PERSONAL FACTORY OR CATALYST FOR PIRACY? THE HYPE, HYSTERIA, AND HARD REALITIES OF CONSUMER 3-D PRINTING♦

INTRODUCTION

For most Americans, manufacturing is likely something that happens far away and has very little to do with them. The average American simply consumes the end-products of what is an essentially foreign process. Historically, large households commonly produced goods as varied as boot polish and tablecloths for themselves, due in part to the absence of commercial alternatives.[1] To one situated in our modern, consumerist society, such an arrangement would probably seem odd, if not actively bizarre. However, new developments in a technology commonly referred to as "3-D printing" may have the potential to blur the bright line between consumers and producers.

3-D printing is dramatically different from currently predominant modes of production. The term describes a class of technologies that share several key commonalities: they can create objects as seamless wholes, sometimes even with moving parts, by gradually adding layer upon layer of material; they work directly from computerized blueprints; and, within certain constraints, they can build from any valid blueprint.[2] This approach differs from traditional assembly-line

1 BILL BRYSON, AT HOME: A SHORT HISTORY OF PRIVATE LIFE 91 (2010).

2 Michael Weinberg, *It Will Be Awesome If They Don't Screw It Up*, PUBLIC KNOWLEDGE 2

manufacturing in several crucial respects. On one hand, 3-D printers are typically self-contained units that can only produce one object at a time, since each copy has to be finished and removed from the printer before a new project may begin. This generally makes them less appropriate for mass production and limits the size of objects that they can produce.[3] On the other hand, 3-D printers, which produce objects through the accretion of layers of material (technically referred to as "additive manufacturing"), enable the creation of shapes that would be difficult or impossible to produce using conventional methods of production.[4] Also, the self-contained, automated process of moving from a digital design to a finished product simplifies the manufacturing process and reduces the need for human intervention and oversight, at least under ideal circumstances.[5] Lastly, 3-D printers' disadvantage in speed and volume of production is balanced by their versatility: by providing the printer with a different design, one can tweak a product or produce something else entirely, thereby avoiding the significant retooling costs that would be required to change a traditional assembly line.[6]

In a 2011 article, *The Economist* addressed the increasingly widespread use of 3-D printing.[7] In an uncharacteristically breathless fashion, it described the comparison between traditional manufacturing techniques and 3-D printing as analogous to the relationship between Gutenberg's moveable type printing press and the inkjet printer.[8] The article emphasized the technology's potential to lower barriers to entry in manufacturing, mitigate economies of scale, and usher in a new era of creativity and customization.[9] However, buried in the last paragraph, one finds the snake in the garden—in a few lines the writer acknowledged that the technology, with all its protean potential, carries with it the danger of intensifying the conflict over intellectual property by allowing imitators to get goods to market as quickly as innovators.[10]

Similarly, a recent presentation on 3-D printing that was transcribed in the Rapid Prototyping Journal flatly dubbed the

(2010), *available at* http://www.publicknowledge.org/files/docs/3DPrintingPaperPublicKnowledge.pdf.

3 *See, e.g.*, *The Printed World*, ECONOMIST (Feb. 10, 2011), http://www.economist.com/node/18114221/print; *Factory on Your Desk*, ECONOMIST TECH. Q., Sept. 5, 2009, at 26, 28.

4 *See* Simon Bradshaw et al., *The Intellectual Property Implications of Low-Cost 3D Printing*, 7 SCRIPTED 5, 7–8 (Apr. 2010).

5 *See Factory on Your Desk*, *supra* note 3, at 27–29; Weinberg, *supra* note 2, at 2.

6 *See Factory on Your Desk*, *supra* note 3, at 28–29.

7 *See The Printed World*, *supra* note 3.

8 *Id.* Although the technology has traditionally been confined to the design process through the creation of prototypes, the article quoted a specialist in the field as claiming that twenty percent of its output was now final products, a number he predicted would rise to fifty percent by 2020. *Id.*

9 *Id.*

10 *Id.*

technology "Napster Fabbing."[11] The speakers predicted that, as 3-D printing becomes available to the general public, peer-to-peer services will be flooded with schematics for physical products,[12] which would pose a similar threat to designers and manufacturers as Napster and its progeny did to the entertainment industry.[13] The Pirate Bay's announcement that it intends to expand into 3-D printing schematics is likely to further inflame such speculation.[14] Reports that common 3-D printers might be used to synthesize guns or drugs have had similar effects,[15] despite evidence that such concerns have been greatly blown out of proportion.[16]

---

[11] Marshal Burns & James Howison, *Digital Manufacturing—Napter Fabbing: Internet Delivery of Physical Products*, 7 RAPID PROTOTYPING J. 194 (2001). "Fabbers" and "Fabbing" generally refer to 3-D printing, as well as other novel manufacturing techniques, whether real or imagined. "3-D printing" is more widely used in the literature and more specific, so its use is preferred.

[12] *Id.*

[13] *Id.* at 196.

[14] The Pirate Bay, a Swedish file-sharing website, views 3-D printing as the "future of file-sharing." *See Evolution: New Category*, PIRATE BAY BLOG (Jan. 23, 2012, 1:24 AM), http://thepiratebay.org/blog/203. However, some commentators have already begun to dismiss the rogue site's effort as unfeasible and naïve. *See, e.g.*, Owen Duffy, *Pirate Bay Irks Games Workshop by Sharing 3D Plans for Its Designs*, GUARDIAN (Jan. 26, 2012, 12:30 PM), http://www.guardian.co.uk/technology/2012/jan/26/pirate-bay-3d-printing; Richard Adhikari, *The Pirate Bay and 3D Printing*, TECHNEWSWORLD (Jan. 24, 2012, 3:24 PM), http://www.technewsworld.com/story/The-Pirate-Bay-and-3D-Printing-Big-Booty-74261.html. It appears that the skeptics may have been right; as of September 2012, only fifty-nine models were listed on the Pirate Bay site. *See Browse Other > Physibles*, PIRATE BAY, http://thepiratebay.se/browse/605 (last visited Sept. 18, 2012).

[15] *See generally* Peter Jensen-Haxel, Note, *3D Printers, Obsolete Firearm Supply Controls, and the Right to Build Self-Defense Weapons under Heller*, 42 GOLDEN GATE U. L. REV. 447 (2012) (suggesting that 3-D printing will make personal production of firearms feasible and thereby render ineffective much of the current regulatory regime); Mark D. Symes, *Integrated 3D-Printed Reactionware for Chemical Synthesis and Analysis*, 4 NATURE CHEMISTRY 349 (2012) (documenting attempts to use a hobbyist 3-D printer to create "reactionware" structures to cheaply facilitate chemical reactions and predicting that refinements of such techniques could make chemical engineering sufficiently cheap and automated for individuals); *see also* Damon Poeter, *Could a 'Printable Gun' Change the World*, PC WORLD (Aug. 24, 2012, 5:30 PM), http://www.pcmag.com/article2/0,2817,2408899,00.asp; Mark Gibbs, *The End of Gun Control?*, FORBES (July 28, 2012, 4:24 PM), www.forbes.com/sites/markgibbs/2012/07/28/the-end-of-gun-control/; Mark Tyson, *3D Printer Tech Can Make Guns and Drugs*, HEXUS (July 26, 2012, 11:32 AM), http://hexus.net/tech/news/peripherals/42941-3d-printer-tech-can-make-guns-drugs/; Tim Adams, *The 'Chemputer' That Could Print Out Any Drug*, GUARDIAN (July 21, 2012, 5:00PM), http://www.guardian.co.uk/science/2012/jul/21/chemputer-that-prints-out-drugs; Chris Brandrick, *3D Printer Lets You Print Your Own Prescription*, PC WORLD (Apr. 19, 2012, 3:59 PM), http://www.pcworld.com/article/254118/3d_printer_lets_you_print_your_own_prescription.html; *3D Printers Could Create Customised Drugs on Demand*, BBC NEWS (Apr. 18, 2012, 5:32 PM), http://www.bbc.co.uk/news/technology-17760085.

[16] A number of commentators, including one who has tested a 3-D-printed AR-15 lower receiver, are skeptical that many firearm components could be printed with sufficient strength and precision to function at all. *See, e.g.*, Michael Guslick, *Gunsmithing with a 3D printer—Part 3*, HAVE BLUE (Aug. 26, 2012), http://haveblue.org/?p=1349; Damon Poeter, *The Skeptics Weigh In*, PC WORLD (Aug. 24, 2012, 5:30PM), http://www.pcmag.com/article2/0,2817,2408900,00.asp; David Chernicoff, *No, You Can't Download a Gun from the Internet*, ZDNET (Aug. 3, 2012, 10:34 PM), http://www.zdnet.com/no-you-cant-download-a-gun-from-the-internet-7000002108/. As for printing drugs, even Professor Lee Cronin, the most visible proponent of the idea, has

On the other side, the public interest group Public Knowledge has issued a white paper broadly supportive of the new technology. The organization, along with other stakeholders in the 3-D printing community, convened at a conference in Washington, D.C. in April 2011 to try to convince policymakers that the technology is not the next Napster and that a prejudicial overreaction by legislators and regulators could strangle a nascent industry with tremendous potential.[17] The purpose of this Note is to determine whether 3-D printing, in the foreseeable future, can or will present a threat to intellectual property ("IP") rights comparable to peer-to-peer file sharing, whether government intervention is justified or necessary, and what form such an intervention might take.

Part I of this Note focuses on the background and development of consumer 3-D printing technology and the hobbyist community that sustains it, as well as examining the first three legal controversies involving 3-D printing and intellectual property. Part II of this Note surveys the existing case law and explores statutory language that may be relevant to consumer 3-D printing. Part III of this Note will analyze how current law may specifically apply to 3-D printing, focusing on the applicability of the policy goals that it reflects and the feasibility of its application in this context. Finally, Part IV argues that, due to basic physical and technological limitations, 3-D printing is far less likely to threaten intellectual property rights than peer-to-peer networks and file sharing services in the foreseeable future. It also observes that 3-D printing technologies have many potentially valuable noninfringing uses that should qualify for protection under the rule established in *Sony Corp. of America v. Universal City Studios, Inc*.[18] This Note concludes by suggesting minor targeted reforms and cautioning that precipitous regulation could stifle innovation and development.

I. BACKGROUND

3-D printing technology has its roots in "rapid prototyping," a technique originally developed for creating models used in guiding the design process of parts and products such as shoe soles and automobile

acknowledged that the concept is still at the "'science fiction' stage." Adams, *supra* note 15. Cronin and his collaborators are still working on synthesizing simple drugs like ibuprofen, and, until recently, their method remained reliant on toxic pipe sealant. *See* Symes, *supra* note 15, at 350; Tyson, *supra* note 15; BBC NEWS, *supra* note 15. It has also been noted that contamination, light, and other factors that might be difficult to control could easily result in a product that might be inert or dangerous. Ryan Whitwam, *Researchers Developing "Chemputer" that Prints Drugs*, GEEK.COM (July 25, 2012, 11:27 AM), http://www.geek.com/articles/geek-cetera/researchers-developing-chemputer-that-prints-drugs-20120725/.

[17] *See Public Knowledge Brings 3D Printing to Washington*, PUBLIC KNOWLEDGE, http://www.publicknowledge.org/public-knowledge-brings-3d-printing-washington (last visited Oct. 20, 2011).

[18] *Sony Corp. of America v. Universal City Studios, Inc*, 464 U.S. 417 (1984).

engines.[19] Rapid prototyping combines two existing technologies: Computer Aided Design and Manufacturing ("CAD/CAM") software and additive manufacturing.[20] Designers use CAD/CAM software to create and edit digital "blueprints" for products. Once completed, the resulting files can be saved in a format that manufacturing equipment can read as a set of instructions.[21] Additive manufacturing is the process of building up whole objects layer by layer, whereas traditional manufacturing involves the cutting or shaping of separate parts for later assembly.[22] 3-D printing was initially limited to modeling and design work, because its end products lacked the precision and strength of traditionally machined parts;[23] however, recent improvements in enterprise-grade additive manufacturing have begun to make it a feasible alternative for some applications.[24]

Furthermore, simpler and cheaper versions of 3-D printers have become available to hobbyists as a result of open-source[25] projects at Cornell University ("Fab@Home")[26] and the University of Bath ("RepRap")[27] in the United Kingdom.[28] Although these printer designs lack many of the capabilities of industrial units based on more sophisticated and complex technologies,[29] they have the advantage of affordability and simplicity; both were designed with the technically savvy layman in mind—to enable relatively easy production and maintenance. A fully assembled 3-D printer based upon the RepRap design may be purchased for less than two thousand dollars,[30] while even the most basic proprietary models begin in the range of fifteen thousand dollars.[31] Online communities such as Thingiverse offer

19 *See Factory on your Desk*, *supra* note 3, at 26–29.

