

Intellectual Property Infringements & 3D Printing: Decentralized Piracy

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By drastically reducing the role of intermediaries in manufacturing, 3D printing is likely to set about the next wave of decentralized, non-commercial infringements of intellectual property rights. Drawing upon the lessons from the entertainment industry's litigation campaign against illegal file sharing, this paper describes some of the common characteristics of decentralized piracy. I show that, like copyright enforcement on file-sharing networks, intellectual property enforcement of 3D printing faces economic and social norm complications that make traditional, litigation based enforcement ineffective and possibly counterproductive.

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INTRODUCTION

If you learn from a loss you have not lost.

—AUSTIN O'MALLEY, KEYSTONES OF THOUGHT 191 (1914).

3D printing technologies promise to revolutionize manufacturing.¹ By uploading digital blueprints to computers, users of 3D printers can create seamless physical objects in an additive process.² As 3D technologies become more widespread, the general public will be able to use cheap, affordable home 3D printers to design and manufacture most products available on retail markets.³ A growing group of consumers are already putting 3D printers to use at home to manufacture household items, small sculptures, and spare parts.⁴

It is already clear that 3D printing will radically change the role of intermediaries in manufacturing.⁵ The declining costs of fabricating physical items will reduce the necessity for specialization in

1. See Deven R. Desai & Gerard N. Magliocca, *Patents, Meet Napster: 3D Printing and the Digitization of Things*, 102 GEO L.J. (forthcoming 2014) (manuscript at 10), available at <http://georgetownlawjournal.org/files/2013/10/Desai-and-Magliocca-3D-Printing-Draft.pdf> (“3D printing will unleash the power of digitized things on manufacturers.”).

2. See Anna Kaziunas France, *Skill Builder: 3D Scanning*, MAKE, Winter 2013, at 92; Sean Buckley, *MakerBot's Digitizer Will Go on Sale Next Week, Promises 3D Scanning to the Masses*, ENGADGET (Aug. 14, 2013, 8:05 PM), <http://www.engadget.com/2013/08/14/makerbots-digitizer-will-go-on-sale-next-week>.

3. CHRIS ANDERSON, MAKERS: THE NEW INDUSTRIAL REVOLUTION 90–92 (2012); Charles W. Finocchiaro, Note, *Personal Factory or Catalyst for Piracy? The Hype, Hysteria, and Hard Realities of Consumer 3-D Printing*, 31 CARDOZO ARTS & ENT. L.J. 473, 473 (2013); Daniel Harris Brean, *Asserting Patents to Combat Infringement via 3D Printing: It's No "Use"*, 23 FORDHAM INTELL. PROP. MEDIA & ENT. L.J. 771, 771 (2013).

4. Neil Gershenfeld, *How to Make Almost Anything: The Digital Fabrication Revolution*, 91 FOREIGN AFF. 43, 43–45 (2012).

5. See *3D Printing: The Printed World*, ECONOMIST, Feb. 12, 2011, at 77; *A Factory on Your Desk*, ECONOMIST, Sept. 5, 2009, at 26.

manufacturing and the attainment of economies of scale.⁶ As a result, manufacturing is no longer synonymous with assembly lines and processing plants. Consumers can copy, adapt,⁷ and design items on their computers and print them out at home, or email blueprint design files to companies that operate more advanced 3D printers.⁸

By reducing the costs of designing, manufacturing, and distributing goods, 3D printing is predicted to set about an “industrial counter-revolution.”⁹ Although personal 3D printers might not be well-suited for mass scale production, they promise to make households largely self-sufficient.¹⁰ As such, 3D printing shifts some core sectors of retailing away from traditional large manufacturers to the various intermediaries that facilitate 3D printing, including (but not limited to) individual designers of blueprints and industries that create and distribute 3D printing technologies and peripherals.

Revolutionary, disruptive technologies bring about novel legal challenges.¹¹ Likewise, 3D printing is likely to raise a host of legal issues.¹² Especially intellectual property (“IP”) holders are likely to be affected because 3D printing makes the infringement of IP rights cheaper and more attractive.¹³ While users of 3D printers may end up designing original products or acquiring licensed blueprints from designers, users

6. Simon Bradshaw et al., *The Intellectual Property Implications of Low-Cost 3D Printing*, 7 Scripted 5, 11 (2010).

7. On the customization possibilities of 3D printing, see NEIL GERSHENFELD, *FAB: THE COMING REVOLUTION ON YOUR DESKTOP—FROM PERSONAL COMPUTERS TO PERSONAL FABRICATION* LOC. 500 (Kindle Edition, 2005).

8. E.g., Steven Kurutz, *Bringing 3-D Power to the People*, N.Y. TIMES, Mar. 27, 2014, at D1.

9. See, e.g., *3D Printing: The Printed World*, supra note 5; Marshall Burns & James Howison, *Digital Manufacturing—Napster Fabbig: Internet Delivery of Physical Products*, 7 RAPID PROTOTYPING J. 194, 196 (2001).

10. See generally Aaron Council & Michael Petch, *3D Printing: Rise of the Third Industrial Revolution* Electronic Book, 2014).

11. On the impact of technological advances on the development of tort law, see, for example, James E. Krier & Clayton P. Gillette, *The Un-Easy Case for Technological Optimism*, 84 MICH. L. REV. 405, 417–26 (1985) (discussing political obstacles to the efficient regulation of new technologies); Richard A. Posner, *A Theory of Negligence*, 1 J. LEGAL STUD. 29, 52–57 (1972) (discussing railroad crossings); see also Mark F. Grady, *Why Are People Negligent? Technology, Nondurable Precautions, and the Medical Malpractice Explosion*, 82 N.W. U. L. REV. 293 (1988) (demonstrating the different effects of durable and non-durable prevention technologies on tortious accidents).

12. These issues include potential claims involving products liability and gun-regulation. 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) (describing how 3D printing renders current firearm regulations obsolete); Nora Freeman Engstrom, *3-D Printing and Product Liability: Identifying the Obstacles*, 162 U. PA. L. REV. ONLINE 35 (2013) (discussing challenges to product liability in 3D printing markets); Mark Gibbs, *The End of Gun Control?*, FORBES.COM (July 28, 2012, 4:24 PM), www.forbes.com/sites/markgibbs/2012/07/28/the-end-of-gun-control/; Chris Brandrick, *3D Printer Lets You Print Your Own Prescription*, PC WORLD (Apr. 19, 2012, 3:59 PM), http://www.techhive.com/article/254118/3d_printer_lets_you_print_your_own_prescription.html.

13. See Bradshaw et al., supra note 6, at 12.

are also likely to print items protected by IP rights without proper authorization. For example, users might download unauthorized blueprints online and print unauthorized reproductions of retail products that violate the exclusive rights of patent, trade dress, or copyright holders. Such IP infringement requires only the purchase of raw input print materials¹⁴ and the blueprints, which are often freely available online.¹⁵

Although manufacturing and retail industries have always faced commercial counterfeit markets, the digital revolution of 3D printing presents an unfamiliar challenge to these industries: highly decentralized piracy where consumers obtain counterfeit goods cheaply, without assistance from commercial counterfeiters. In this regard, 3D printing presents some of the same challenges as the digitization of music, books, and movies before it.

This shift from traditional commercial counterfeit markets to decentralized, non-commercial piracy sets the stage for a potential explosion of IP infringements. IP enforcement against decentralized infringements is an uphill battle, as the entertainment industry experienced in the wake of the widespread use of file-sharing technologies. Commentators already predict that IP enforcement on 3D printing is a lost cause based on the limited success of copyright enforcement against file sharing.¹⁶

What makes IP enforcement so difficult when infringement is decentralized? Is IP enforcement a lost cause in the context of 3D printing? This Article discusses common characteristics of decentralized infringement and the unique challenges they present for the enforcement of IP rights. I argue that decentralized piracy creates unique practical, as well as normative obstacles that render traditional means of IP enforcement troublesome. The social costs of enforcing IP rights in these settings are likely to be high, making alternative regulatory approaches more appealing.

