'Y (1999), http://www.w3.org/Protocols/rfc2616/rfc2616.html.

141 BRUCE STERLING, THE HACKER CRACKDOWN: LAW AND DISORDER ON THE ELECTRONIC FRONTIER 61, 62 (1994).

142 Bryans, *supra* note 10, at 928.

of products are all existing mechanisms that work in various types of products. We thus claim that similar requirements in the context of 3D printing will make the technology more viable for widespread public use without unduly limiting the public's freedom of speech. Further, controlling the registration of 3D printers as well as products printed therefrom will enable the open market to distinguish good from bad quality and original from counterfeit. Moreover, the proposed mechanism will discourage people from counterfeiting and using potentially unsafe products since they can be easily detected and held liable. In the long run, existing laws can survive and handle the situation as the identities of culprits can be detected.

As with any field and legal norm, we expect there to be violators of the proposed model, just like people today who counterfeit products, avoid registration of their license agreement, drive vehicles without proper licenses, etc. The mere possibility of violators, however, should never factor into whether legislation is appropriate or how we should maintain people's rights and public safety. In the end, our proposed model makes it easier to detect illegal activity.

E. *A Working Example*

The following is a brief description of how the system described above could work. First, every 3D printer is required to bear a unique identification number. Moreover, the 3D printer must be configured to imprint information identifying the printer (e.g., in the form of a stamp) on each product that it prints. This is regardless of whether the printed object is a piece of jewelry, clothing, a pair of shoes, dishes, a gun, food products, drugs, medicine, or a human organ. Second, each 3D printer user must log his or her 3D printer onto the Authentication System via the Internet. Upon authorizing the user's identity, the user would submit a print request including the CAD model that he would like to print. The system would examine the CAD model and identify whether the product to be printed is illegal or banned—there are many ways to implement this, such as detecting the shape of the model, detecting if certain materials are required to print the object, such as metals that guns are typically composed of, etc. If the system detects a banned item from the CAD model, it would reject the print request and prevent the user's 3D printer from printing the object. If the system does not detect a banned item, it would approve the print request and allow the 3D printer to print the object. In some aspects, the system would also identify whether the CAD model to be printed matches one of the CAD models stored in the repository. If an intellectual property owner has uploaded that very same or a similar model that is being requested to be

printed, the system would alert the user that the CAD model may be IP-protected and notify that appropriate intellectual property owner regarding the attempted print request.

CONCLUSION

In this Article, we argue that at the heart of the debate about 3D printing lies a disagreement as to whether mass 3D printing will benefit society in the long run or not. From a legal perspective the question might be whether principles of legal norms can be reformed to balance the growing and inevitable tug-of-war between individual users of the technology and stakeholders, such as intellectual property rights holders, to benefit society. In more specific terms, how can the technology be embraced and its benefits reaped without desecrating the very fundamentals not only of intellectual property law but also products and regulation that influence public safety? And how can the rights of intellectual property owners be acknowledged and protected without severely limiting the public's use of 3D printing?

While the effects that the technology will have on traditional manufacturing would be extensive and interesting to prospect, one of the most critical outcomes this Article addresses is the effects that 3D printing has on intellectual property rights. Indeed, the most dangerous threat to intellectual property nowadays is infringement via 3D printing. The potential for the masses to print a wide variety of objects opens the door to widespread infringement of copyrights and patents, and possibly even trademarks.[143] It is thus appropriate to examine and adjust the existing intellectual property framework to adapt to the reality that 3D printing technology is here to stay, and yet ensure that users of the technology are compelled to behave within the confines of the law.

The current legal norms of intellectual property are inadequate in the face of widespread 3D printing. Additionally, laws protecting the public from the dangers of 3D printing (such as 3D printed weapons) are only at the beginning stages and do not serve to prevent illegal uses in the first place. To prevent the issues that stakeholders and legal authorities will inevitably face, certain reforms need to be made to existing norms in copyright, patent, and trademark enforcement. These

143 *See* Depoorter, *supra* note 4, at 1485 ("[I]ntellectual property ('IP') holders are likely to be affected because 3D printing makes the infringement of IP rights cheaper and more attractive."); *id.* at 1487–88 (explaining how 3D printing technology will impact industries protected by copyright, trademark, and patent law); Desai & Magliocca, *supra* note 8, at 1713–19 (discussing how Congress can address the inevitable ways 3D printing will infringe patents, copyrights, and trademarks).

changes should not be so drastic, however, as to severely limit use of the technology.

In addition to preliminary reforms (such as patent and trademark versions of the DMCA), we propose a substantive adaptation to the existing intellectual property framework in the United States with a 3D printer registration and print activity-tracking system. The rights of intellectual property owners can be protected without foreclosing user creativity that 3D printing encourages. In brief, the system allows users nearly free use of 3D printing but warns them when they attempt to print illegal or potentially infringing products. Additionally, it alerts intellectual property owners as well as the appropriate public safety officials when potential infringing print requests are made, which allows them to take any further action to halt infringing activities according to existing laws. Accommodations of the system embedded in the proposed model according to existing laws should also be done in order to functionalize the model. However, although the model faces some hurdles in the form of the actual functionality and, more significantly, freedom of speech and privacy, imprinting and labeling have been recognized as a legitimate requirement for the sale of every day products, from food and beverage products, to drugs, vehicles, and even patents. Therefore, the adaptation of the rules to 3D printers can be an easy and open path, unlike other scholarly suggestions of banning 3D printing or exempting individuals' use of 3D printing from copyright enforcement. This model also keeps the current laws intact and protects them from becoming old and irrelevant. More importantly, the 3D "away from control" will be (at least partially) under control.