20 Bruce Schechter & Cindy Lollar, *Manufacturing*, *in* AMERICA'S INVESTMENT IN THE FUTURE 48, 51, 54 (Cindy Lollar ed., 2001), *available at* http://www.nsf.gov/about/history/nsf0050/pdf/aif.pdf.

21 Weinberg, *supra* note 2, at 2–3.

22 Bradshaw, *supra* note 4, at 6–8.

23 J. M. Pearce et al., *3-D Printing of Open Source Appropriate Technologies for Self-Directed Sustainable Development*, J. SUSTAINABLE DEV., Dec. 2010, at 17, 18.

24 *See The Printed World*, *supra* note 3.

25 Although the term is more commonly applied to software, the projects are "open source" in the sense that the printer designs are published online under licenses that essentially allow for free copying and modification by anyone. *See FAQ Fab@Home*, FAB@HOME, http://www.fabathome.org/?q=faq (last visited Sept. 1, 2012); *Open Source Hardware*, REPRAP WIKI, http://www.reprap.org/wiki/Open_source_hardware (last visited Mar. 18, 2012).

26 *See* FAB@HOME, http://www.fabathome.org/ (last visited Sept. 1, 2012).

27 *See* REPRAP WIKI, http://reprap.org/wiki/Main_Page (last visited Sept. 1, 2012).

28 Pearce, *supra* note 23, at 18.

29 *See* Timothy Nixon & Adrian Tan, *Rapid Prototyping Manufacturing System*, U. ADELAIDE SCH. MECHANICAL ENGINEERING, 9–15 (2007), http://www.fabathome.org/wiki/uploads/c/cd/Rapid_Prototype_Manufacturing_System_-_Timothy_Nixon_%26_Adrian_Tan_2007.pdf.

30 *See MakerBot Replicator*, MAKERBOT STORE, http://store.makerbot.com/replicator.html (last visited Oct. 28, 2012).

31 *See, e.g.*, *UPrintSE 3D Print Pack*, UPRINT 3D PRINTING (Nov. 9, 2011), http://www.uprint3dprinting.com/pdfs/specs/uPrintSE_SEPlus_3DPrintPack.pdf.

support for DIY 3-D printing projects, where hobbyists can exchange advice, ideas, and schematics for 3-D printing projects.[32] The 3-D printing boom has also sparked the emergence of online services such as Shapeways, which allows anyone to design and order customized 3-D objects and serves as a marketplace for designers to sell copies of their original designs to third parties.[33] Nevertheless, 3-D printing technologies are still considered to be at a very early stage of development for widespread consumer use.[34]

Even at this early stage, however, several incidents have already emerged involving accusations of copyright infringement. The first incident involved a dispute over a 3-D printed version of a famous optical illusion—the Penrose Triangle.[35] The Dutch designer Ulrich Schwanitz posted a video of his physical rendering of the Penrose Triangle on YouTube and offered to sell copies for seventy dollars through Shapeways.[36] Within a few weeks, a former Shapeways intern, Artur Tchoukanov, managed to reverse-engineer[37] the design by repeatedly watching the video Schwanitz had published.[38] Tchoukanov released his reworked schematic onto Thingiverse, allowing anyone to download it for free.[39] Schwanitz lodged a Digital Millennium Copyright Act ("DMCA") takedown request, the first ever documented complaint with respect to 3-D printing. Thingiverse initially complied, but eventually re-posted the schematic with Schwanitz's permission after he withdrew the request due to heavy criticism and ensuing controversy over the validity of Schwanitz's copyright claim to a design based on a public domain optical illusion.[40] Schwanitz ultimately released his design for free as well, but the incident generated an intense discussion about the role of intellectual property law in 3-D printing. Shapeways' responded to the incident by expressing its commitment to

[32] *See* THINGIVERSE, http://www.thingiverse.com (last visited Sept. 1, 2012); *Community Fab@Home*, FAB@HOME, http://www.fabathome.org/?q=node/4 (last visited Sept. 1, 2012).

[33] *See Shapeways About Us*, SHAPEWAYS, http://www.shapeways.com/about/ (last visited Oct. 20, 2011).

[34] *See, e.g.*, Pearce, *supra* note 23, at 18; Weinberg, *supra* note 2, at 4.

[35] *See Penrose Triangle*, WOLFRAMMATHWORLD, http://mathworld.wolfram.com/PenroseTriangle.html (last visited Sept. 1, 2012).

[36] Peter Hanna, *The Next Napster? Copyright Questions as 3D Printing Comes of Age*, ARS TECHNICA (Apr. 5, 2011, 12:35 AM), http://arstechnica.com/tech-policy/news/2011/04/the-next-napster-copyright-questions-as-3d-printing-comes-of-age.ars.

[37] A process aptly described by Merriam-Webster as examining or analyzing a product "in detail . . . to discover the concepts involved in manufacture usually in order to produce something similar." *Reverse Engineer*, MERRIAM-WEBSTER.COM, http://www.merriam-webster.com/dictionary/reverse%20engineering (last visited Nov. 7, 2011).

[38] Hanna, *supra* note 36, at 1.

[39] *See Penrose Triangle*, THINGIVERSE, http://www.thingiverse.com/thing:6456 (last visited Oct. 10, 2011).

[40] *See* Cory Doctorow, *3D Printing's First Copyright Complaint Goes Away, but Things are Just Getting Started*, BOINGBOING (Feb. 21, 2011, 12:11 AM), http://boingboing.net/2011/02/21/3d-printings-first-c.html.

resolve conflicts informally and warning that premature government regulation could smother innovation and entrepreneurship in the 3-D printing community.[41]

Two more recent conflicts were resolved less amicably. The first arose when an engineer, Todd Blatt, created a CAD design for one of the "alien cubes" from the movie *Super 8*, uploaded the file to Shapeways, and ordered a copy.[42] This was not notable in itself; Blatt had previously designed and sold through Shapeways replicas of props from other movies, such as the spinning top from the movie *Inception*, without incident.[43] The 3-D schematic site Thingiverse, had also previously made available schematics designed by hobbyists for numerous objects inspired by films such as the head of Darth Vader from *Star Wars*, and the "companion cube" from the computer game *Portal*.[44] Some observers speculated that the small size of the 3-D printing community and the possibility of negative publicity deterred legal action in these other cases.[45] Unfortunately for Mr. Blatt, he received a cease-and-desist letter from Paramount, the producers of *Super 8* within 24 hours of uploading his schematic to Shapeways.[46]

The intervening factor here seems to have been that Paramount had already licensed to another party the right to produce replicas of the *Super 8* alien cube, as well as other merchandise based on the movie.[47] While George Lucas might not be greatly concerned with crude thermoplastic replicas of his most famous villain's head, Paramount apparently viewed Blatt's hobbyist design as direct competition with its licensee, Quantum Mechanix.[48] Blatt immediately took down the design from Shapeways and posted an entry to his blog explaining what had happened—emphasizing his desire to avoid litigation.[49] No further action was taken by or against Mr. Blatt or Shapeways.

Most recently, in December 2011, Games Workshop, the producer of tabletop game *Warhammer*, sent takedown notices to Thingiverse regarding two schematics designed and uploaded by Thomas Valenty,

---

41 *IP, 3D Printing, and DMCA*, SHAPEWAYS (Feb. 20, 2011, 9:11 PM), http://www.shapeways.com/blog/archives/747-IP,-3D-Printing-DMCA.html (citing Michael Weinberg, *It Will Be Awesome If They Don't Screw It Up*, PUBLIC KNOWLEDGE (2010)).

42 Nate Anderson, *Paramount: No 3D Printing of Our Alien Super 8 Cubes!*, ARS TECHNICA (June 29, 2011, 5:21 PM), http://arstechnica.com/tech-policy/news/2011/06/paramount-no-3d-printing-of-our-alien-super-8-cubes.ars.

43 *Id.*

44 *See Darth Vader*, THINGIVERSE, http://www.thingiverse.com/thing:609 (last visited Oct. 18, 2012); *Companion Cube*, THINGIVERSE, http://www.thingiverse.com/thing:1622 (last visited Oct. 18, 2012).

45 Hanna, *supra* note 36, at 2.

46 *See* Anderson, *supra* note 42.

47 *Id.*

48 *Id.*

49 Todd Blatt, *Cease and Desist*, TODD BLATT (June 27, 2011, 12:23 AM), http://toddblatt.blogspot.com/2011/06/cease-and-desist.html.

which he apparently based upon official *Warhammer* models.[50] Valenty and his supporters publicly disputed the legitimacy of Games Workshop's DMCA takedown, arguing that the models were "in the style of" *Warhammer* figurines rather than slavish copies. In the end, Mr. Valenty, like Todd Blatt, did not pursue a legal challenge to the takedown request, stating that he lacked the resources to contest Games Workshops's claim.[51]

Since each of these controversies was resolved without litigation, the courts have not yet had an opportunity to address disputes involving intellectual property and consumer 3-D printing. Therefore, one must look to analogies in existing case law for insight into courts might approach such conflicts. Two potentially useful precedents are *Sony Corp. of America v. Universal City Studios, Inc.*,[52] which established the "substantial noninfringing uses" doctrine applied first to the video tape recorder ("VTR"),[53] and *Metro-Goldwyn-Meyer Studios Inc. v. Grokster, Ltd.*,[54] which declined to clarify *Sony* in an infringement action against file-sharing services.[55]

II. FILE-SHARING AND THE COURTS: A REVIEW OF THE CASE LAW

New technologies often have disruptive effects on existing systems of IP and the production and distribution of content. Some scholars trace this phenomenon back to Gutenberg's invention of moveable type, which thoroughly disrupted the monastic system of copying manuscript by hand and allowed the uncontrolled spread of the printed word in a manner that the authorities of the time found thoroughly disconcerting.[56] 3-D printing, in the long term, has the potential to have a similarly disruptive effect on IP by decentralizing the means of production and challenging many of the assumptions on which modern IP law are based. In order to contemplate the potential effects of 3-D printing on

---

[50] *See* Clive Thompson, *Clive Thompson on 3-D Printing's Legal Morass*, WIRED DESIGN (May 30, 2012, 1:43 PM), http://www.wired.com/design/2012/05/3-D-printing-patent-law; *Things to Make: 3D Printed Warhammer 40K Figures*, 3D PRINTING IS THE FUTURE (Dec. 3, 2011), http://www.3dfuture.com.au/2011/12/thinks-to-make-3d-printed-warhammer-40k-figures/.

[51] *See* John Newman, *3D Printing, IP and Industry: Opening Shots*, RAPID READY TECHNOLOGY (June 6, 2012), http://www.rapidreadytech.com/2012/06/3d-printing-ip-and-industry-opening-shots/; *Games Workshop Submits DMCA Takedown Notices to Thingiverse*, 3D PRINTING IS THE FUTURE (Dec. 16, 2011), http://www.3dfuture.com.au/2011/12/games-workshop-submits-dmca-takedown-notices-to-thingiverse/.

[52] 464 U.S. 417 (1984).

[53] *Id.* at 442.

[54] 545 U.S. 913 (2005).

[55] *Id.* at 918–19, 933–35. *But see id.* at 942–49 (Ginsburg, J., concurring) (disagreeing about the proper scope of *Sony*'s safe harbor); *see also id.* at 949–66. (Breyer, J., concurring).

[56] *See* DIARMAID MACCULLOCH, THE REFORMATION 70–79 (2003) (noting that the advent of print encouraged original thought rather than the curation of ancient authority that characterized manuscript culture, as well as the resulting alarm in the Church hierarchy at the independence of thought it encouraged among the literate laity).

IP, it is helpful to first examine how courts have dealt with the effects of other transformative technologies.

A. *The* Sony *Doctrine and Staple Articles of Commerce*

The first relevant case to consider in the context of 3-D printing is *Sony Corp. of America v. Universal City Studios, Inc*.[57] The technology at issue was Sony's Betamax video tape recorder ("VTR")—specifically, its ability to record television broadcasts for later viewing.[58] Several copyright owners whose works had been broadcasted on television sued Sony in the Central District of California,[59] contending that Betamax owners had infringed their copyrights by recording their content, and that Sony should be held contributorily liable for marketing and selling the machines. They sought both money damages and an injunction against further Betamax production and sales.[60] The district court ruled for Sony after trial, but the Ninth Circuit reversed, and the Supreme Court granted certiorari.[61]

Writing for a bare majority of the Court, Justice Stevens quoted the Constitution's Intellectual Property Clause and emphasized the instrumental and limited nature of such rights.[62] He stressed that IP rights are "intended to motivate the creative activity of authors and inventors . . . and to allow the public access to the products of their genius after the limited period of exclusive control has expired."[63] The Court also stated that "[c]reative work is to be encouraged and rewarded, but private motivation must ultimately serve the cause of promoting broad public availability of literature, music, and the other arts."[64] The purpose of copyright and other intellectual property rights was thus not merely to reward creators, but rather to encourage creativity and innovation for the benefit of society by adding works to the public domain, free to all, once their protection expires. In other words, intellectual property rights holders have constitutionally distinct and inferior rights as compared to owners of conventional property because their property interests are limited in contexts where they cease to serve the public good.