Part I of this Article examines the IP rights affected by 3D printing. Part II considers the legal uncertainty involved with 3D printing. Part III describes common characteristics of decentralized piracy and discusses the main enforcement challenges. This Article concludes with a few reflections to address the challenges of 3D printing.

14. *Printing Material Suppliers*, REPRAP.ORG, http://reprap.org/wiki/Printing_Material_Suppliers (last visited Aug. 1, 2014).

15. Legitimate blueprint download sites might emerge as well. See GERSHENFELD, *SUPRA* note 7, at Loc. 590-92.

16. *Infra* Part III.

I. 3D PRINTING'S POTENTIAL FOR INTELLECTUAL PROPERTY INFRINGEMENTS

Producers and distributors of physical objects have generally been shielded from the problem of widespread, direct infringement online.¹⁷ As opposed to literature, music, film, and other types of copyrighted content, most physical objects cannot be rendered into a digital format without taking away their utilitarian features. For instance, the unauthorized pictorial rendition of a designer clock online presents potential copyright issues relating to copyright in the photo itself. Such copyright infringement, however, leaves unaffected (and may even promote) the demand for the actual clock as a useful and/or aesthetic physical object.

Enter 3D printing. A 3D scanner can create a computer-aided design (“CAD”) map of the clock.¹⁸ This CAD blueprint can be distributed on the Internet, and anyone with a 3D printer can print an exact replica of the clock.¹⁹ The creation and distribution of unauthorized reproductions of the clock by way of 3D technology potentially infringes on the exclusive rights of holders of utility patents, design patents, and trademarks.²⁰

First and foremost, 3D printing may involve the infringement of multiple patent rights. When a user of a 3D printer renders the physical object that is the subject of a patent, the CAD blueprint might infringe the applicable patent rights on that article. Using a 3D printer to then reproduce a patented product infringes on the patent right. Moreover, any use of the printed object may violate the rights on the patent.²¹

Second, trademark holders will also be affected by 3D printing. Any sale of a 3D printed object that includes a trademark might infringe on the rights of the trademark owner. In most instances, the user of the 3D printer can avoid trademark infringement by reproducing the product without the logo or trademark. But even on products that do not have a logo, trademark right violations might take place whenever a user seeks to print products that are protected by trade dress. Even if the 3D printer does not seek to include a trademark or the seller does not actively pass off the item as being manufactured by the owner of the right, it might be an infringement to sell any printed products in a shape that resembles

17. Of course, illegal markets for counterfeit goods became more accessible online. Yet, as opposed to digital goods, physical counterfeit goods are relatively expensive to produce and infringement is less anonymous and more risky, since such illicit markets require physical locations and addresses to ship from.

18. See France, *supra* note 2.

19. PETER SCHMITT, WORKS BY PETER SCHMITT 2000–2014 9 (2014), <http://web.media.mit.edu/~peter/about/Portfolio-Peter-Schmitt.pdf> (last visited Aug. 1, 2014).

20. For an overview, see Desai & Magliocca, *supra* note 1 (manuscript at 2).

21. *Id.*

established trade dress. Such unauthorized third-party uses of trademarks constitute an infringement, and sales of those products might run afoul of the post-sale confusion doctrine even if purchasers are not confused.²²

Finally, 3D printing technology also presents challenges to industries protected by copyright law. Whenever 3D printers are used to make counterfeit items, this might infringe the copyright on creative designs that appear on such items. That is, if the decorative features of a product can be separated, either physically or conceptually, from the useful aspects of the article,²³ then the holder of the copyright in the aesthetic design has a potential claim against any unauthorized reproduction.²⁴ Take the example of an individual who reproduces a coat hanger. The individual might have downloaded the blueprint of the particular coat hanger because it is the right size for her wall. If, however, the coat hanger has decorative elements (such as a colorful drawing, etched designs, etc.) that can be identified separately from the useful aspects of the coat hanger, the original manufacturer might be able to bring a claim for copyright infringement for the reproduction of the decorative design. In the context of 3D printing, a copyright claimant can pursue a claim of direct infringement against any individual who reproduced the creative design on a physical object (owners of 3D printers). Claimants may also pursue claims for indirect infringement on the basis of contributory or vicarious copyright liability against manufactures, writers of CAD designs, and other intermediaries that facilitated the infringing activity.

22. The trademark law post-sale confusion doctrine holds that infringing trade dress can infringe upon the rights of the owner of a mark even if purchasers of the infringing product are not confused. See Connie Davis Powell, *We All Know It's A Knock-Off! Re-Evaluating the Need for the Post-Sale Confusion Doctrine in Trademark Law*, 14 N.C. J.L. & TECH. 1, 35 (2012).

23. The 1976 Copyright Act defines pictorial, graphic, and sculptural works. 17 U.S.C. § 101 (2011) (“Pictorial, graphic, and sculptural works’ include two-dimensional and three-dimensional works of fine, graphic, and applied art, photographs, prints and art reproductions, maps, globes, charts, diagrams, models, and technical drawings, including architectural plans. Such works shall include works of artistic craftsmanship insofar as their form but not their mechanical or utilitarian aspects are concerned; the design of a useful article, as defined in this section, shall be considered a pictorial, graphic, or sculptural work only if, and only to the extent that, such design incorporates pictorial, graphic, or sculptural features that can be identified separately from, and are capable of existing independently of, the utilitarian aspects of the article.”). When a work’s useful and aesthetic features are so intertwined that they cannot be separated physically, courts must consider whether there is conceptual separability between the form and function of a work. *Carol Barnhart Inc. v. Economy Cover Corp.*, 773 F.2d 411 (2d Cir. 1985).

24. For a discussion of copyright issues involving 3D printing, see, for example, Brian Rideout, *Printing the Impossible Triangle: The Copyright Implications of Three-Dimensional Printing*, 5 J. BUS. ENTREPRENEURSHIP & L. 161, 163–64 (2012); Haritha Dasari, *Assessing Copyright Protection and Infringement Issues Involved With 3D Printing and Scanning*, 41 AIPLA Q.J. 279 (2013); Edward Lee, *Digital Originality*, 14 VAND. J. ENT. & TECH. L. 919 (2012).

3D printers also might be used to produce unauthorized derivate works. These secondary derivate work markets, such as t-shirts, toys, and game boards, are a means for copyright holders to recoup some of their initial investment in an underlying music album, movie, or TV show.²⁵ One might be tempted to suggest that derivate work markets can even explain some creative decisions.²⁶ 3D printers enable fans to scan, reproduce, and modify these derivate physical products without authorization. For instance, a fan of the HBO series *Game of Thrones*, one of the most illegally downloaded TV shows of all time,²⁷ independently developed and printed a *Game of Thrones* iPhone docking station.²⁸ Such unauthorized reproductions are appealing in the context of 3D printing because the technology enables fans to create or otherwise obtain customized, altered versions of derivate works. As Deven R. Desai and Gerard N. Magliocca illustrate:

Today, if you buy a doll, a Lego set, or a car, the ability to alter, tinker, or improve your purchase is low. 3D printing, however, opens the door to personal improvement. You still buy the doll or dollhouse; but once a child is bored, 3D printing allows you to design and create new heads, limbs, or furniture. Instead of relying on Lego to decide what a piece looks like or does, the consumer can make new ones.²⁹

In this process, 3D printing potentially disrupts the secondary markets that help sustain copyright holders in today's world of illegal music and movie file sharing, where illegal digital downloading has already eroded revenues from record and DVD sales.³⁰

II. 3D PRINTING AND INTELLECTUAL PROPERTY UNCERTAINTY

Innovation is often rapid and unpredictable. Legal systems take time to adapt to new technological advancements. Lawmaking is a complex process that involves planning, procedures, and the

25. Take the example of *Game of Thrones*. Reporting on a recent infringement issue, HBO Vice President of Corporate Affairs Jeff Cusson commented that “with a show like *Game of Thrones*, the amount of product licensed around . . . is exorbitant.” Nathan Hurst, *HBO Blocks 3-D Printed Game of Thrones iPhone Dock*, WIRE (Feb. 13, 2013, 1:57 PM), <http://www.wired.com/design/2013/02/got-hbo-cease-and-desist>.