The Court further noted that the statutory protection granted to authors in the Copyright Act is further limited by, among other things,

---

57 464 U.S. 417 (1984).
58 *Id.* at 420.
59 *Id.*
60 *Id.*
61 *Id.* at 420–21.
62 *Id.* at 428 ("'The Congress shall have Power … to Promote the Progress of Science and useful Arts, by securing for limited Times to Authors and Inventors the exclusive Right to their respective Writings and Discoveries.'") (quoting U.S. CONST. art. I, § 8, cl. 8.).
63 *Id.* at 429.
64 *Id.* at 431–32.

the "fair use" doctrine.[65] In doing so, the Court refused to accept the Ninth Circuit's categorical assertion that home use of a VTR did not qualify as fair use because it was not a "productive use."[66] Instead, it focused on the factual findings of the trial court: that VTRs were primarily used for "time-shifting" (recording programs in order to watch them once at a more convenient time),[67] that there was no evidence that VTR ownership reduced viewership,[68] and that a significant number of content owners did not object to home taping of their programs.[69] The Court found that time-shifting of non-copyrighted content and time-shifting of copyrighted content condoned by rights-holders constituted a legitimate use for the VTR.[70]

However, the Court went further, finding that even time-shifting of broadcast content unauthorized by rights-holders constituted fair use according to the relevant factors.[71] First, the court found that time-shifting for private use was clearly noncommercial activity, free of the presumption of unfairness attached to copying for profit.[72] Second, the nature of broadcast television, which is provided free of charge to all, was judged to legitimate time-shifting, even if an entire program was copied, since it "merely enable[d] a viewer to see [something] which he had been invited to witness in its entirety free of charge[.]"[73] Lastly, as private time-shifting had been deemed noncommercial, the Court stated that the plaintiffs had the burden of providing sufficient evidence that

65 The Court also noted that the statutory protection granted to authors in the Copyright Act is further limited by, among other things, the "fair use" doctrine. The judicially developed fair use doctrine was endorsed by Congress in the 1976 revision of the Copyright Act. *See id.* at 447; 17 U.S.C. § 107 (2012). *See also id.* at 450 n.31 (quoting H.R. Rep. No. 94-1476, at 65–66 (1976)) (stating that despite fair use's long standing, "no real definition of the concept has ever emerged. Indeed, since the doctrine is an equitable rule of reason, no generally applicable definition is possible. . . . The bill endorses the purpose and general scope of . . . fair use, but there is no disposition to freeze the doctrine . . . especially during a period of rapid technological change."). The tenor of the passage reflects Justice Steven's approach in Sony. He noted that "this task involves a difficult balance between the interests of [IP holders] . . . and society's competing interest in the free flow of ideas, information and commerce," and that copyright law itself had developed in response to advances in technology, beginning with the printing press. *Id.* at 429. This consciousness of the need for balance between competing interests and caution and flexibility in the face of rapid technological change pervades the Court's opinion.

66 *Id.* at 427.

67 *Id.* at 423.

68 *Id.* at 423–24.

69 *Id.*

70 *Id.* at 446. This finding was supported primarily by the testimony of Mr. Fred Rogers (of the children's television program, *Mr. Rogers*), who welcomed home-taping of his program and emphasized its social utility in expanding viewership in markets where it was broadcast at hours inconvenient to his target audience. *Id.* at 445 n.27.

71 17 U.S.C. § 107 (2012) ("(1) the purpose and character of the use, including whether such use is of a commercial nature or is for nonprofit educational purposes; (2) the nature of the copyrighted work; (3) the amount and substantiality of the portion used in relation of the whole; and (4) the effect of the use upon the potential market for or value of the copyrighted work.")

72 Sony, 464 U.S. at 449.

73 *Id.* at 449-50.

such activity decreased the value of their copyrights or the potential to negatively affect the market for their protected works, a burden the Court determined that they had not met.[74] As a result, the Court determined that the Betamax VTR had substantial noninfringing uses.[75]

Moreover, the Court had found that Sony only had constructive, rather than actual, knowledge of the potential for copyright infringement using for its VTRs.[76] This was based on the district court's findings that Sony and its employees had no direct involvement with Betamax users who had taped copyrighted works and that its advertising did not promote the device's potential infringing uses.[77] The Court found that the cases of "contributory infringement" of copyright, upon which the plaintiffs based their claims of Sony's secondary liability, were clearly distinguishable, as they all involved "an ongoing relationship between the direct infringer and the contributory infringer," a condition absent here.[78] The Court concluded that "[t]here was no precedent in the law of copyright for . . . vicarious liability on such a theory," and that it was necessary to borrow concepts from patent law.[79]

In retrospect, this decision was momentous, as it set the stage for the adoption of the safe harbor known as the *Sony* doctrine, which remains crucially important for technologies with the potential to be used in manners that infringe upon existing intellectual property rights.

The concept of contributory infringement is statutorily defined in patent law as "the knowing sale of a component especially made for use in connection with a particular patent."[80] The statute also provides that the sale of a "staple article of commerce" suitable for substantial noninfringing uses does not constitute contributory infringement.[81] This was the key to the Court's decision. The Court believed that finding for the plaintiffs would effectively give them complete control over any future sales of VTRs,[82] an outcome the Court regarded as extraordinary and unacceptable, as it would deny the public the use of the device even for purposes the Court regarded as legitimate and noninfringing.[83] Recalling the principle that the primary purpose of copyright is the promotion of the public interest, the Court stated that, in contributory infringement cases, courts may have to look "beyond actual duplication of a device or publication to the products or activities that make such

74 *Id.* at 451.
75 *Id.* at 456.
76 *Id.* at 439.
77 *Id.* at 438.
78 *Id.* at 437.
79 *Id.* at 439.
80 *Id.* at 440.
81 *Id.*
82 *Id.* at 441 n.21.
83 *See id.* at 440-43.

duplication possible" and that a balance must be struck between "a copyright holder's . . . demand for . . . protection . . . and the rights of others freely to engage in . . . unrelated areas of commerce."[84] It therefore qualified as the VTR as a staple article of commerce,[85] and held that Sony's sale of the VTR did not constitute an infringement of the plaintiffs' copyrights.[86]

B. Grokster: Sony*'s Unresolved Conflicts*

The issue of secondary liability for copyright infringement came before the Supreme Court again in *Metro-Goldwyn-Mayer Studios v. Grokster, Ltd.*,[87] this time in the context of ad-supported peer-to-peer file sharing programs distributed by the defendants, Grokster and Streamcast Networks.[88] At the very least, the parameters of the case bore a superficial resemblance to *Sony*;[89] and it is reasonable to infer that the plaintiffs hoped to erode the safe harbor *Sony* established. However, the Court unanimously declined to revisit *Sony*'s holding.[90] Instead, it articulated a theory of contributory infringement based on evidence of the defendants' active inducement of actual infringement.[91] However, the continuing tension between copyright protection and technological innovation was acknowledged by the Court to be "the subject of the case,"[92] and it took specific notice of the claim that digital file sharing presented an unprecedented threat to copyright "because every copy is identical to the original, copying is easy, and many people . . . use file-sharing software to download copyrighted works."[93] The two concurring opinions, authored by Justices Ginsburg and Breyer, sharply disagreed on the breadth of the safe harbor provided by *Sony*.[94]

The action was brought by a group of copyright holders, including movie studios and record companies, who accused the defendants of distributing their software with the intent of enabling the unauthorized distribution of copyrighted works.[95] As the Court noted, peer-to-peer networks, including those of the defendants, normally lack centralized servers for storing files or processing search requests; therefore, neither the defendants nor anyone else could obtain concrete data on the

84 *Id.* at 442.
85 *Id.* at 442.
86 *Id.* at 456.
87 Metro-Goldwyn-Mayer Studios v. Grokster, Ltd., 545 U.S. 913 (2005).
88 *Id.* at 919–20.
89 *See supra* notes 58–60 and accompanying text.
90 *Grokster*, 545 U.S. at 934.
91 *Id.* at 936.
92 *Id.* at 928.
93 *Id.* at 928–29.
94 *See id.* at 942–49 (Ginsburg, J., concurring); *id.* at 949–66. (Breyer, J., concurring).
95 *Id.* at 920–21 (majority opinion).

frequency of certain search terms or the number of copyrighted files which passed through the network.[96] In spite of this evidentiary hurdle, the plaintiffs commissioned a study that suggested that almost ninety percent of the files made available on Grokster's network were copyrighted works.[97]

The defendants did not contest that their software was "primarily" used for infringement.[98] Indeed, the Court found that the companies had direct knowledge of infringement from users who emailed them for technical assistance and that plaintiffs had notified them of the presence of infringing files on their networks.[99] These facts would seem to distinguish *Grokster* from *Sony*, as Sony was found to have only constructive knowledge of infringement by Betamax users,[100] and the transfer of copyrighted material on videotape was explicitly not at issue.[101] However, *Grokster* went further, focusing on evidence of the defendants' specific intent to actively induce infringement, including their overt solicitation of former Napster users and attempts to promote the availability of popular copyrighted material on their networks.[102] The Court also noted that the defendants' business models relied on advertising, thus causing their revenue to depend directly on the volume of use, which they knew to be predominantly infringing.[103] This was clearly different from the facts of *Sony*, where the defendant simply sold the equipment to consumers and had no further contact after the point of sale.[104] Although the defendants argued that some copyright holders might authorize free copying of their works, and that their networks had also been used to distribute non-copyrighted works,[105] this effort was fruitless. The court ruled for plaintiffs based upon the defendants' active efforts to induce infringement,[106] simply stating that "this case is significantly different from *Sony* and reliance on that case to rule in

96 *Id.* at 922–23.
97 *Id.* at 922.
98 *Id.* at 923.
99 *Id.* at 923.
100 Sony Corp. of Am. v. Universal City Studios, Inc., 464 U.S. 417, 439 (1984).
101 *Id.* at 425.
102 As Napster began to founder, both Streamcast and Grokster produced Napster-compatible file-sharing programs (respectively OpenNap and Swaptor) , apparently in order to attract Napster users to their own offerings. *Grokster*, 545 U.S. at 937–38. Streamcast used OpenNap to distribute and promote its own program, Morpheus, and internal communications and promotional materials documented the company's intent to attract former Napster users and increase the amount of infringin material on its network. *Id.* at 924-26. Grokster distributed a newsletter "promoting its ability to provide particular, popular copyrighted materials" and attempted to attract search queries for "Napster" and "[f]ree file-sharing" to its website. *Id.* at 925-26.
103 *Id.* at 939–40.
104 Sony Corp. of Am. v. Universal City Studios, Inc., 464 U.S. 417, 438 (1984).
105 *Grokster*, 545 U.S. at 922–23.
106 *Id.* at 919.

favor of Streamcast and Grokster was error."[107] If the *Grokster* opinion limited *Sony* in any way, it was only in reversing the Ninth Circuit's interpretation of that case as creating a categorical bar on secondary infringement, under any theory, for a product that was capable of substantial lawful uses.[108]

The concurring opinions differed significantly in their willingness to directly confront interpretation of the *Sony* doctrine. While the Court simply reversed the initial ruling of summary judgment for the defendants and ordered reconsideration of the plaintiffs' cross-motion,[109] Justice Ginsburg's concurrence, joined by Justices Kennedy and the Chief Justice,[110] suggested that summary judgment should be granted to the plaintiffs on remand.[111] Justice Ginsburg suggested that the Court could have drawn contributory liability,[112] as well as inducement liability, from patent law as grounds for ruling against plaintiff, which would have drawn the Court into the key inquiry, left unanswered in *Sony*, of "how much [actual or potential] use is commercially significant."[113] Justice Ginsburg was dismissive of evidence of noninfringing uses,[114] and she expressed skepticism that noninfringing uses for the networks were likely to develop.[115] Although Ginsburg was careful to distinguish between the specific networks at issue in the case and peer-to-peer technology more generally,[116] her concurrence suggested a willingness to reconsider, and possibly curtail, the undefined scope of *Sony*'s doctrine.

Justice Breyer's concurrence, joined by Justices Stevens and O'Connor, explicitly disagreed with Justice Ginsburg's contention that the defendants' products were not "capable of 'substantial' or 'commercially significant' noninfringing uses" under the *Sony* standard.[117] While Justice Breyer agreed with the Court's application of the inducement standard to the defendant's conduct,[118] he disagreed with Justice Ginsburg's assertion that the Ninth Circuit erred when it granted summary judgment on the substantial noninfringing uses

107 *Id.* at 941.
108 *Id.* at 934.
109 *Id.* at 941.
110 *Id.* at 941 (Ginsburg, J., concurring).
111 *Id.* at 948.
112 *Id.* at 942 ("Liability under our jurisprudence may be predicated on . . . distributing a product distributees use to infringe copyrights, if the product is not capable of 'substantial' or 'commercially significant' noninfringing uses") (quoting Sony Corp. of Am. v. Universal City Studios, Inc., 464 U.S. 417, 442 (1984)).
113 *Id.* at 943–44 (quoting *Sony*, 464 U.S. at 442).
114 *Id.* at 946.
115 *Id.*
116 *Id.*
117 *Id.* at 949 (Breyer, J., concurring) (quoting *id.* at 943 (Ginsburg, J., concurring)).
118 *Id.* at 949.

issue,[119] asserting that her opinion represented a significantly stricter interpretation of *Sony*.[120] He emphasized that under the version of the staple article of commerce doctrine adopted there, the Court had found that a product "*need merely be capable of substantial noninfringing uses*" to avoid contributory liability.[121] He then noted that the findings in *Sony* suggested that roughly nine percent of the recordings made were owned by rights-holders who did not object to time-shifting or otherwise fell into the category which *Sony* regarded as authorized[122]—a percentage Justice Breyer regarded as not significantly different from the ten percent which the plaintiff's own expert had not labeled as infringing or "likely infringing."[123] He stated that *Sony* had found that this proportion of "authorized programming was 'significant,' and it also noted the 'significant potential for future authorized copying.'"[124] Justice Breyer further noted that *Sony* had "determined that producers . . . had authorized [taping] . . . 'in significant enough numbers to create a *substantial* market for . . . noninfringing use[s].'"[125] The Court's use of the word "substantial," according to Justice Breyer, indicated that the small percentage of authorized uses in *Sony* was sufficient in and of itself for the Court to reject secondary liability for the defendant;[126] *Sony*'s further finding that even unauthorized time-shifting could be fair use was not necessary to its holding.[127]

After reviewing evidence of authorized and noninfringing files on Grokster's network,[128] Justice Breyer concluded that there was no plausible evidence in the record indicating that there was a significant difference between the amount of lawful use at issue in *Grokster* and that which the Court had deemed "substantial" in *Sony*.[129] He also found that *Sony* indicated it was appropriate to look not only at present lawful uses, but also future uses in determining "whether the product is '*capable of*' substantial noninfringing uses."[130] Justice Breyer indicated that he believed there was a significant and growing potential for noninfringing uses of networks such as those maintained by defendant.[131] His survey of such uses led him to the conclusion that

119 *Id.*
120 *Id.* at 956 (internal citation omitted).
121 *Id.* at 950 (quoting Sony Corp. of Am. v. Universal City Studios, Inc., 464 U.S. 417, 442 (1984).).
122 *Id.* at 950–51.
123 *Id.* at 952.
124 *Id.* at 951 (quoting *Sony*, 464 U.S. at 444).
125 *Id.* (quoting *Sony*, 464 U.S. at 447 n.28).
126 *Id.*
127 *Id.* at 952 (citing *Sony*, 464 U.S. at 447–56).
128 *Id.* at 952–53.
129 *Id.* at 953.
130 *Id.* at 953–54 (quoting *Sony*, 464 U.S. at 444).
131 *Id.* at 954.

there legitimate uses would continue to proliferate.[132] Breyer specifically noted the unforeseen development of the video-rental industry as a result of the VTR and suggested that similar unforeseen uses could develop for peer-to-peer networks.[133]

Justice Breyer wrote that the real question at issue was not whether the *Sony* standard had been satisfied,[134] but rather whether *Sony* should be modified or interpreted more strictly, as he believed the plaintiffs and Justice Ginsburg had proposed.[135] Noting that *Sony* itself addressed the tension between copyright protection and new technology,[136] Justice Breyer turned to the question of whether the *Sony* doctrine, as he interpreted it, struck the proper balance between the two values.[137] He concluded that, based on his analysis, a stricter application of *Sony* would have a significant chilling effect on technological innovation,[138] while the corresponding benefits to copyright were insufficiently clear to justify such a change.[139] In doing so, Justice Breyer asserted that the law disfavored equating the two values, and that in fact it "lean[ed] in favor of protecting technology[.]"[140] To support this proposition, he cited the Court's expression of doubts in *Sony* as to the wisdom of construing copyright in a manner that might choke the development of new technologies.[141] Although Justice Breyer's technology-protective approach only attracted the votes of two other Justices,[142] it is illustrative of the Court's larger direction. In *Sony*, Justice Stevens wrote for a bare majority in establishing the doctrine's safe harbor.[143] In *Grokster*, none of the Justices challenged the legitimacy of the safe harbor itself; even Justice Ginsburg only argued that there might be a need for it to be limited and clarified,[144] and her concurrence attracted no more support than Justice Breyer's.[145] On the whole, *Grokster* suggests that developments over the intervening decades have secured *Sony*'s place in IP law and that the safe harbor will remain in place.

132 *See id.* at 95–55.
133 *Id.* at 955.
134 *Id.*
135 *Id.* at 956 (citing *id.* at 943–47 (Ginsburg. J., concurring)).
136 *Id.*
137 *Id.* at 956–57 (asking "(1) Has *Sony* (as [Justice Breyer] interpret[s] it) worked to protect new technology? (2) If so, would modification or strict interpretation significantly weaken that protection? (3) If so, would new or necessary copyright-related benefits outweigh any such weakening?").
138 *Id.* at 959–60.
139 *Id.* at 960–61.
140 *Id.*
141 *Id.* (citing Sony Corp. of Am. v. Universal City Studios, Inc., 464 U.S. 417, 431 (1984)).
142 *Id.* at 949.
143 *See Sony*, 464 U.S. at 457.
144 *See Grokster*, 545 U.S. at 943–44. (Ginsburg. J., concurring).
145 *See id.* at 941.

III. ANALYSIS: "NAPSTER FABBING" OR NEW INDUSTRY?

It is important to remember that 3-D printing refers not to a single phenomenon, but rather to several inter-related but distinct developments. The discussion surrounding consumer 3-D printers is typically based on one of the two major open-source projects discussed above.[146] The emergence of online communities where hobbyists freely exchange advice and designs for home 3-D printers, such as Thingiverse and the Fab@Home site, represents what has been referred to as the "open model."[147] Lastly, there is the "money model," dominated by Shapeways, which might be better characterized as a *provider* of 3-D printing services, allowing users both to pay for printed versions of their own uploaded designs and to purchase copies of designs offered for sale by other users.[148] These aspects of the 3-D printing ecology differ significantly in their capabilities and probable economic impact. They also present different legal problems and issues in the context of intellectual property protection.

A. *Home 3-D Printers*

Numerous articles about 3-D printing make broad claims regarding its potential, or peril, but devote little attention to the details of the technology.[149] As noted in Peter Hanna's more sober consideration of the subject, home 3-D printing "remains a hobbyist-driven enterprise with a high barrier to entry,"[150] not least because even hobbyist models remain relatively expensive. A typical 3-D printer, such as the Replicator from Makerbot, costs $1,749.[151] Like most consumer-grade units, it is only capable of working with a few different thermoplastics,[152] has a small build area,[153] and slow build speeds.[154] Such units lack the capability to work with materials like metal or ceramic, cannot build units any longer than seven or eight inches, and produce things much more slowly than commercial printers or traditional manufacturing processes. Furthermore, 3-D printers require careful calibration[155] and are often unreliable,[156] as evidenced by the

146 *See FAQ Fab@Home*, *supra* note 25; *Open Source Hardware*, *supra* note 25.
147 Hanna, *supra* note 36, at 2.
148 *See* Hod Lipson & Melba Kurman, *Factory @ Home*, OCCASIONAL PAPERS SCI. & TECH. POL'Y, 22–23 (2010), http://web.mae.cornell.edu/lipson/FactoryAtHome.pdf.
149 *See The Printed World*, *supra* note 3; Burns, *supra* note 11.
150 Hanna, *supra* note 36, at 2.
151 *See Makerbot Replicator*, *supra* note 30
152 *See 3 Dimensional Printers Below $20,000*, ADDITIVE3D.COM, (Oct. 17, 2011), http://www.additive3d.com/3dpr_cht.htm.
153 *See* Pearce, *supra* note 23, at 19, 23; *Makerbot Replicator*, *supra* note 30.
154 *See* Lipson, *supra* note 148, at 14; Pearce, *supra* note 23, at 19, 23.
155 Pearce, *supra* note 23, at 20.
156 Paul Wallich, *3-D Printer Proliferate*, IEEE SPECTRUM (Sept. 2010), http://spectrum.ieee.org/robotics/diy/3d-printers-proliferate.

RepRap Wiki's extensive documentation regarding jamming of the extruder head.[157] Despite these technological issues, comparisons between file-sharing and 3-D printing have become commonplace;[158] however, these comparisons are often taken too far.

As *Grokster* noted, online file-sharing was of special concern because "every copy is identical to the original, copying is easy, and many people . . . use file-sharing software to download copyrighted works."[159] Presently, none of this is true of home 3-D printing. Rather than a simple, free program, home 3-D printing requires a relatively expensive and complex piece of equipment. Secondly, copying and printing objects may require non-trivial effort and expertise, and the small 3-D printing community has of yet given rise to relatively few claims of infringement.[160] Admittedly, this last point is likely due in part to the relatively small size of the 3-D printing community; infringing designs such as the Darth Vader head replicas do circulate, but the failure of rights-holders to sue may be due to unawareness of the small community or to their regard of legal action as not being worth its costs.[161] However, some suggest that the small, undeveloped nature of the industry itself is an argument against regulation, as its future course cannot be predicted and a wrong step could strangle innovation.[162] In this context, where a still-developing but potentially disruptive technology faces established and powerful IP interests, it is vital to remember the Supreme Court's repeated invocations of the tension between IP protection on one hand and technical innovation and the free flow of ideas on the other.[163] The social benefits of creativity and innovation must remain paramount in calculating the resulting balance.[164]

As stated above, *Grokster* found online file-sharing to be of specific concern because the copies were identical to the sources and the

---

157 *See Mendel User Manual: Extruder*, REPRAP WIKI, http://reprap.org/wiki/Mendel_User_Manual:_Extruder (last visited Nov. 6, 2011). Like many a home project, calibrating consumer-grade 3-D printers can require a great deal of trial and error and are prone to the 3-D equivalents of printer-head problems and paper jams.

158 *See, e.g.*, Burns, *supra* note 11; Hanna, *supra* note 36.

159 Metro-Goldwyn-Mayer Studios Inc. v. Grokster Ltd., 545 U.S. 913, 928–29 (2005).

160 *See supra* notes 35–51 and accompanying text.

161 *See* Hanna, *supra* note 36, at 2.

162 *See id.*

163 *See Grokster*, 545 U.S. at 928; Sony Corp. of Am. v. Universal City Studios, Inc., 464 U.S. 417, 429–30 (1984).

164 *See Sony*, 464 U.S. at 429 n.10 ("'[C]opyright legislation . . . is not based upon any natural right that the author has in his writings . . . but upon the grounds that the welfare of the public will be served . . . . In enacting a copyright law Congress must consider . . . two questions: First, how much will the legislation stimulate the producer and so benefit the public, and, second, how much will the monopoly granted be detrimental to the public?'") (quoting H.R. Rep. No. 60-2222, at 7 (1909)).

copying was easy and widespread.[165] Also, the fact that the defendants actively induced infringement was crucial to the Court's holding.[166] By contrast, 3-D printers are more analogous to the facts of *Sony* where the defendant had only constructive knowledge that its customers might use VTRs for infringing purposes and that the product had substantial noninfringing uses.[167]

The present state of consumer 3-D printing is considerably closer to *Sony* than to *Grokster* for several reasons. The first of these reasons is technological. Translating a copyright-protected object into a format recognizable by a 3-D printer remains a difficult and exacting task—arguably more difficult than designing an entirely new one. This undermines any assertion that printer vendors expect or induce the end-users of their products to infringe.[168] Objects may be copied through reverse engineering,[169] as in the Penrose Triangle affair,[170] or through the use of a 3-D scanner. Both approaches have their difficulties. The Penrose Triangle is actually a comparatively simple case for the application of reverse engineering, as it was ultimately a single plastic shape. Anything more complicated, such as a mechanism with moving parts, would likely require the copyist to disassemble it, develop an understanding of the total mechanism and how its components fit together, and carefully reproduce each piece in CAD software for separate printing and assembly.[171] Even leaving aside the patience and mechanical aptitude required to understand the physical product, mastering the CAD software itself remains a nontrivial task.[172]

---

165 *See Grokster*, 545 U.S. at 928–29.