26. For example, a new generation of toy buyers could help explain the *Star Wars* and *Lego* movies, etc.

27. Ernesto, ‘*Game of Thrones*’ Most Pirated TV-Show of 2013, TORRENTFREAK (Dec. 25, 2013), <http://torrentfreak.com/game-of-thrones-most-pirated-tv-show-of-2013-131225> (“*Game of Thrones* has the honor of becoming the most downloaded TV-show for the second year in a row.”); Kory Grow, ‘*Game of Thrones*,’ ‘*Breaking Bad*’ Among the Most Pirated Shows of 2013, ROLLING STONE (Dec. 26, 2013, 2:50 PM), <http://www.rollingstone.com/movies/news/game-of-thrones-breaking-bad-among-the-most-pirated-shows-of-2013-20131226>.

28. See Hurst, *supra* note 25.

29. See Desai & Magliocca, *supra* note 1 (manuscript at 12).

30. See, e.g., Stan J. Liebowitz, *Testing File-Sharing's Impact by Examining Record Sales in Cities*, 54 MGMT. SCI., 852 (2008) (presenting empirical evidence that file sharing is responsible for historical decline in record sales).

participation of various stakeholders. The dynamic and unpredictable nature of technological innovation makes it difficult for lawmakers to predict or anticipate forthcoming inventions. As a result, courts and legislators have a difficult time responding proactively to avoid delays between the time people begin to use a technology and its legal classification (including the allocation of liability). Additionally, many areas of law apply open-ended standards. While standards reduce the cost of errors and enable copyright decisionmakers to be more flexible, these open-ended standards increase the number of difficult questions that courts must confront.³¹

The initial ambiguity as to the potential social and economic implications of a novel technology also contributes to the gap between the use of a technology and its legal classification by courts and legislators. It must first become apparent that the use of novel technology entails substantial opportunity costs to producers—that is, that there are “gains to be internalized.”³² Not until the opportunity costs of unregulated use of 3D printers become fully clear will manufacturers push to obtain protection through litigation and legislation. Until then, manufactures and users of 3D printers will continue to operate in a vacuum of considerable legal uncertainty.³³ Consider, for example, the difficulty of perfectly predicting *ex ante* how courts will apply the law to new circumstances *ex post*.³⁴

31. On the distinction between rules and standards, see, for example, Hans-Bernd Schäfer, *Rules Versus Standards in Rich and Poor Countries: Precise Legal Norms as Substitutes for Human Capital in Low-Income Countries*, 14 SUP. CT. ECON. REV. 113, 113 (2006) (“Legal norms can be precise rules, which are blueprints for action and allow for mechanical decisions by judges and civil servants. Alternatively, they can be vague, mission-oriented standards, which delegate decisions from the maker of the law to the judiciary and the administration. Rules economize on the costs of adjudication and administration. Standards economize on the costs of norm specification.”); Louis Kaplow, *Rules Versus Standards: An Economic Analysis*, 42 DUKE L.J. 557 (1992); Pierre Schlag, *Rules and Standards*, 33 UCLA L. REV. 379 (1985).

32. On the evolution of IP rights, see Ben Depoorter, *The Several Lives of Mickey Mouse: The Expanding Boundaries of Intellectual Property Law*, 9 VA. J.L. & TECH. 1, 34–41 (2004) [hereinafter, Depoorter, *Several Lives*]; Ben Depoorter, *Technology and Uncertainty: The Shaping Effect on Copyright Law*, 157 U. PA. L. REV. 1830, 1841–42 (2009) [hereinafter, Depoorter, *Technology and Uncertainty*] (“The initial ambiguity of the socioeconomic implications of a new technology can be illustrated, for example, by peer-to-peer music exchanges. The music industry discovered that huge profits could be made by delivering music in a compressed format (MP3) only after such exchanges were already relatively common.”). See Peter S. Menell, *Envisioning Copyright Law’s Digital Future*, 46 N.Y.L. SCH. L. REV. 63, 99 (2002) (“Even with the introduction and rapid popularity of digitally-encoded compact disks (CDs) and the proliferation of microcomputers beginning in the early 1980s, the record industry did not appreciate the dramatic changes that would be brought about by the emerging digital technologies.”).

33. One current definition of legal uncertainty is that it describes a situation where an act is “said by informed attorneys to have an expected official outcome at or near the 0.5 level of predictability.” Anthony D’Amato, *Legal Uncertainty*, 71 CALIF. L. REV. 1, 2 (1983).

34. Note that there is a distinction between risk and uncertainty. Individuals are subject to risk if (1) an event may or may not happen in the future, and (2) the chance that the event will happen is

Although uncertainty pervades all areas of the law,³⁵ technological breakthroughs, by their nature, make it more difficult to apply judicial precedent by analogy.³⁶ This is certainly the case for 3D printing. As commentators have noted, 3D printers, like file sharing before them, present a series of novel legal questions that require courts to stretch existing doctrines to a radically new technology. IP rights holders will face hurdles in cabining new uses of 3D printers into existing IP doctrines.³⁷ For patent right holders, 3D printing presents novel legal issues pertaining to infringement. When pursuing claims against individual users of 3D printers, a patent right holder will need to make the case that the creation and distribution of CAD files is the legal equivalent of a use or sale of the underlying patented invention.³⁸ When suing manufacturers of the printers or providers of the CAD/Computer Aided Manufacturing (“CAM”) files based on of patent law’s indirect infringement doctrine, patent holders will need to meet the difficult burden of proving that the alleged infringer possessed actual knowledge of a specific, infringed patent.³⁹ As a result, although “consumer use of 3D printers may create multiple instances of patent infringement, policing and protecting patent rights in inventions copied on 3D printers may present significant challenges for patent holders.”⁴⁰

Similarly, trademark owners face a number of obstacles that hinder effective enforcement of their rights. First, trademark owners will find it difficult to enforce their rights as against 3D printouts of trademarked goods when the actual logo or trademark is removed from the printed product, while owners of product configurations will always need to

known. By contrast, an event is uncertain if (1) it may or may not happen in the future, and (2) we do not know the chances that it will happen. See generally FRANK H. KNIGHT, *RISK, UNCERTAINTY AND PROFIT* (Harper & Row 1965) (1921).

35. On legal uncertainty generally, see D’Amato, *supra* note 33 (describing a trend toward greater uncertainty); Isaac Ehrlich & Richard A. Posner, *An Economic Analysis of Legal Rulemaking*, 3 J. LEGAL STUD. 257 (1974) (examining the optimal level of precision for rules and standards); Werner Z. Hirsch, *Reducing Law’s Uncertainty and Complexity*, 21 UCLA L. REV. 1233 (1974) (discussing considerations involved in, and obstacles to, reducing uncertainty); Jason Scott Johnston, *Uncertainty, Chaos, and the Torts Process: An Economic Analysis of Legal Form*, 76 CORNELL L. REV. 341 (1991) (examining how rules and balancing approaches evolve out of litigation).