166 *Id.* at 937–38.

167 *Sony*, 464 U.S. at 439, 451.

168 Despite the recent furor over 3-D-printed handcuff keys, this assertion remains true. Both keys that were successfully reverse engineered were of comparatively simple shapes, and the reverse engineering was done by a professional security consultant for use in a talk he was giving at a security conference. *See* Andy Greenberg, *Hacker Opens High Security Handcuffs with 3D-Printed and Laser-Cut Keys*, FORBES (July 16, 2012, 9:00 AM), http://www.forbes.com/sites/andygreenberg/2012/07/16/hacker-opens-high-security-handcuffs-with-3d-printed-and-laser-cut-keys/print/. The consultant himself later observed that copies of the keys in question could be trivially produced by any number of methods, including hand tools, and that he had mainly been interested in whether the materials involved would be strong enough to open actual handcuffs. Ray, Comment to *Making Handcuff Keys with 3D Printers*, SCHNEIER ON SECURITY (Aug. 6, 2012, 6:42 PM), http://www.schneier.com/blog/archives/2012/07/making_handcuff.html#c837695.

169 *See Reverse Engineer*, *supra* note 37.

170 *See supra* notes 35–41 and accompanying text.

171 *See Reverse Engineering*, MECHANICAL ENGINEERING BLOG (May 11, 2011), http://www.mechanicalengineeringblog.com/2245-reverse-engineering-re-reverse-engineering-in-mechanical-parts-reverse-engineering-softwares-inspection-software-reverse-engineering-technology-reverse-engineering-in-product-developmen/.

172 Traditionally, the complexity and expense of CAD software rendered it primarily the province of industrial designers and engineers. Lipson, *supra* note 148, at 18. More recently, simpler and cheaper alternatives such as Google SketchUp have emerged, but even they require a certain amount of skill and are not yet designed to take into account the special limitations and

Replicating an object with a 3-D printer is nowhere near as simple or effortless as taping a television program with a VTR or sharing a file on a peer-to-peer network, and it is unlikely that this will change any time soon.

It may be unclear why the technical difficulty of the task is relevant to the issue of the likelihood of infringement; here, one must recall the Court's attention to the fidelity of copying, ease of copying, and widespread use of the defendants' networks in *Grokster*.[173] The guaranteed fidelity of digital copies was a crucial property absent from previous means of piracy like using a tape recorder to copy audio cassettes or record a live radio broadcast, and the widespread embrace of peer-to-peer networks was driven by their promise of simple and convenient access to high-fidelity copies of songs. *Sony* itself took note of the issue of ease of use,[174] and in light of *Grokster*, it seems reasonable to conclude that such factors will continue to be considered.

3-D scanning, although superficially simpler, is also problematic. Commercial scanners remain extremely expensive; even the most basic models cost thousands of dollars,[175] and prices in the tens of thousands of dollars are common.[176] Hobbyists have developed home-built 3-D scanners for far less; however, these introduce problems of construction and calibration, as well as lower resolution than commercial scanners.[177] More recently, online services have emerged that provide crude 3-D models based on sets of digital photographs;[178] however, both of these methods require significant post-processing in order to create a printable design. Although scanners employ many various methods, their raw output is usually a "cloud" of disconnected points,[179] which must be integrated into a "mesh" surface to produce a usable model.[180] Especially for homemade scanners, this may involve computationally difficult problems, like integrating scans from different angles, and/or

requirements of 3-D printing. *Id.* at 19.

173 Metro-Goldwyn-Mayer Studios Inc. v. Grokster Ltd., 545 U.S. 913, 928–29 (2005).

174 Sony Corp. of Am. v. Universal City Studios, Inc., 464 U.S. 417, 452 n.36 (1984) (noting the district court's rejection of claims that VTRs would be widely used to omit or fast-forward through commercials, due to the tedious and inexact nature of the procedures necessary to accomplish this).

175 *See, e.g.*, *NextEngine 3D Scanner Specifications*, NEXTENGINE, http://www.nextengine.com/assets/pdf/scanner-techspecs.pdf (last visited Sept. 1, 2012).

176 *See, e.g.*, *Laser Scanners*, DIRECT DIMENSIONS, http://www.dirdim.com/prod_laserscanners.htm (last visited Sept. 1, 2012).

177 *See MakerScanner*, MAKERBOT WIKI, http://wiki.makerbot.com/makerscanner (last visited Sept. 2, 2012); *Makerbot 3D Scanner*, MAKERBOT WIKI, http://wiki.makerbot.com/3d-scanner (last visited Sept. 2, 2012).

178 *See, e.g.*, *Scanning without a Scanner*, MAKERBOT BLOG (Nov. 4, 2011), http://www.makerbot.com/blog/2011/11/04/scanning-without-a-scanner-hypr3d-com/.

179 Fausto Bernardini & Holly Rushmeier, *The 3D Model Acquisition Pipeline*, 21 COMPUTER GRAPHICS F. 149, 150 (2002).

180 *Id.*

the necessity of human expertise and judgment.[181] Furthermore, the scanning process is subject to much error.[182]

While vendors of commercial scanners today commonly offer proprietary software intended to automate much of this process,[183] use of a homebuilt scanner may require manual editing of the raw data in several different free programs to achieve a printable result.[184] Anything more complex than a unitary shape, such as a design containing moving parts, would still require the disassembly of the original and the complete process, from scanning to post-processing to printing, for each individual part. Leaving aside for the moment online trading of CAD files, direct copying is in fact far more difficult in the context of 3-D printers than in that of VTRs or file-sharing networks, and it is likely to remain so for the foreseeable future.[185]

Additionally, an examination of the economics of consumer 3-D printing makes it clear that the rationale of *Grokster* is not applicable and that the printers themselves should fall under the safe harbor of the *Sony* doctrine. The two major 3-D printing projects themselves are both primarily academic enterprises; they may publish parts lists and instructions, but they sell nothing.[186] Even commercial providers like Makerbot[187] are far more like the defendants in *Sony* than those in *Grokster*. As in *Sony*, Makerbot's primary, if not only, contact with users is at the point of sale,[188] and its business plan is not dependent on encouraging a large volume of infringing use, as in Grokster's and

---

[181] *Id.* at 151; *see also Using Meshlab to Clean and Assemble Laser Scan Data*, INSTRUCTABLES (Aug. 19, 2009), http://www.instructables.com/id/Using-Meshlab-to-Clean-and-Assemble-Laser-Scan-Dat/.

[182] *See* Tamás Várady et al., *Reverse Engineering of Geometric Models—An Introduction*, 29 COMPUTER-AIDED DESIGN 255, 260–61 (1997); *Makerbot 3D Scanner Usage*, MAKERBOT WIKI, http://wiki.makerbot.com/3d-scanner-usage (last visited Sept. 2, 2012).

[183] *See, e.g.*, *ZEdit Pro Data Sheet*, 3DSYSTEMS (Jan. 2012), http://www.zcorp.com/documents/214_ZEdit%20Pro%20Data%20Sheet.pdf; *ScanStudio CAD Tools*, NEXTENGINE, http://www.nextengine.com/products/scanstudio-cad-tools/specs/overview (last visited Sept. 2, 2012).

[184] *See MakerScanner Post Processing*, MAKERBOT WIKI, http://wiki.makerbot.com/makerscanner-post-processing (last visited Nov. 7, 2011); *MakerScanner Meshing*, MAKERBOT WIKI, http://wiki.makerbot.com/makerscanner-meshing (last visited Nov. 7, 2011).

[185] Clive Thompson, in his recent discussion of developments in 3-D printing, suggested that hobbyist-grade printers with integrated scanning capability would be available in the near future. However, he provided neither any suggestions as to how this might be accomplished nor evidence that any entity was attempting to provide such a capability in a consumer-grade printer. Thompson, *supra* note 50.

[186] *See FAQ Fab@Home*, *supra* note 25; *RepRap Buyers' Guide*, REPRAP WIKI, http://reprap.org/wiki/Prusa_Buyers_Guide (last visited Sept. 2, 2012); *see also Prusa Mendal Assembly*, REPRAP WIKI, http://reprap.org/wiki/Prusa_Build_Manual (last visited Sept. 2, 2012).

[187] Makerbot is the most prominent manufacturer and vendor of consumer 3-D printers. The company claims that, in 2011, it controlled 21.6% of the total market for 3-D printers, including both consumer and industrial units. *FAQ*, MAKERBOT, http://www.makerbot.com/faq/ (last visited Nov. 15, 2012).

[188] Sony Corp. of Am. v. Universal City Studios, Inc., 464 U.S. 417, 438 (1984).

Streamcast's advertising-driven networks.[189]

More importantly, 3-D printers are potentially capable of a far greater number of noninfringing uses than the VTR at issue in *Sony*; the Betamax was limited to recording television programs,[190] while, within the limits of materials and present technology, 3-D printers can create any shape or simple device designable in a CAD program. A cursory search of the most popular designs on Thingiverse produces results like a printable spring toy, originally created by accident,[191] and a scale model of an ongoing attempt by a hobbyist to create a user-printable prosthetic hand.[192] Although current units remain limited and improvement may be gradual, clearly 3-D printing technology has tremendous potential to eventually promote innovation and produce new industries by lowering the costs of entry in manufacturing,[193] and, as Justice Breyer cautioned in his *Grokster* concurrence, one often cannot foresee many of the uses of a new technology in advance.[194]

For example, an article in the *Journal of Sustainable Development* has explored the potential of open-source 3-D printers to assist poor communities in developing nations in their struggles with poverty.[195] The authors specifically cite the example of village water pumps, which frequently break down and for which funding or availability of spare parts is often an issue. A village equipped with an appropriate 3-D printer could produce simple parts or tools for itself, thereby avoiding any logistical or bureaucratic issues.[196] The article also highlighted research into making such systems more self-sufficient, such as developing methods for 3-D printers to use local materials and waste as feedstock,[197] and suggested pairing printers with solar panels and cheap, energy-efficient laptops in order to serve isolated rural areas.[198]

Arguably, the consumer 3-D printing industry has far more potential for innovative legitimate uses than the Betamax at issue in *Sony* did, and is thus more deserving of *Sony* protection. In the long term, the potential of 3-D printers is enormous, as is "the public interest in access to [such] articles of commerce,"[199] causing concern that

189 Metro-Goldwyn-Mayer Studios Inc. v. Grokster Ltd., 545 U.S. 913, 939–40 (2005).
190 *Sony*, 464 U.S. at 422.
191 *Springamathing*, THINGIVERSE, http://www.thingiverse.com/thing:12053 (last visited Nov. 6, 2011).
192 *A Little Hand, Big Idea*, THINGIVERSE, http://www.thingiverse.com/thing:13117 (last visited Nov 6, 2011).
193 *See* Lipson, *supra* note 148, at 9–10.
194 Metro-Goldwyn-Mayer Studios Inc. v. Grokster Ltd., 545 U.S. 913, 955 (2005) (Breyer, J., concurring).
195 *See* Pearce, *supra* note 23.
196 *Id.* at 21.
197 *Id.* at 22–23.
198 *Id.* at 23.
199 Sony Corp. of Am. v. Universal City Studios, Inc., 464 U.S. 417, 440 (1984).

restrictions placed upon their production and sale simply due to the fear of individual infringement could be to the detriment of the public interest. At the present time, such interventions should be considered unadvisable at this stage due to the fledgling nature of the industry and the inevitably ill-defined regulation that would result.

B. *Online Communities and Free Exchange*

As discussed earlier, hobbyists and other enthusiasts discuss 3-D printing and post CAD files for others to freely modify and print themselves in various online forums. Thingiverse is the leading website that caters to the 3-D printing community. It is run by Makerbot Industries, a major producer of kits and 3-D printers based upon the RepRap project.[200] When users upload CAD files, they are given several options for licensing regarding how other users may use their content. Until February 2012, this included the option to reserve all rights or place the object in the public domain; the site has since moved exclusively to the use of Creative Commons ("CC")[201] licenses on all new designs.[202] All CC licenses allow for non-commercial copying of the content licensed provided there is attribution to the source,[203] and many of the licenses available on the site allow third parties to modify and republish schematics subject to certain conditions.[204] Thingiverse's own statements regarding "trees" of derivative designs,[205] and the fact that a section of its front page is devoted specifically to derivative works, suggest that this is a common, encouraged practice.

This model might seem superficially closer to the facts of *Grokster* than that of 3-D printers in that it enables the easy and perfect copying of schematics for a potentially large group of users.[206] However, one must first remember that, unlike in *Grokster*, the CAD schematic is not

---

[200] *See* Zach Smith, *Announcing MakerBot Industries*, REPRAP BLOG (Mar. 16, 2009), http://blog.reprap.org/2009/03/announcing-makerbot-industries.html.

[201] Creative Commons is a non-profit organization that develops and provides standardized copyright licenses that allow content creators a simple method to permit certain uses of their content (e.g. non-commercial copying) while, usually, reserving some rights. *See About – Creative Commons*, CREATIVE COMMONS, http://creativecommons.org/about (last visited Oct. 30, 2012).

[202] Bre Pettis, *Thingiverse Updates Terms of Use and License Options*, THINGIVERSE BLOG (Feb. 10, 2012), http://blog.thingiverse.com/2012/02/10/thingiverse-updates-terms-of-use-and-license-options/.

[203] *About the Licenses*, CREATIVE COMMONS, http://creativecommons.org/licenses/ (last visited Sept. 2, 2012).

[204] *Creative Commons—Attribution-ShareAlike 3.0 Unported*, CREATIVE COMMONS, http://creativecommons.org/licenses/by-sa/3.0/ (last visited Sept. 2, 2012).

[205] *See* Allan Ecker, *This is Why CC Licenses are Important*, THINGIVERSE BLOG (Feb. 18, 2011), http://blog.thingiverse.com/2011/02/18/this-is-why-cc-licenses-are-important/.

[206] *Cf.* Metro-Goldwyn-Mayer Studios, Inc. v. Grokster, Ltd., 545 U.S. 913, 928–29 (2005) (stating that file-sharing presents a novel threat to copyright "because every copy is identical to the original, copying is easy, and many people . . . use file-sharing software to download copyrighted works.").

the final product. Although a Thingiverse user may not need a 3-D scanner or CAD software and training to obtain schematics, she still needs a 3-D printer to produce the actual object. Even if one assumes the existence of a party using commercial-grade scanning equipment to upload high-quality infringing schematics, each downloading party would still have to have purchased or built a 3-D printer and gone through the slow and often imperfect process of printing the object in order to actually obtain the product.[207] For the foreseeable future, this technological bottleneck will frustrate use of the site for significant IP infringement. Much the same can, and has, been said about the Pirate Bay's surprise excursion into this area.[208]

One also might be concerned that Thingiverse is owned by Makerbot, a vendor of 3-D printer kits and feedstock, and that the site carries advertising. Makerbot thus arguably has a financial incentive to drive traffic to the site to increase ad revenues and potential sales of their 3-D printers. In *Grokster*, the fact that the defendants' business models relied on encouraging high-volume copying was one element of the Court's decision against them.[209] However, *Grokster* also cautioned that such evidence, standing alone, would be insufficient to "justify an inference of unlawful intent" to induce infringement;[210] the Court suggested that the incentives created by the defendants' business models simply complemented the direct evidence of their knowledge of and intent to induce infringing activity.[211] Although the statement was arguably dicta, the Court indicated that, so long as a service or device had "substantial noninfringing uses," contributory infringement liability would not lie simply because a provider failed to take affirmative steps to prevent infringement, absent actual evidence of intent to induce it.[212]

As already indicated, Thingiverse serves as a forum for the free exchange of numerous original CAD schematics.[213] Although there have been examples of potentially infringing content, the site does not direct users towards infringing content or promote its availability, as the defendant did in *Grokster*.[214] Furthermore, the site's terms of use warns users that they must respect the licensing limitations placed upon content uploaded to the site and that uploading infringing material is not permitted.[215] The terms of use also link to the company's intellectual

[207] *See supra* notes 150–157 and accompanying text.
[208] *See, e.g.*, Duffy, *supra* note 14; Adhikari, *supra* note 14.
[209] *Grokster*, 545 U.S. at 939–40.
[210] *Id.* at 940.
[211] *Id.* at 939-40.
[212] *Id.* at 939 n.12.
[213] *See supra* notes 190–205 and accompanying text.
[214] *Grokster*, 545 U.S. at 926.
[215] *Terms of Use*, THINGIVERSE, http://www.thingiverse.com/legal (last visited Sept. 3, 2012).

property policy,[216] which complies with the system of notifications and counter-notifications set up by the Digital Millennium Copyright Act ("DMCA").[217] Despite the fact that the DMCA regime is explicitly limited to copyright, Thingiverse has proactively taken the step of including other types of intellectual property in its notice-and-takedown regime as well.[218] The Penrose Triangle affair serves as evidence that the site will enforce its policy.[219]

The importance attached to appropriate licensing of uploaded schematics,[220] the seriousness with which Thingiverse and its blog have considered intellectual property issues,[221] and the lack of evidence that Thingiverse hosts a substantial amount of infringing content all distinguish it from the *Grokster* defendants, who based their business on flouting copyright law and refused to take remedial action even when informed of infringement by rights-holders.[222] Furthermore, under the safe harbor provisions of the DMCA,[223] services such as Thingiverse are protected from liability for infringement by their users, so long as they lack actual knowledge or are "not aware of facts or circumstances" that make it clear that infringement is occurring, and remove any infringing content they do discover, either directly or through a DMCA takedown notice.[224] The safe harbor's requirement that the service provider "not receive a financial benefit directly attributable to the infringing activity" is unlikely to be problematic for Thingiverse,[225] despite its use of ads and connection to Makerbot, because unlike in *Grokster*, there is no evidence that Thingiverse's business model is driven by providing access to infringing content or that the level of

---

216 *Intellectual Property Policy*, THINGIVERSE, http://www.thingiverse.com/legal/ip-policy (last visited Sept. 3, 2012). The site's IP policy was far more explicit regarding its inclusion of other types of IP, such as patents, before the February 2012 revision, but the changes do not suggest their exclusion. *See, e.g.*, *Thingiverse Terms of Services*, INTERNET ARCHIVE (July 7, 2011), http://web.archive.org/web/20110707143620/http://www.thingiverse.com/legal ("Please specify the type of infringement at issue and the notice must include the following information: . . . Identification in sufficient detail of the material being infringed upon (for an allegation of a patent infringement, please provide a patent number).").

217 *See* 17 U.S.C. § 512(c) (2012); Digital Millennium Copyright Act, Pub. L. No. 105-304, 112 Stat. 2860 (1998).

218 *See Intellectual Property Policy*, *supra* note 216; *Thingiverse Terms of Services*, *supra* note 216.

219 *See supra* notes 36–41 and accompanying text.

220 *See, e.g.*, *Intellectual Property Policy*, *supra* note 216; *Thingiverse Terms of Services*, *supra* note 216; Ecker, *supra* note 205.

221 *See, e.g.*, Bre Pettis, *Copyright Policy*, THINGIVERSE BLOG (Feb. 18, 2011), http://blog.thingiverse.com/2011/02/18/copyright-and-intellectual-property-policy/; Bre Pettis, *Share and Share Alike*, THINGIVERSE BLOG (Sept. 19, 2010), http://blog.thingiverse.com/2010/09/19/share-and-share-alike/; Dominic Muren, *Toe Stepping: Thingiverse and IP Law*, THINGIVERSE BLOG (Nov. 3, 2009), http://blog.thingiverse.com/2009/11/03/thingiverse-and-ip/.

222 Metro-Goldwyn-Mayer Studios, Inc. v. Grokster, Ltd., 545 U.S. 913, 925–26 (2005).

223 17 U.S.C. § 512 (2012).

224 § 512(c)(1).

225 § 512(c)(1)(b).

traffic to the site and advertising revenue is "a function of free access to copyrighted work."[226]

However, other areas of IP law may prove more problematic. As earlier noted, the DMCA only addresses issues of copyright; Thingiverse's ad-hoc extension of the Act's notice-and-takedown procedures may be evidence of their good faith, but the fact remains that the DMCA's safe harbor provision does not extend to patents. And unlike copyright, patent law regards even innocent and independent reinvention of patented matter as infringing.[227] This could potentially open both schematic repositories and individual designers to liability even if they act in good faith and have no intent to infringe or facilitate infringement. This approach to patent law and infringement may have made some sense in the past, as product design and innovation have commonly been limited to larger organizations having the knowledge, expertise, and resources to avoid infringement.[228] As 3-D printing technology and CAD/CAM tools become increasingly available to the general public, relying on such assumptions will become increasingly untenable.[229] It is thus likely that the spread of 3-D printers will give rise to cases involving individuals innocently infringing upon patents by producing schematics and sharing them online. It must be conceded that it would likely be more difficult to make out a case of patent infringement based on a CAD file than of copyright infringement based on a shared music file, due to the requirement that actual infringement (i.e. printing the schematic) be shown, and sites like Thingiverse, if sued for contributory infringement, could invoke the staple article of commerce doctrine in their defense, absent evidence of inducement or actual knowledge.[230] However, considering the uncertainty and fear in the hobbyist community over IP issues, it may be advisable to extend similar notice-and-takedown and safe harbor provisions into patent law, in order to alleviate potential chilling effects on innovation while still providing some protection for patent rights. There have been concerns that the DMCA notice-and-takedown regime in practice is over-inclusive and subject to abuse,[231] especially in cases where the target is

226 *Grokster*, 545 U.S. at 926.

227 Weinberg, *supra* note 2, at 5.

228 *Id.*

229 Individuals working to solve similar practical problems have often independently come up with similar solutions; historical examples include the modern theory of evolution, developed independently by Darwin and Alfred Wallace, the telephone, for which Alexander Bell and Elisha Gray applied for patents on the same day, and the incandescent light bulb, twenty-three versions of which were produced before Edison's "invention." *See* Kevin Kelly, *Progression of the Inevitable*, TECHNIUM (Aug. 6, 2009), http://www.kk.org/thetechnium/archives/2009/08/progression_of.php.

230 *See* Weinberg, *supra* note 2, at 12–13.

231 *See* Jacqui Cheng, *Five Examples of Lame DMCA Takedowns*, ARS TECHNICA (May 16, 2010, 9:00 PM), http://arstechnica.com/tech-policy/news/2010/05/five-examples-of-lame-dmca-

a private individual, such as Todd Blatt, lacking the resources and knowledge to file a counter-notification and contest the claim.[232] However valid, such issues are too complex to discuss in detail here; the fact remains that some form of notice-and-takedown regime and a corresponding safe harbor would be desirable.

C. *3-D Printing Services*

Although much of the excitement and debate surrounding 3-D printing has focused on consumer-grade printers, in the near future the greatest impact of the technology is likely to be felt in 3-D printing services such as Shapeways. Such services eliminate many of the barriers facing hobbyist printers, such as the required cost and expertise involved and the design, resolution, and materials limitations of the consumer level kits.[233] A private company like Shapeways has the capital and expertise to employ more advanced commercial printers.[234] It can provide designers with the capability to realize creations that require degrees of precision and materials not possible with hobbyist kits.[235] Shapeways also allows designers to create storefronts on Shapeways to market their products to third parties. Shapeways handles billing, manufacturing and shipping; prospective vendors simply set the markup over Shapeways's production prices.[236] The service model frees potential creators and sellers to focus on design rather than maintenance and logistics, while allowing consumers who lack the means or expertise to build and maintain a home printer access to the kinds of customized or unique products that 3-D printing can enable.

Between the two extremes, Shapeways provides a significantly less daunting prospect to interested amateurs than setting up their own 3-D printer, providing design tools, tutorials, and assistance,[237] as well as obviating the assembly and maintenance of a personal 3-D printer. Such a model is considerably less exciting to ideological supporters of open-source methods and decentralized production such as author Cory Doctorow, whose novel *Makers* took a radical view of the transformative potential of 3-D printing,[238] but it is far more likely to

takedowns.ars.

232 *See supra* notes 42–49 and accompanying text.

233 *See supra* Part III.A.

234 *See Design Rules and Detail Resolution for SLS 3D Printing*, SHAPEWAYS, http://www.shapeways.com/tutorials/design_rules_for_3d_printing (last visited Sept. 3, 2012).

235 *See id.*; *Materials Comparison Sheet*, SHAPEWAYS, http://www.shapeways.com/materials/ (last visited Sept. 3, 2012).

236 *See FAQs Shops*, SHAPEWAYS, http://www.shapeways.com/betashops/faq_s_shops (last visited Sept. 3, 2012).

237 *See Tutorials*, SHAPEWAYS, http://www.shapeways.com/tutorials/ (last visited Sept. 3, 2012).

238 *See generally* CORY DOCTOROW, MAKERS (2009), *available at* http://craphound.com/makers/Cory_Doctorow_-_Makers_Letter.pdf (asserting that rapid prototyping will render traditional manufacturing and intellectual property models obsolete, leaving innovation to small groups of

have an impact in the near future than models premised on consumers designing their own products and maintaining 3-D printers in their homes.