36. Even what looks straightforward now in hindsight is often anything but obvious at the time a new technology emerges. File sharing, for instance, challenged our understanding of piracy: many direct infringements lack a commercial purpose, and there are no conventional intermediaries.

37. *Infra* Part III.

38. For an in-depth discussion of the doctrinal issues involving 3D printing, see Brean, *supra* note 3.

39. See Finocchiaro, *supra* note 3 (noting that the substantial non-infringing uses of 3D printing bring the technology closer to the *Sony* precedent than *Grokster*).

40. Bryan J. Vogel, *IP: 3D Printing and Potential Patent Infringement*, INSIDE COUNSEL (Oct. 29, 2013), <http://www.insidecounsel.com/2013/10/29/ip-3d-printing-and-potential-patent-infringement.html>.

demonstrate that their trade dress has acquired secondary meaning.⁴¹ Moreover, trademark plaintiffs will need to demonstrate that the alleged infringer has “used the mark in commerce,” as opposed to having engaged in a merely personal use.⁴² On the copyright front, most instances of copyright infringement involving 3D printing will force courts to concentrate on an area of law that is mired in doctrinal confusion and uncertainty: the conceptual separation of useful and creative aspects of a product.⁴³ In order to determine whether separate copyrightable features are present, courts apply opposing artistic theories of interpretation, often mixing various incompatible theories together within one decision.⁴⁴

It is difficult to predict *ex ante* how courts or legislators will categorize some of the potential uses of 3D printers. The resulting ambiguity provides ample opportunity for owners of 3D printers to engage in self-serving interpretations and to convince themselves that no infringement has been committed.⁴⁵ As research in the field of cognitive psychology demonstrates, individuals are inclined to construct facts in ways that align with their own preconceived beliefs.⁴⁶ Just as was the case

41. While simple trade dress can be “inherently” distinctive, valid product-design trade dress must acquire a distinct association with a specific manufacturer in the public’s mind. *Wal-Mart Stores, Inc. v. Samara Bros.*, 529 U.S. 205, 215 (2000).

42. 15 U.S.C. § 114 (2011). For a discussion of trademark issues relating to 3D printing, see MICHAEL WEINBERG, PUBLIC KNOWLEDGE, IT WILL BE AWESOME IF THEY DON’T SCREW IT UP: 3D PRINTING, INTELLECTUAL PROPERTY, AND THE FIGHT OVER THE NEXT GREAT DISRUPTIVE TECHNOLOGY 1, 3 (2010); Desai & Magliocca, *supra* note 1 (manuscript at 34).

43. For a discussion of the doctrinal confusion among courts, see, for example, Ben Depoorter & Robert Kirk Walker, *The Dangerous Undertaking: How Courts Should Approach Aesthetic Judgments in Copyright Law*, 108 NW. U. L. REV. (forthcoming 2014) [hereinafter Depoorter & Walker, *Dangerous Undertaking*]; Alfred C. Yen, *Copyright Opinions and Aesthetic Theory*, 71 S. CAL. L. REV. 247 (1998); Christine Haight Farley, *Judging Art*, 79 TUL. L. REV. 805 (2005).

44. For instance, the Second Circuit held that the useful aspects of decorative belt buckles could be sufficiently separated from their ornamental, aesthetic aspects; the Second Circuit applied all three major, but internally incompatible, theories of artistic interpretation. See Depoorter & Walker, *Dangerous Undertaking*, *supra* note 43 (“In finding that the buckles in question ‘rise to the level of creative art,’ the court referred to the intention of the author, but also noted that the buckles were well received in art and fashion circles. Institutional interpretations surfaced as well when the court rejected the notion that the utilitarian nature of fashion items excludes such articles from copyright protection: ‘body ornamentation has been an art form since the earliest days, as anyone who has seen the Tutankhamen or Scythian gold exhibits at the Metropolitan Museum will readily attest.’” (quoting *Kieselstein-Cord v. Accessories by Pearl, Inc.*, 632 F.2d 989, 990 (2d Cir. 1980)).

45. See generally Depoorter, *Technology and Uncertainty*, *supra* note 32 (exploring the enabling effect of legal uncertainty and delay on norm formation processes generally and in the context of peer-to-peer file sharing).

46. See Linda Babcock & George Loewenstein, *Explaining Bargaining Impasse: The Role of Self-Serving Biases*, 11 J. OF ECON. PERSPECTIVES 109, 113 (1997) (authors assigned participants in a study to either the plaintiff or defendant in a hypothetical automotive accident tort case with a maximum potential damages payment of \$100,000. The plaintiff’s prediction of the likely judicial award was on average \$14,527 higher than the defendant’s. The plaintiff’s average nomination of a “fair” figure was \$17,709 higher than the defendant’s). See generally Donald Braman and Dan M.

with file sharing,⁴⁷ by the time that courts and legislators have ruled on the legal effects of many uses of 3D printers, many users will no longer be neutral bystanders. Users of 3D printers will likely form beliefs and attitudes that support liberal uses of 3D printers and will reject legal reform to the contrary.⁴⁸ Users of 3D printers might experience loss aversion when what they consider to be legitimate is suddenly found to be illegal. In this process, the perception of having something “taken away” might add to the resistance we can expect when IP rights will be enforced on products of 3D printing.⁴⁹

In the meantime, while courts begin to examine a fit between existing IP laws and 3D printing, the legal ambiguities will foster 3D printing activities without much consideration for IP laws. Moreover, the decentralized nature of infringement in a 3D setting adds another complication to the enforcement of IP rights.

III. DECENTRALIZED PIRACY AND ENFORCEMENT

Broadband networks, digital music files, and peer-to-peer file-sharing applications widely expanded access to unlicensed copies of copyrighted material. Organizations such as the Recording Industry Association of America (“RIAA”), the Motion Picture Association of America (“MPAA”), and the Entertainment Software Association (“ESA”) argue that file sharing is responsible for significant declines in the sale of music, DVDs, and videogames.⁵⁰ Over the past decade the entertainment industry worked hard to combat online infringement of

Kahan, *More Statistics, Less Persuasion: A Cultural Theory of Gun-Risk Perceptions*, 151 U. PA. L. REV. 1291 (2003) (describing culturally biased interpretations of data).

47. See Depoorter, *Several Lives*, *supra* note 32 (describing cyclical process of technology, norm adaptation and judicial determination).

48. On the internalization of social norms, see Robert Cooter, *Three Effects of Social Norms on Law: Expression, Deterrence, and Internalization*, 79 OR. L. REV. 1 (2000); Robert Cooter, *Do Good Laws Make Good Citizens? An Economic Analysis of Internalized Norms*, 86 VA. L. REV. 1577 (2000).

49. Experimental research demonstrates that individuals value certain resources or legal entitlements that they possess more than they would value the exact same thing had they never possessed it at all. See, e.g., Daniel Kahneman, et al., *Experimental Tests of the Endowment Effect and the Coase Theorem*, 98 J. OF POL. ECON. 1325 (1990); George Lowenstein & Samuel Issacharoff, *Source Dependence in the Valuation of Objects*, 7 J. OF BEHAV. DECISION MAKING 157 (1994).

50. For empirical evidence, see, for example, Stan J. Liebowitz, *File Sharing: Creative Destruction or Just Plain Destruction?*, 49 J.L. & ECON. 1, 14–17 (2006) (presenting evidence that file sharing reduced recording industry revenues); Rafael Rob & Joel Waldfogel, *Piracy on the High C's: Music Downloading, Sales Displacement, and Social Welfare in a Sample of College Students*, 49 J.L. & ECON. 29, 30 (2006) (downloading reduced purchases by individuals in their sample by about ten percent during 2003). For an overview, see Stan J. Liebowitz, *Economists Examine File Sharing and Music Sales*, in *INDUSTRIAL ORGANIZATION AND THE DIGITAL ECONOMY* 145 (Gerhard Illing & Martin Peitz eds., 2006). *But see* Felix Oberholzer-Gee & Koleman Strumpf, *The Effect of File Sharing on Record Sales: An Empirical Analysis*, 115 J. POL. ECON. 1, 3 (2007) (finding no negative impact of file sharing on CD sales). On video game piracy, see Ben Depoorter, *What Happened to Video Game Piracy?*, COMM. OF THE ACM (Ass'n for Computing Mach., New York, N.Y.), May 2014, at 33.

copyrighted content on file-sharing networks and BitTorrent sites. The music industry has waged a litigation campaign on various fronts, targeting individual end users of file-sharing technologies,⁵¹ as well as software developers and various other intermediaries, such as Internet service providers and website hosts.⁵² These enforcement efforts have failed to create a satisfactory reduction in file sharing for the industry. By most accounts, file sharing and massive online copyright infringement continue unabated.⁵³ In 2012, the industry decided to abandon deterrence strategies in favor of more cooperative models,⁵⁴ while continuing to pursue favorable legislation.⁵⁵

As a practical matter, 3D printing technologies enable decentralized, mainstream piracy. 3D printing fundamentally alters the production function of piracy because it enables consumers to obtain counterfeit goods cheaply, without assistance from commercial

51. For a discussion of the RIAA litigation campaign against individual file sharers, see Ben Depoorter et al., *Copyright Backlash*, 84 S. CAL. L. REV. 1251 (2011) [hereinafter Depoorter et al., *Copyright Backlash*]. For an overview of RIAA litigation actions, see, for example, *Recording Industry Association of America Case Activity from Lexis/Nexis Courtlink*, LEXIS NEXIS, <http://www.lexisnexis.com/trial/nalm100181clinkriaa.asp> (last visited Aug. 1, 2014); *infra* note 60.

52. See, e.g., *In re Aimster Copyright Litig.*, 334 F.3d 643, 646 (7th Cir. 2003); *A&M Records, Inc. v. Napster, Inc.*, 239 F.3d 1004, 1013 (9th Cir. 2001) (“Plaintiffs claim Napster users are engaged in the wholesale reproduction and distribution of copyrighted works, all constituting direct infringement.”); *Metro-Goldwyn-Mayer Studios, Inc. v. Grokster, Ltd.*, 259 F. Supp. 2d 1029 (C.D. Cal. 2003) (plaintiff claiming contributory and vicarious copyright infringement on behalf of producers of file-sharing application), *aff’d*, 380 F.3d 1154 (9th Cir. 2004), *vacated*, 545 U.S. 913 (2005). For Internet service providers, see, for example, *In re Verizon Internet Servs., Inc.* 240 F. Supp. 2d 24, 26 (D.D.C. 2003) (copyright holders seeking enforcement of subpoenas demanding the identities of copyright infringers), *rev’d*, 351 F.3d 1229 (D.C. Cir. 2003).

53. *Press Release: BitTorrent and µTorrent Software Surpass 150 Million User Milestone: Announce New Consumer Electronics Partnerships*, BITTORRENT (Jan. 9, 2012), http://www.bittorrent.com/intl/es/company/about/ces_2012_150m_users (“BitTorrent Mainline and µTorrent software clients have grown to over 150 million monthly active users worldwide.”); Ernesto, *BitTorrent Accounts for 35% of All Upload Traffic, VPNs are Booming*, TORRENTFREAK (May 18, 2013), <http://torrentfreak.com/bittorrent-accounts-for-35-of-all-upload-traffic-vpns-are-booming-130518> (“New data published by the Canadian broadband management company Sandvine reveals that BitTorrent can be credited for one third of all North American upload traffic during peak hours. BitTorrent usage also remains strong in Europe, Latin America and Asia Pacific. The report further confirms that SSL traffic has more than doubled in a year, partly due to an increase in VPN use.”).

54. On the U.S. Copyright Alert system, see, for example, Abigail Phillips, *The Content Industry and ISPs Announce a “Common Framework for Copyright Alerts”: What Does it Mean for Users?*, ELECTRONIC FRONTIER FOUND. (July 7, 2011), <https://www.eff.org/deeplinks/2011/07/content-industry-and-isps-announce-common>; Chris Morran, *COMCASTIC 3 Report: Comcast Sends Out Around 1,800 Copyright Alert Notices Each Day*, CONSUMERIST (Mar. 6, 2014), <http://consumerist.com/2014/02/07/report-comcast-sends-out-around-1800-copyright-alert-notices-each-day>.

55. Past attempts include, for example, the Piracy Deterrence and Education Act of 2004, H.R. 4077, 108th Cong. (2004) (bolstering copyright enforcement on the Internet); Author, Consumer, and Computer Owner Protection and Security Act of 2003, H.R. 2752, 108th Cong. (2003) (expanding domestic and international copyright enforcement); Piracy Deterrence and Education Act of 2003, H.R. 2517, 108th Cong. (2003) (expanding the authority of the government to seize pirated works).

counterfeiters. In this regard, 3D printing shares common ground with the digitization of music, books, and movies before it. The technology facilitates massive direct, non-commercial infringement of IP rights by individual consumers. In other words, 3D printing brings the “Napster” revolution of decentralized infringement to the doorstep of manufacturers and retailers of physical articles.⁵⁶ As a result, commentators predict that 3D printing infringement will devalue IP rights and that “even the best efforts to stop this surge in infringement will fall short.”⁵⁷ The assumption is that 3D printing creates similar infringement dynamics that have made the enforcement of copyright law for file sharing so difficult. The next Subpart of this Article examines this assumption and analyzes the common characteristics of decentralized piracy. Drawing upon the lessons from the entertainment industry’s litigation campaign against file sharing, it is clear that IP litigation is not likely to provide an effective countermeasure to 3D printing copyright infringement.

A. THE ECONOMICS OF ENFORCING DECENTRALIZED INFRINGEMENT

3D printing drastically reduces the role of intermediaries in manufacturing. At the same time, it also reduces the potential role of intermediaries in the production of counterfeit goods and other piracy related activities. Individuals that possess personal 3D printers can print infringing materials inside their home with hardly any outside assistance. Whoever owns a 3D printer and a 3D scanner can simply scan and copy any existing product in their possession. Worse, 3D printer users can download blueprint CAD files of existing products online and print physical copies at home. Although printing larger items may require the involvement of intermediaries operating commercial 3D printers, consumers can manufacture regular-size counterfeit items. As with peer-to-peer file sharing and music copyright before it, counterfeit piracy becomes a mainstream, non-commercial activity in a world of 3D printing.

The novel, decentralized nature of 3D piracy has a profound effect on the enforcement of IP rights as they relate to 3D printing. To the extent that third parties, such as designers of blueprints or distributors of CAD files, are involved with facilitating 3D printing IP infringements, these third parties may not be held liable. As was clarified in the context

56. See Davis Doherty, *Downloading Infringement: Patent Law as a Roadblock to the 3D Printing Revolution*, 26 HARV. J.L. & TECH. 353, 355 (2012) (“3D printing also enables widespread patent infringement in the form of digital downloads in much the same manner that the advent of digital music enabled widespread copyright infringement.”); Brean, *supra* note 3.