The paid 3-D printing services model presents both advantages and potential perils when compared to the non-commercial models above. Its development and expansion do not depend on the potentially fickle interest and uneven expertise of loose groups of hobbyists and academics. Not being limited to techniques and materials that a technically-minded amateur could reasonably work with in his own home, Shapeways gives its customers access to far more advanced commercial machines, as well as enable talented designers to profit from their labors without worrying about the details of manufacturing and distribution. As of December 2011, the company's site hosted roughly four thousand user "shops,"[239] and the company stated that sellers had made twenty-six thousand dollars in profits between August 15th and November 15th.[240] Although the amount may seem small, the future possibilities are significant: creators can monetize their designs without losing control or worrying about selling enough copies to break even, and buyers can purchase customized objects or niche products for which demand is too low to justify mass production. The 3-D printing services model arguably represents an extension of Christopher Anderson's Long Tail to the area of physical products.[241] This will be a potentially revolutionary development in and of itself, if Shapeways and similar businesses can avoid the moral panic over IP that seized the music industry.

Shapeways' history and development would not seem to be suggestive of an enterprise devoted to or dependent on infringement of intellectual property.[242] The company began as a subsidiary of Phillips, the Dutch conglomerate; it branched off in September 2010, though Philips retains a substantial ownership interest.[243] Although the most

creators making a profit through designing new products faster than they can be effectively knocked off).

239 Nitasha Tiku, *After a Year in New York City, 3D Printer Shapeways Quintuples Its Staff*, BETABEAT (Dec. 20, 2011, 4:45 PM), http://www.betabeat.com/2011/12/20/shapeways-3d-printing-12202011/.

240 *The Tidal Wave of 3D Printing Hits NYC*, SHAPEWAYS (Dec. 20, 2011, 5:54 PM), http://www.shapeways.com/blog/archives/1136-The-Tidal-Wave-of-3D-Printing-Hits-NYC.html#extended.

241 *See generally* CHRISTOPHER ANDERSON, THE LONG TAIL (rev. ed. 2008). The "Long Tail" is shorthand for Anderson's thesis that, due to developments in digital media and distribution that have lowered or eliminated the marginal costs of production and distribution, the market for niche and low-popularity entertainment goods has potentially become larger and more profitable than that for "hit" products that the industry has traditionally focused on. *See also* Christopher Anderson, *The Long Tail*, WIRED, Oct. 2004, *available at* http://www.wired.com/wired/archive/12.10/tail_pr.html.

242 *Cf.* Metro-Goldwyn-Mayer Studios Inc. v. Grokster Ltd., 545 U.S. 913, 923–27 (2005).

243 Adam Ludwig, *Mass Production for the Masses*, FORBES (Oct. 10, 2011, 7:55 AM), http://

recent financial data suggested that the company is not yet close to profitability and is burning rapidly through capital,[244] it was still attractive enough to attract a five million dollar investment in 2010.[245] More recently, in November 2011, Shapeways announced plans to double the size of its staff in its New York office and open up a new production facility in the city.[246] Soon after, it announced that it had shipped eighty thousand products that November—four times the total for that month in the previous year.[247] Although Shapeways does not publish information on its earnings, this suggests that the 2009 losses were more likely indicative of the considerable capital expenditures necessary to acquire high-end commercial equipment and the time it takes a new enterprise to stabilize rather than of lack of demand. Nor is Shapeways the only entrant into this sector, even if it is the most prominent.[248] The sector seems likely to become increasingly economically significant regardless of which players capture the market. As the business model seems unlikely to disappear, it remains to be determined whether it represents a significant threat to intellectual property and what, if any, policy interventions would be appropriate, whether to discourage infringement or to prevent potential litigation from chilling the development of the sector.

Once again, it is wise to preempt some of the more extremist positions by emphasizing what 3-D printing services are not. As previously discussed, *Grokster* emphasized three concerns that made file-sharing especially problematic: perfect copying, ease of copying, and widespread use.[249] Although the greater range of materials and higher printing resolution that services such as Shapeways provides would theoretically lend themselves far more easily to producing copies of other's intellectual property, the problem of obtaining an accurate schematic to work from remains an issue. As rapid prototyping is still extremely rare in the manufacture of final products, a prospective pirate

www.forbes.com/sites/techonomy/2011/10/10/mass-production-for-the-masses-shapeways-ceo-peter-weijmarshausen-on-the-rise-of-personal-manufacturing/.

[244] Joris Peels, *Shapeways Has 244,000 Euro in Revenue, Losses of 1.4 Million*, I.MATERAIALIZE (Nov. 18, 2010), http://i.materialise.com/blog/entry/shapeways-has-244000-euro-in-revenue-losses-of-1-4-million.

[245] Peter Weijmarshausen, *Shapeways Raises $5M and Opens HQ in New York*, SHAPEWAYS (Sept. 23, 2010, 10:51 AM), http://www.shapeways.com/blog/archives/595-Shapeways-raises-5M-and-opens-HQ-in-New-York.html. It has been noted that such a period of losses before profitability is common among startups, and sources within the company were contemporaneously claiming that the company's production facilities were running at maximum capacity. *Shapeways Finances Exposed*, FABALOO (Nov. 23, 2010), http://fabbaloo.com/blog/2010/11/23/shapeways-finances-exposed.html.

[246] *Building the Future of Stuff in NYC*, SHAPEWAYS (Nov. 17, 2011, 8:14 PM), http://www.shapeways.com/blog/archives/1097-Building-the-Future-of-Stuff-in-NYC.html#extended.

[247] Tiku, *supra* note 239.

[248] *See, e.g.*, I.MATERIALIZE, http://i.materialise.com/; PONOKO, http://www.ponoko.com/.

[249] Metro-Goldwyn-Mayer Studios Inc. v. Grokster, Ltd., 545 U.S. 913, 928–29 (2005).

would have to create a schematic himself through one of the methods discussed earlier with regard to reverse engineering and 3-D scanning, both of which remain difficult and problematic.[250] The task of producing a new object that incorporates a copyrighted design or character, like Darth Vader's head,[251] is simpler than making a faithful copy of an entire product, but it still requires a non-trivial amount of skill and effort; and the extent to which it is likely to harm the original rights-holder is far less clear. Furthermore, even if an ideal schematic could be obtained, procuring an instantiation of an infringing design through Shapeways is neither free nor anywhere near instant, unlike online file-sharing.

Shapeways cites periods from ten to twenty-one business days for delivery of orders, and the website makes it clear that these are rough and perhaps optimistic estimates, not hard and fast deadlines.[252] Leaving aside charges for shipping and handling, Shapeways charges based upon the volume of each material used, with rates ranging from $1.40 per cubic centimeter ("cc") for white plastic, to $8.00 per cc for stainless steel, up to $20.00 per cc for sterling silver.[253] Shapeways also makes it clear that it does not offer volume discounts for bulk purchases, as its marginal costs remain the same regardless of the number of copies produced.[254] Even on the high-end commercial level, 3-D printing's strengths lie in versatility and customization, not in speed and economies of scale. Although some have predicted that eventually high-end printers could economically supplant more traditional manufacturing models for small production runs of finished products,[255] the technology has not yet reached that point. Even if it does, time and cost are likely to remain significant barriers to large-scale infringement that will differentiate even 3-D printing services from the rapid and frictionless diffusion of files over peer-to-peer networks. The Shapeways model clearly does not involve the three elements that so alarmed the *Grokster* court.[256] Producing a schematic for a protected object remains a problematic and imprecise process; the prospect of copying physical objects with the fidelity possible with digital files is a remote one. Although using a 3-D printing service may be simpler than maintaining a home 3-D printer, the time and cost involved clearly distinguish Shapeways from the ease of copying digital content freely and nearly instantly via a file-sharing network.

---

250 *See supra* notes 168–185 and accompanying text.
251 *Darth Vader*, *supra* note 44.
252 *Shapeways FAQs*, SHAPEWAYS, http://www.shapeways.com/support/faq (last visited Sept. 3, 2012).
253 *See Materials Comparison Sheet*, *supra* note 235.
254 *Shapeways FAQs*, *supra* note 252.
255 *Factory on Your Desk*, *supra* note 3, at 28–29.
256 Metro-Goldwyn-Mayer Studios, Inc. v. Grokster, Ltd., 545 U.S. 913, 928–29 (2005).

While neither the *Grokster* nor *Sony* defendants had any significant ability to control or directly monitor the copying activity at issue—the former because of the decentralized nature of Grokster's peer-to-peer networks and the latter due to the fact that Sony had no contact with Betamax users beyond the point of sale[257]—3-D printing service providers such as Shapeways directly control their own manufacturing and distribution infrastructure. Although the designs they produce come from their users, the production process is centralized, a distinction that makes the services model fundamentally different from the cases and models already examined. In many ways, the Shapeways business model is actually dependent on intellectual property, as evidenced by the Penrose Triangle affair[258]: if Shapeways attains profitability, it will be because consumers are willing to pay for the designs of creators making their wares available on the site. It must be conceded that 3-D printing services may be used to produce infringing content, as suggested by the *Super 8* controversy[259] as well as the presence of other recreations of movie and game props among the sites most popular designs.[260] However, it seems unlikely that Shapeways or a similar company would become a major vector for infringement.

First and foremost, it seems relatively clear after *Grokster* that openly flouting intellectual property laws in order to attract lawsuits and press attention, the strategy articulated by one of the *Grokster* defendant's executives,[261] is not a viable way to build a company. This is significant, since providing 3-D printing services is far more capital-intensive than maintaining a file-sharing service. Shapeways itself has articulated a much more nuanced position on IP issues, acknowledging the importance of protecting the rights both of its own designer-customers and of third parties, while taking the position that disputes should be handled amicably and through community self-regulation when possible.[262] The company has, quite reasonably, expressed the fear that, if infringement were allowed to expand, the entire industry might be crippled by litigation and punitive regulation.[263] Although Shapeways is not the only company trying to build a business based

257 *See Grokster*, 545 U.S. at 918–23; Sony Corp. of Am. v. Universal City Studios, Inc., 464 U.S. 417, 438 (1984).

258 *See supra* notes 35–41 and accompanying text.

259 *See supra* notes 42–49 and accompanying text.

260 *See, e.g.*, *Shapeways Gallery*, SHAPEWAYS, http://www.shapeways.com/gallery?mg [page]=1#mg (last visited Feb. 5, 2012); *Inception*, SHAPEWAYS, http://www.shapeways.com/model/137798/inception.html?gid=mg (last visited Feb. 5, 2012); *Skyrim Pendant*, SHAPEWAYS, http://www.shapeways.com/model/419681/skyrim_pendant.html?gid=mg (last visited Feb. 5, 2012).

261 *Grokster*, 545 U.S. at 925.

262 *IP, 3D Printing, & DMCA*, *supra* note 41.

263 *Id.*

around 3-D printing services, it is unlikely that any enterprise willing to emulate Grokster's approach to intellectual property issues could raise enough capital to obtain the kind of commercial equipment required to produce quality printed products on the scale necessary to be commercially viable. It is suggestive that in Peter Hanna's survey of the intellectual property issues surrounding 3-D printing for Ars Technica, both of his examples of companies actively attempting to sell infringing material involved offerings of CAD/CAM files of copyrighted designs for home printing, with all its attendant problems,[264] rather than actual knockoffs of the products themselves; the parties behind the sites were apparently unwilling or unable to risk the capital required to produce the goods in-house.[265] Once again, the difference between the traffic in infringing digital material and that in physical goods is crucial. A file-sharing site requires only server space, can use peer-to-peer technologies to offload most of its storage and bandwidth requirements onto its users' equipment, and can relatively easily shift its operations across national borders.[266] The same cannot be said of any enterprise involved in commercial 3-D printing, which, for the foreseeable future, will necessarily require an expensive and immobile production and distribution network.

Another factor that distinguishes the services model is that, unlike Thingiverse or traditional file-sharing networks, the company, rather than the user, has direct responsibility for and control over the printing of every product. A number of commentators, especially during the Penrose Triangle affair, have questioned whether simply creating and distributing a CAD/CAM schematic based on an physical object protected by copyright constitutes infringement in and of itself[267]—an as yet unresolved issue.[268] However, since Shapeways' business model inherently involves producing physical reproductions of such schematics, such legal ambiguities are moot. The difference is even clearer in the area of patents. Patent infringement requires evidence that an infringing embodiment of the patent has actually been produced.[269] While this requirement would likely complicate legal action against sites like Thingiverse barring evidence of inducement, again the nature of Shapeways' business would make it far simpler to establish liability. Even in the absence of evidence of inducement or other grounds for

264 *See supra* Part III.A.

265 Hanna, *supra* note 36, at 3.

266 *See, e.g.*, *About*, PIRATE BAY, http://thepiratebay.se/about (last visited Sept. 3, 2012); *Legal Threats*, PIRATE BAY, http://thepiratebay.se/legal (last visited Sept. 3, 2012).