57. Desai & Magliocca, *supra* note 1 (manuscript at 4). *But see* Finocchiaro, *supra* note 3 (arguing that physical and technological limitations make 3D printing less likely to threaten IP rights than peer-to-peer and file-sharing technologies before it).

of decentralized file-sharing technologies, contributory or vicarious liability requires a certain level of control or involvement in enabling infringing uses of the technology that might not be present in this context.⁵⁸ Moreover, even if creators and distributors of blueprint designs can be held liable, enforcement will be difficult as a practical matter. The creation and distribution of blueprint designs do not necessitate substantial investments. Rather, these activities may be driven by intrinsic and social motivations, reputation, and informal relationships. In such online, user-driven, and peer-production environments, the absence of a central, hierarchical residual claimant complicates case enforcement because it is more difficult to target offenders whose sole presence is online and whose purpose is not commercial.

The reduced involvement of intermediaries drastically increases the economic costs of enforcement overall. If no intermediary can be held liable, monitoring and enforcement cannot be delegated onto these third-party intermediaries. As a result, instead of pursuing claims against a few intermediaries, rights holders must file claims against individual infringers.⁵⁹

When facing decentralized enforcement, IP rights holders thus face a daunting challenge. First, since most infringement occurs inside private homes, there is a greater perception of safety and anonymity with unauthorized 3D printing than when purchasing illegal goods in markets or online using a credit card. Like music and movie downloading on peer-to-peer networks, most infringement will be difficult to detect.

Second, since infringement is easy and relatively cheap, affordable 3D printers are likely to generate a great number of infringements. Most users of 3D printers will realize that the probability of being caught is remote, given the vast amount of infringing uses that occur at any given moment.

58. For instance, in the context of indirect liability of providers, courts rejected the application of *Napster* to decentralized file-sharing services because liability for contributory infringement implies “actual knowledge of infringement at a time when [file-sharing services] can use that knowledge to stop the particular infringement.” *Metro-Goldwyn-Mayer Studios, Inc. v. Grokster, Ltd.*, 259 F. Supp. 2d 1029, 1037 (C.D. Cal. 2003), *aff’d*, *Metro-Goldwyn-Mayer Studios, Inc. v. Grokster, Ltd.*, 380 F.3d 1154 (9th Cir. 2004). Additionally, 3D print technologies are capable of substantial non-infringing uses. See *Sony Corp. of America v. Universal City Studios, Inc.*, 464 U.S. 417 (1984) (protecting time shifting of television recordings as substantially non-infringing use).

59. On the economics of gate-keeper liability in the context of copyright infringement, see Douglas Lichtman & William Landes, *Indirect Liability for Copyright Infringement: An Economic Perspective*, 16 HARV. J.L. & TECH. 395, 396 (2003) (“The argument in favor of [indirect] liability is that third parties are often in a good position to discourage copyright infringement either by monitoring direct infringers or by redesigning their technologies to make infringement more difficult.”); William Landes & Douglas Lichtman, *Indirect Liability for Copyright Infringement: Napster and Beyond*, 17 J. ECON. PERSP. 113 (2003). See generally Reinier Kraakman, *Third-Party Liability*, in PALGRAVE DICTIONARY OF ECONOMICS AND THE LAW 583 (Peter Newman ed., 1998).

Third, as the amount of infringement increases, the probability of getting caught reduces further for every potential infringer. Because the rights holders' resources to pursue IP violations are limited, as the number of infringers increases, each individual infringer's chance of being caught decreases. This, in turn, will likely lower inhibitions against producing counterfeit items on 3D printers even further.

Unless IP rights holders can easily obtain the identities of infringers and file class-action lawsuits, something that has so far eluded copyright owners in the context of file sharing,⁶⁰ IP rights holders will not have the resources to pursue most infringement. Efforts by rights holders to reduce the costs of enforcement will likely create new legal questions involving a wide array of issues relating to privacy, procedural issues such as class certifications, subpoena requests, and the involvement of Internet service providers.⁶¹ It will take time for these questions to work their way through the courts or Congress, as was the case with peer-to-peer litigation concerning many other revolutionary technologies. Meanwhile, the legal uncertainty and delay sets up an environment conducive to infringing behavior.

In order to have a deterrent effect and create a perception of effective enforcement, IP rights holders might resort to aggressive tactics: strike hard and set salient examples that highlight the dangers of infringing patent, trademark, or copyrights by way of unauthorized 3D printing. In doing so, however, overly aggressive enforcement might undermine public support for IP rights.⁶²

B. DECENTRALIZED ENFORCEMENT AND SOCIAL NORM COMPLICATIONS

By resorting to aggressive tactics, IP rights holders face the risk of undermining public support for the very rights that they are seeking to protect. The punitive litigation campaign of the RIAA, which included mass settlement demand letters and large statutory damage awards, illustrates the public relations downside to heavy-handed enforcement in a decentralized infringement environment. First, due to the large number of infringers, any instance of individual enforcement appears random. Targeting a limited number of infringers in an effort to set an example risks creating the perception that a few individuals are arbitrarily being singled out in a negative litigation lottery. This is one of the lessons from the peer-to-peer litigation campaign. When the music industry attempted

60. On the different stages of the copyright enforcement campaign and the various setbacks, see *RIAA v. The People: Five Years Later*, ELECTRONIC FRONTIER FOUND. (Sept. 30, 2008), <https://www.eff.org/wp/riaa-v-people-five-years-later>.

61. *Id.*

62. *Infra* Part III-B.

to set examples,⁶³ the resulting statutory damage awards were widely condemned as arbitrary and excessive, setting in motion proposals to reform copyright law.⁶⁴

Alternatively, IP holders might ramp up the scale of enforcement. For instance, like copyright holders today, rights holders might try to stem the distribution of CAD files, and target distributors by way of “algorithmic enforcement,” where computer programs (“bots”) scour the Internet looking for content that bears the markings of an infringement.⁶⁵ By using bots rather than human spotters, a broader range of infringing activities can be detected at far less cost than is required for manual enforcement. But economizing enforcement efforts has drawbacks. Invariably, such automated enforcement efforts are more prone to errors⁶⁶ and inadvertent public relation mistakes.⁶⁷ Moreover, mechanical enforcement operations (like the RIAA’s mass settlement campaign) are more likely to be perceived negatively, as is the case with formal litigation business models associated with trolling.⁶⁸

Overall, as rights holders ramp up enforcement, the negative perception is likely to increase, which could be detrimental to the interests of IP rights holders. If the public perceives enforcement to be

63. Following 17 U.S.C. § 504 (2006), a prevailing plaintiff may recover statutory damages between \$750 and \$30,000 per copyrighted work. In the case of willful infringement by the defendant, damages of up to \$150,000 per work may be recovered. Statutory damages were awarded in two peer-to-peer cases. *Capitol Records, Inc. v. Thomas-Rasset*, 692 F.3d 899, 902 (8th Cir. 2012) (upholding damages of \$222,000 for the infringement of twenty-four songs by a single mother); *Sony BMG Music Entm’t v. Tenenbaum*, 721 F. Supp. 2d 85, 116–17 (D. Mass. 2010), *aff’d in part, rev’d in part*, 660 F.3d 487, 515 (1st Cir. 2011) (upholding the constitutionality of statutory damages for copyright violations and remanding for reconsideration of the remittitur motion), *on remand*, 103 U.S.P.Q.2d 1902 (D. Mass. 2012) (reinstating initial jury award of statutory damages, imposing \$22,500 per song shared by Boston University graduate student on peer-to-peer network).

64. See generally Pamela Samuelson & Tara Wheatland, *Statutory Damages in Copyright Law: A Remedy in Need of Reform*, 51 WM. & MARY L. REV. 439 (2009) (discussing copyright damages reform).