267 *See, e.g.*, Hanna, *supra* note 36, at 1; Doctorow, *supra* note 40; *IP, 3D Printing, & DMCA*, *supra* note 41; *Copyright Policy*, *supra* note 221.

268 *See* 17 U.S.C. § 101 (2012) ("'Copies' are material objects . . . in which a work is fixed . . . .").

269 Weinberg, *supra* note 2, at 12.

secondary liability, it is quite likely that a rights-holder could sue Shapeways for direct infringement,[270] since the DMCA safe harbor covers online hosting of copyrighted material, not the unauthorized manufacturing of infringing copies.[271]

However, since 3-D printing's strengths are primarily in production of unique or low-volume custom goods, suits based on direct infringement would likely be unfeasible in many cases. Although it has its problems, the DMCA's notice-and-takedown regime provides a faster and cheaper method for rights-holders to address copyright infringement; extending it to patents could provide a feasible method to ameliorate some of the problematic aspects of patent law highlighted by Public Knowledge.[272] Recent events, ranging from the virtual revolt against the Stop Online Piracy Act ("SOPA")[273] to the open criticisms of the patent system voiced by influential Judge Richard Posner,[274] suggest that more is needed to readjust the balance between IP and technology, but such larger issues lie outside the scope of this note.

As discussed, both physical and economic factors make it unlikely that 3-D services will be a major source of infringement, while fear of such sanctions could have a chilling effect on such enterprises, since they involve major capital investments and are unlikely to be able to vet every submitted design without drastically slowing order fulfillment and threatening their profitability. Such an outcome would seriously disrupt the balance between IP protection and innovation, and would likely cause more economic damage than it would prevent. In *Sony*, the Court observed that the plaintiffs' position would lead to the absurd result of giving them a stranglehold over the manufacture and sale of VTRs;[275] some of the proposals that have been backed by rights-holders, even if not directed specifically at 3-D printing, could lead to the analogous and equally absurd result of stifling the development of an entire new model of manufacturing. Such a use of the intellectual property system would

---

270 *See* 17 U.S.C. § 501 (2012); 35 U.S.C. § 271(a) (2012); Hanna, *supra* note 36, at 3.

271 *See* 17 U.S.C. § 512(c) (2012).

272 Weinberg, *supra* note 2, at 5–6.

273 Stop Online Piracy Act, H.R. 3261, 112th Cong. (2011), *available at* http://judiciary.house.gov/hearings/pdf/112%20HR%203261.pdf. *See, e.g.* Mark Lemley, David S. Levine & David G. Post, *Don't Break the Internet*, 64 STAN. L. REV. ONLINE 34 (Dec. 19, 2011), *available at* http://www.stanfordlawreview.org/sites/default/files/online/articles/64-SLRO-34_0.pdf; Timothy B. Lee, *SOPA Protest by the Numbers: 162M Pageviews, 7 Million Signatures*, ARS TECHNICA (Jan. 19, 2012, 1:45 PM), http://arstechnica.com/tech-policy/2012/01/sopa-protest-by-the-numbers-162m-pageviews-7-million-signatures/.

274 *See* Richard A. Posner, *Why There Are Too Many Patents in America*, THE ATLANTIC (July 12, 2012, 10:20 AM), http://www.theatlantic.com/business/archive/2012/07/why-there-are-too-many-patents-in-america/259725/. Judge Posner has served on the Seventh Circuit since 1981 and is a leading authority in the field of Law and Economics. *See Richard A. Posner*, UNIVERSITY OF CHICAGO LAW SCHOOL, http://www.law.uchicago.edu/faculty/posner-r (last visited Oct. 30, 2012).

275 Sony Corp. of Am. v. Universal City Studios, Inc., 464 U.S. 417, 441 n.21 (1984).

be contrary to the basic principles of advancing the public good that informed its establishment in the Constitution.[276]

CONCLUSION

Ultimately, it should be emphasized that, despite the common comparison of the present state of 3-D printing to that of the early computer industry,[277] its development is unlikely to be as rapid. The near-exponential advance in the power and complexity of solid-state circuits that drove the revolution in computing over the past several decades, commonly referred to as Moore's Law,[278] is unlikely to be applicable to a technology based upon moving parts and still often prone, in its consumer incarnations, to catastrophic failures and "printer jams" of molten plastic.[279] Some have argued that such trends arise out of the particular characteristics of technologies based on solid-state material science and nano-scale structures, pointing out that we don't see or expect comparable rates of progress in areas like automobiles or construction.[280] Mr. Moore himself is believed to share such skepticism. He is claimed to have joked that if Moore's Law applied to innovations in air travel, "a modern day commercial aircraft would cost $500, circle the earth in 20 minutes, and only use five gallons of fuel for the trip."[281] This witticism has appeared in so many forms that it is probably apocryphal, but its message remains a valid admonition to those making some of the wilder claims about the potential and peril of 3-D printing technology. There will be time, as the technology develops, for policymakers to judge how best to respond to its evolution, the direction of which it is impossible to predict beforehand. In his concurrence in *Grokster*, Justice Breyer observed that at the time of *Sony*, no one could have predicted the possible applications of the VTR, such as the video-rental industry.[282] His warning that the judiciary should tread lightly in imposing liability on new technologies

276 *See* U.S. CONST. art. I, § 8, cl. 8; *see also Sony*, 464 U.S. at 431–32.

277 *See, e.g.*, John Brandon, *What is 3D Printing? A Beginner's Guide to the Desktop Factory*, DIGITAL TRENDS (June 27, 2011), http://www.digitaltrends.com/computing/what-is-3d-printing-a-beginners-guide-to-the-desktop-factory/; Weinberg, *supra* note 2, at 1; Burns, *supra* note 11.

278 After Gordon Moore, a co-founder of Intel, who originally framed it in a 1965 prediction that the transistor density on integrated circuits would double every two years. *See Excerpts from a Conversation with Gordon Moore*, INTEL (2005), ftp://download.intel.com/museum/Moores_Law/Video-Transcripts/Excepts_A_Conversation_with_Gordon_Moore.pdf; Gordon E. Moore, *Cramming More Components onto Integrated Circuits*, ELECTRONICS MAG., Apr. 19, 1965, *available at* ftp://download.intel.com/museum/Moores_Law/Articles-Press_Releases/Gordon_Moore_1965_Article.pdf.

279 Wallich, *supra* note 156.

280 Kevin Kelly, *Was Moore's Law Inevitable?*, TECHNIUM (July 17, 2009), http://www.kk.org/thetechnium/archives/2009/07/was_moores_law.php.

281 *Id.*

282 Metro-Goldwyn-Mayer Studios Inc. v. Grokster, Ltd., 545 U.S. 913, 955 (2005) (Breyer, J., concurring).

should be well-heeded by legislators.[283]

Napster and its progeny sent shocks through the music industry because the combination of relatively inexpensive PCs, widespread broadband Internet, and peer-to-peer file sharing allowed the copying and distribution of the record labels' content at a cost far lower than the industry's traditional distribution channels could achieve and, crucially, in a manner far more convenient to the consumer. Even with such advantages and widespread adoption, the degree to which file-sharing actually caused economic damage to the record industry remains a hotly debated issue.[284] None of the models examined above, even that of 3-D printing services, is likely to rival the cost or convenience of traditional methods of production in the near future, due to the limitations of hobbyist-grade printers and the high prices of even the most basic commercial units. For example, a simple and reliable method of printing circuitry, necessary for making anything more than the simplest of products, is a process that even large enterprises are still struggling to commercialize, often using techniques that are likely to be difficult to replicate, at least in home printers.[285] In a widely quoted and misunderstood statement, David ten Have, CEO of Shapeways competitor Ponoko, suggested 3-D printed circuitry would be available by 2013, but then clarified that he was referring only to printing the basic wiring, but still requiring conventionally produced versions of more complex components, such as resistors, in post-production.[286] A printed iPod, or even a printed alarm clock, remain for now in the realm of fantasy.

Lastly, it should be emphasized that the fear, invoked by Public Knowledge, of entrenched interest groups using their influence with policymakers to hamstring disruptive technologies is not idle.[287] Although the safe harbor provided by the DMCA may be useful in the context of 3-D printing, Public Knowledge's white paper presents the Act as a whole as a key example of damaging regulation pushed by

---

283 *Id.* at 957–60.

284 *See, e.g.*, *id.* at 961–62; Felix Oberholzer-Gee & Koleman Strumpf, *The Effect of File Sharing on Record Sales: An Empirical Analysis*, 115 J. POL. ECON. 1 (2007); Alejandro Zentner, *Measuring the Effect of File Sharing on Music Purchases*, 49 J. L. & ECON. 63 (2006).

285 *See, e.g.*, *Successful Operation of Carbon Nanotube-Based Integrated Circuits Manufactured on Plastic Substrates*, SCI. DAILY (Feb. 9, 2011), http://www.sciencedaily.com/releases/2011/02/110208091557.htm; Adam C. Siegel et al., *Foldable Printed Circuit Boards on Paper Substrates*, 20 ADVANCED FUNCTIONAL MATERIALS 28 (2010); Aaron Saenz, *Is Xerox's Silver Ink Ready to Print Circuits?*, SINGULARITY HUB (Oct. 30, 2009, 10:56 AM), http://singularityhub.com/2009/10/30/is-xeroxs-silver-ink-ready-to-print-circuits/; Joris Peels, *3D Printed Circuit Board*, SHAPEWAYS BLOG (Mar. 10, 2009, 10:24 AM), http://www.shapeways.com/blog/archives/196-3D-printed-circuit-board.html.

286 Caleb Garling, *3-D Printers Will Build Circuit Boards 'In 2 Years'*, WIRED (Nov. 4, 2011, 8:23 PM), http://www.wired.com/wiredenterprise/2011/11/3d-printing-autodesk/.

287 Weinberg, *supra* note 2, at 1.

entrenched interests.[288] The DMCA's provisions regarding the notice-and-takedown process and anti-circumvention have been widely criticized as being widely abused by rights-holders and dampening innovation.[289] The reaction against SOPA was even stronger, drawing opposition from not only the tech industry but also such strange bedfellows as the Heritage Foundation, the Cato Institute, and the ACLU, attacking it as both economically misguided and a danger to freedom of speech.[290] Ultimately, both 3-D printing technology's presently limited potential to cause economic damage to rights-holders and the fact that neither policymakers nor judges can reasonably foresee its potential, suggest that it would be prudent to limit regulatory intrusions into the sector.

*Charles W. Finocchiaro**

[288] *Id.*

[289] *See* 17 U.S.C. §§ 512(c)(3), 1201–05 (2012). *See also* John Timmer, *A Decade of the DMCA: Keep the Safe Harbor, Ditch the Rest*, ARS TECHNICA (Oct. 28, 2008, 9:05 PM), http://arstechnica.com/tech-policy/news/2008/10/adecade-of-the-dmca-keep-the-safe-harbor-ditch-the-rest.ars; *Unintended Consequences*, ELECTRONIC FRONTIER FOUND. (Oct. 2008), http://www.eff.org/files/DMCAUnintended10.pdf; Fred von Lohmann & Wendy Seltzer, *Death by DMCA*, IEEE SPECTRUM (June 2006), http://spectrum.ieee.org/computing/software/death-by-dmca/0.

[290] *See, e.g.*, Michael Masnick, *Cato Institute Digs into MPAA's Own Research to Show That SOPA Wouldn't Save a Single Net Job,* TECHDIRT (Jan. 4, 2012, 11:04 AM), http://www.techdirt.com/articles/20120104/04545217274/cato-institute-digs-into-mpaas-own-research-to-show-that-sopa-wouldnt-save-single-net-job.shtml; Michael Masnick, *Surprise: Heritage Foundation, Who Almost Always Supports MPAA, Comes Out Against SOPA*, TECHDIRT (Dec. 23, 2011, 7:17 AM), http://www.techdirt.com/articles/20111222/04041517170/surprise-heritage-foundation-who-almost-always-supports-mpaa-comes-out-against-sopa.shtml; Michael Masnick, *Hackers, ACLU, Consumer Rights Groups, Human Rights Groups, Many More All Come Out Against SOPA*, TECHDIRT (Nov. 16, 2011, 4:36 AM), http://www.techdirt.com/articles/20111115/18152616785/hackers-aclu-consumer-rights-groups-human-rights-groups-many-more-all-come-out-against-sopa.shtml.

* Notes Editor, CARDOZO ARTS & ENT. L.J. Vol. 31, J.D. Candidate, Benjamin N. Cardozo School of Law (2013); B.A., Brown University. Many thanks to Jeremy Schachter and other members of the AELJ Editorial Board for their encouragement and feedback, to my wife, Laura Gendron, for her patience and understanding during the writing process, and to my family and friends, for the constant support and stream of articles that they sent my way. To Shawn Fanning and Lars Ulrich, for inadvertently sparking my interest in intellectual property many years ago.