65. See Geeta Dayal, *The Algorithmic Copyright Cops: Streaming Videos Robotic Overlords*, WIRED (Sept. 6, 2012, 6:00 AM), <http://www.wired.com/threatlevel/2012/09/streaming-videos-robotic-overlords-algorithmic-copyright-cops/all> (describing automated copyright systems that search for copyrighted material in real time).

66. See generally Ben Depoorter & Robert Kirk Walker, *Copyright False Positives*, 89 NOTRE DAME L. REV. 319 (2013) (describing sources and consequences of copyright enforcement mistakes).

67. For instance, media outlets reported that the RIAA filed a claim against a twelve-year-old New York girl whose mother lived in a low-income area of New York City, and had accused an eighty-three-year-old woman who had died over a month earlier. See John Borland, *RIAA Settles with 12-Year-Old Girl*, CNET NEWS (Sept. 9, 2003, 4:05 PM), <http://news.cnet.com/2100-1027-5073717.html>; Andrew Orłowski, *RIAA Sues the Dead*, THE REGISTER (Feb. 5, 2005), http://www.theregister.co.uk/2005/02/05/riaa_sues_the_dead.

68. James DeBriyn, *Shedding Light on Copyright Trolls: An Analysis of Mass Copyright Litigation in the Age of Statutory Damages*, 19 UCLA ENT. L. REV. 79, 79 (2012) (“To supplement profits from copyrighted works, copyright holders have devised a mass-litigation model to monetize, rather than deter, infringement . . . utiliz[ing] the threat of outlandish damage awards to force alleged infringers into quick settlements.”).

excessive, this might reinforce or strengthen a belief that the legal regime is not legitimate or that a legal rule is unjust.⁶⁹ This is likely what happened in the wake of the highly publicized litigation campaign of the record industry. The public perceived that the industry was targeting college students in a settlement extortion campaign because the proposed \$3000 settlement was always preferable to the individual's financial exposure in litigation.⁷⁰ Media reports that a single mother and a college student were each charged with six-figure damage awards for copyright infringements involving a handful of songs⁷¹ likely undermined the public support for the enforcement of copyright law and might have contributed to a public belief that the campaign against file sharing was excessive.⁷²

How much should such negative public attitudes be of concern to content rights holders? Can rights holders afford to ignore public backlash? What if increasing deterrence is the only way to discourage infringing behavior?⁷³

First, social science scholarship warns against purely coercive approaches to enforcement. For instance, experiments show that individuals tend to obey rules when they believe that it is the right thing to do.⁷⁴ For that reason, it may matter a great deal whether the law or its

69. See generally Francesco Parisi & Georg Von Wangenheim, *Legislation and Countervailing Effects from Social Norms*, in *EVOLUTION AND DESIGN OF INSTITUTIONS* 25 (Christian Schubert & Georg Von Wangenheim eds., 2006), available at http://www.law.gmu.edu/assets/files/publications/working_papers/04-31.pdf (providing formal mathematical model of norm backlash effects).

70. Grant Gross, *Congress Scrutinizes RIAA Tactics*, IDG NEWS (Sept. 17, 2003), <http://www.pcworld.com/article/112535/article.html>; Katie Dean, *Senator Wants Answers From RIAA*, WIRED (Aug. 1, 2003), <http://archive.wired.com/politics/law/news/2003/08/59862>; J. Cam Barker, Note, *Grossly Excessive Penalties in the Battle Against Illegal File-Sharing: The Troubling Effects of Aggregating Minimum Statutory Damages for Copyright Infringement*, 83 TEX. L. REV. 525, 526 (2004); Daniel Reynolds, Note, *The RIAA Litigation War on File Sharing and Alternatives More Compatible with Public Morality*, 9 MINN. J.L. SCI. & TECH. 977, 978–87 (2008). See generally Pamela Samuelson & Ben Sheffner, Debate, *Unconstitutionally Excessive Statutory Damage Awards in Copyright Cases*, 158 U. PA. L. REV. 53 (2009) (discussing the constitutionality of copyright statutory damage awards).

71. See *supra* text accompanying note 63.

72. Depoorter et al., *Copyright Backlash*, *supra* note 51.

73. See generally George J. Stigler, *The Optimum Enforcement of Laws*, 78 J. POL. ECON. 526 (1970) (theory of rational law enforcement); RICHARD A. POSNER, *ECONOMIC ANALYSIS OF LAW* (5th ed. 1998) (explaining fundamental concepts of the economic approach to law).

74. For instance, in the context of tax compliance, extensive literature suggests that social motivations (ethical concerns, social norms, perceptions of fairness, etc.) can be stronger determinants of taxpaying behavior than material considerations. See Michael Wenzel, *Motivation or Rationalization? Causal Relations Between Ethics, Norms and Tax Compliance*, 26 J. ECON. PSYCHOL. 491, 492 (2005); see also John S. Carroll, *Compliance with the Law: A Decision-Making Approach to Taxpaying*, 11 LAW & HUM. BEHAV. 319, 319–35 (1987) (applying decisionmaking models to tax law); Simon James, et al., *Developing a Tax Compliance Strategy for Revenue Services*, 55 BULL. FOR INT'L FISCAL DOCUMENTATION 158–64 (2001). In fact, a number of empirical studies find that norms and beliefs are a stronger determinant of compliance than deterrence. For an overview, see Leandra

enforcement is perceived as being “just” or “fair.” Conversely, individuals might decide *not* to obey a legal command if the rule is considered “unjust.” In this process, normative intuitions about morality might cause individuals to set aside the risks associated with the illegal behavior.

Second, when behavior is driven by normative viewpoints, unbalanced enforcement efforts might reinforce and strengthen the underlying opposition against the applicable laws.⁷⁵ This effect is particularly strong when law enforcement conflicts with social norms or personal beliefs of what should be allowed. In the context of file sharing, the strongest opponents of enforcement were the most frequent file sharers. Frequent infringers, of course, had the most to lose from stringent enforcement, so their personal beliefs might simply reflect a self-serving bias. Moreover, research on cognitive dissonance suggests that individuals often adjust their attitudes and beliefs⁷⁶ when they experience a conflict in their perceptions of reality.⁷⁷ The next step in this process is to generalize these personal views to others. Indeed, individuals often believe that others are more like themselves than they actually are in reality. As a result, predictions about others’ beliefs or behaviors based on casual observation are very likely to err in the direction of one’s own personal beliefs.⁷⁸

Legal scholarship describes how vigorous legal condemnations of norms may end up strengthening the very antisocial norms that they are meant to combat.⁷⁹ In the context of criminal law, for instance, William J. Stuntz has described situations in which prosecutions can work against the very norms on which they rest, causing “popular norms . . . to move

Lederman, *The Interplay Between Norms and Enforcement in Tax Compliance*, 64 OHIO ST. L.J. 1453 (2003).

75. See generally Dan M. Kahan, *Social Meaning and the Economic Analysis of Crime*, 27 J. LEGAL STUD. 609 (1998); Timur Kuran & Cass R. Sunstein, *Availability Cascades and Risk Regulation*, 51 STAN. L. REV. 683 (1999); Tracey L. Meares & Dan M. Kahan, *Law and (Norms of) Order in the Inner City*, 32 LAW & SOC’Y REV. 805 (1998).

76. Joshua D. Rosenberg, *The Psychology of Taxes: Why They Drive Us Crazy, and How We Can Make Them Sane*, 16 VA. TAX REV. 155, 200 (1996) (describing how people amend their cognitive frame to reduce conflict by incorporating new perceptions of reality).

77. See, e.g., LEO FESTINGER, *A THEORY OF COGNITIVE DISSONANCE* (1957); JON ELSTER, *SOUL GRAPES: STUDIES IN THE SUBVERSION OF RATIONALITY* (1983). The classic example of this is expressed in the fable where a fox sees some high-hanging grapes and wishes to eat them. When the fox is unable to reach the grapes, he surmises that the grapes are probably not worth eating, as they must not be ripe or that they are probably sour. AESOP, *THE FOX AND THE GRAPES* (ca. 620–564 BCE).

78. The false consensus effect is described in, for example, Brian Mullen, et al., *The False Consensus Effect: A Meta-Analysis of 115 Hypothesis Tests*, 21 J. OF EXPERIMENTAL SOC. PSYCHOL. 262 (1985); Lee Ross, et al., *The “False Consensus Effect”: An Egocentric Bias In Social Perception And Attribution Processes*, 13 J. OF EXPERIMENTAL SOC. PSYCHOL. 279 (1977).

79. For a theoretical model, see Parisi & Wangenheim, *supra* note 69 (describing a cycle of opinion formation in which public acts of disobedience and protest undermine the legitimacy of legislation, which leads to further opposition).

in the *opposite* direction from the law.”⁸⁰ Specifically, enforcement may reinforce or strengthen a belief that the legal regime is not legitimate or that a legal rule is unjust. This is especially true if the public perceives the legal sanction to be excessive in relation to the punished behavior. Several studies document that enforcement measures can backfire and cause an overall increase in illicit behavior.⁸¹ These dynamics help explain the public backlash in response to the music industry’s litigation campaign. By increasing enforcement without regard to the public’s perception, the record industry might have increased, rather than decreased, the rate and frequency of infringing activities, particularly among college students.⁸²

3D printing will likely exhibit similar dynamics. Users of 3D printing obviously benefit from the use of their printer and might adopt a liberal viewpoint on what can be printed out at home without much regard for IP rights. Much like users of peer-to-peer networks, owners of 3D printers might externalize these personal beliefs and come to consider their own beliefs as social norms. Such liberal, non-commercial 3D printing norms might be particularly strong since, like file sharing before it, users might (1) download and print materials that they would not have bought anyway; (2) believe that their unauthorized print-outs might inspire others—say a visitor to their home—to buy the actual product in stores; (3) have altered the design of the items to their own preferences, creating an attribution effect that causes them to feel entitled to print the altered version without a license. Given these circumstances, it is reasonable to assume that pro-3D printing norms will be quite robust and that enforcement measures might induce a counterproductive backlash effect.

Punitive deterrence measures may well undermine the interests of IP rights holders in the forthcoming confrontation with counterfeit 3D printing. First, enforcement measures that are perceived as excessive might cause potential infringers to disregard the law on inconsequential grounds. If the deterrent or coercive aspects of enforcement create a belief that the underlying legal rules are unjust, individuals might decide to disobey the law—despite the added costs associated with breaking the law. Second, evading unjust or immoral enforcement measures might be

80. William J. Stuntz, *Self-Defeating Crimes*, 86 VA. L. REV. 1871, 1872 (2000) (suggesting that misguided enforcement priorities can inadvertently shift public support away from the underlying laws).

81. See, e.g., John S. Carroll, *A Psychological Approach to Deterrence: The Evaluation of Crime Opportunities*, 36 J. OF PERSONALITY & SOC. PSYCHOL. 1512 (1978); Harold G. Grasmick & Donald Green, *Legal Punishment, Social Disapproval and Internalization as Inhibitors of Illegal Behavior*, 71 J. OF CRIM. LAW & CRIMINOLOGY 325 (1980); Kent W. Smith, *Integrating Three Perspectives on Noncompliance: A Sequential Decision Model*, 17 CRIM. JUST. & BEHAV. 350 (1990).

82. See Depoorter et al., *Copyright Backlash*, *supra* note 51 (providing experimental evidence of normative backlash effect in the context of file sharing and copyright enforcement).

gratifying to some individuals, perhaps sufficiently so that it may outweigh the risks involved with engaging in infringing behavior. Finally, in the long run, normatively excessive deterrence may undermine the political support for the underlying protected rights. As public attitudes change, political actors are more likely to consider revoking or moderating the legal framework and available remedies. When confronting 3D printing infringements, manufacturers would be wise to heed these lessons from the record industry's experience with file sharing.

CONCLUSION: ALTERNATIVES

The enforcement of IP rights on 3D printing presents a vexing dilemma for holders of patents, trademarks, and copyrights: when noncompliance and infringement are widespread, effective deterrence cannot be attained without raising enforcement to levels that threaten to undermine support for IP rights.

If property rights are costly to enforce (litigation expenses, social friction) and enforcement is not very effective, the legitimacy of the legal rights are undermined. In the classic treatment of the emergence of property rights, Harold Demsetz sets out the conditions that foster the creation of property rights.⁸³ Several scholars have since elaborated on the effects of enforcement costs on the efficiency and effectiveness of private property rights.⁸⁴ As the classic story of the enclosure movement illustrates, reductions in private enforcement costs (such as the invention of barbed wire, for instance) are traditionally associated with an expansion of private property rights. In this framework, recent technological changes might suggest a move away from private property rights to a society favoring the idea of common property.⁸⁵ It is worth considering whether 3D printing is one such technology. Like peer-to-peer file sharing and copyright enforcement before it, 3D printing technologies will make it increasingly difficult to enforce IP rights on physical items. Because infringers are decentralized, enforcement is ineffective and costly. Moreover, efforts to bolster enforcement through

83. Harold Demsetz, *Toward a Theory of Property Rights*, 57 AM. ECON. REV. 347 (1967). Demsetz attributes the relative absence of private property rights on the Southwestern plains to the high costs of containing wide range, migratory animals. For Native Americans of the Labrador Peninsula, fencing forest animals was relatively less expensive. Variance in the degree of private property rights protection can be explained in relation to the costs involved in the "fencing" of those assets.

84. See Robert C. Ellickson, *Property in Land*, 102 YALE L.J. 1315, 1315-44 (1993); Barry C. Field, *The Evolution of Property Rights*, 42 KYKLOS 319, (1989); Terry L. Anderson & P.J. Hill, *The Evolution of Property Rights: A Study of the American West*, 18 J. LAW & ECON. 163, 164-68 (1975).

85. Saul Levmore, *Two Stories About the Evolution of Property Rights*, 31 J. LEGAL STUD. 421, 429-33 (2002) (describing how technologies may affect a shift from commons to private property rights and back to common property).

technological protections are likely to set off an arms race between manufacturers and hackers, involving costly, non-productive uses of resources. These difficulties are illustrated in the long-standing litigation involving peer-to-peer technologies and copyright law.⁸⁶

These insights increase the appeal of alternative measures that might protect the incentives and investments of product designers and manufactures in a world of 3D printing. All options have their downsides, of course. Regulating the manufacturing and technical design of 3D printers to prevent infringing uses may interfere with innovation and inadvertently tax legitimate uses of 3D printers.⁸⁷ Imposing IP levies on raw materials or 3D printers indiscriminately affects all users of 3D printers, making even legitimate uses of 3D printers more costly.

The costs of enforcing IP rights must be considered fully when regulating and setting the boundaries of rights on new technologies. 3D technology is no different. It is important to note that in certain industries, 3D printing not only reduces the costs of IP infringements, but also the costs of designing and producing new items of manufacture. Given that IP rights are created to provide incentives and enable property right holders to recoup their investments, when those investment costs decrease, so does the need for IP rights.

When 3D printing reduces the costs of production as well as distribution of products, the enforcement of IP rights on 3D printing is likely to create social costs without generating offsetting benefits. This reason alone justifies taking a hard look at IP doctrine with an eye towards adapting it to the social and economic changes affected by the revolution of 3D printing.

86. See Depoorter, *Technology and Uncertainty*, *supra* note 32.

87. See Desai & Magliocca, *supra* note 1 (manuscript at 2).
