March 2, 2013

Desktop Piracy Factories: Will Existing Law Be Enough?

Andrew J Daddono, Florida State University
DESKTOP PIRACY FACTORIES: Will Existing Law Be Enough?

Drew Daddono

A brief essay on how this disruptive technology will affect the future of our existing legal regimes for intellectual property, what foreseeable problems there are, and possible ways that we may address them.
I. Introduction

3D printing is a disruptive technology in that it brings complex manufacture process, previously limited by high-cost of access and high level of technical requirements, within the reach of anyone with $500 and access to the internet. Even though 3D printers have been in existence since the mid 1980's, it is only within the past decade that this technology has really found traction, and only within the past four that it has become readily available and affordable to the individual.(1) These printers have extremely high societal benefits by bringing powerful developmental technology to everyone— the ideas and concepts created by hobbyists and non-professionals have the potential to change our world now that their ideas can become reality. This technology empowers the public domain, where “… peer review, diffusion of ideas, recognition as source of motivation, and interest in protecting knowledge from being depleted” control, more than legal regimes.(2) The dark side of 3D printing however carries with it many legal issues that have previously been left underdeveloped for decades. While the advancements that come from individuals utilizing this new technology will benefit all, there is the potential for piracy and intellectual property (IP) infringement with the commercialization of these inexpensive machines. This technology also has the potential to challenge creative industries, “where “products” are often pieces of arts mingled with more standardized products and services, and are sold on the mass markets.”(3) That is precisely what this new technology enables

---

1Drew Daddono, FSU law student, written for Cyber Law Seminar Fall 2012 semester. Thank you professor Jones for all of your input and your essential assistance collecting sources.

2Even as recently as 2006, basic models of 3D printers cost $20,000 - $50,000.(4)

3Dahlander discusses these principles as they correlate to free and open source software communities in much of the same manner as they apply to open science and academia communities. I relate and include these communities as facets to the greater gem that is the Public Domain.
individuals to do, which challenges the existing industrial player balance.\(^4\)

In this paper I will cover the three major areas of concern regarding current IP law as it applies to this new access to existing technology, mainly the issues and limitations of copyright law, patent law, and enforcement of both. In doing so I will discuss the various changes both sides of the fight—individual developers on one side and IP-holding firms on the other—and would like to see occur, and the benefits and costs involved. Perhaps the more complex topic covered will be how future enforcement of IPR will exist in such a democratized manufacturing world, along with possible solutions and alternatives to existing enforcement. We will then discuss which IP legal scheme modifications if any will offer the greatest all around benefits--i.e. what will simultaneously fulfill the need to protect manufacturers, inventors, and their products, as well as to protect and encourage this technological advancement in such a way as to facilitate further inventions and developments, previously denied to the public at the individual level. “...[T]he key mechanism that channels the creative ideas emitted by talented individuals in the underground to bring them progressively to market is played by informal collectives or creative communities. The role played by these communities in the creative process is essential; they achieve the progressive building of a common base of knowledge.” (5). The dangers of overreaching and under-reaching IP legal schemes are abundantly clear, and the crux of the issue is best expressed by the question: can we simultaneously encourage large-scale investment and innovation, while protecting the public domain and creative communities from stifling IP regimes?\(^5\) After examining this question in detail from the various perspectives current IP law provides, I will discuss what I propose as one possible solution to the myriad of IPR concerns raised by the rapid advancement of 3D printing technology, utilizing current (although modified)

\(^4\)Bach, Cohendet, Penin, and Simon describe the three players comprising our industrial arena as traditional industries (firms), creative communities, and individuals.

\(^5\)“In short, is it possible to manage and drive creative communities without sterilizing them?”(6).
The intellectual property rights battlefield will change dramatically with the opening of this new market, and the players of manufacturers, individuals, and creative communities will all be involved. “Since the Industrial Revolution, manufacturers have been forced to worry about the mass appeal of their products… That equation has been flipped on its head. A designer can afford to sell things one or 10 at a time because there is no manufacturing cost until the item is actually ordered.” (7). The manufacturers on one side will be vying for an expansion of existing copyright and patent law in order to protect their products from replication, not only with the intent of reselling but also in the interest of stopping individual use. On the other side there will be individuals, inventors, creative communities, and small groups of developers hoping to stop any such expansion of IP regulations in the interest of protecting the advancement of ideas in the free market. This battleground is made up of the competing interests of the players and the current void between copyright and patent laws.

Currently, copyright law, while effective for protecting ideas including designs and writings even when created simultaneously although unilaterally, is extremely difficult to employ in attempting to protect useful objects—the manifestation of these ideas—from infringement.

---

6Manufacturers will be empowered in this goal by their vast resources in the area of IP protection, including lobbying abilities, legal teams, experience in the field, and the ability to absorb/acquire outside IP.
7The only advantage they hold is the ease and apparent willingness at which they operate outside the law, due largely in part to the enforcement issues discussed infra.
8Bach, Cohendet, Penin, and Simon describe this battlefield as the “IPR Dilema;” “…[H]ow can we reconcile the different wants and needs of three basic stakeholders (firms, individuals, and creative communities). Which are equally important in the dynamics of creative industries and which have contradictory interests. Basically, we argue that individuals desire strong individual IPR, firms aim at strong “corporate” IPR, whereas creative communities require weak IPR, or even not IPR at all...” (8).
Copyrights are easy to obtain (in fact, their protection often begins automatically)\(^9\) and comparatively inexpensive to enhance via registration, however the substance of what can be protected is rather limited. On the other end of the spectrum is patent law. Patents are extremely effective at protecting functional objects and will be enforceable against any identical or even similar object, even when created unknowingly in violation of the patent. The problem with patents is that they are more difficult to get, more expensive, and if you're looking for the nearly complete protection offered by a utility patent time and cost are mostly prohibitive. Beyond those limits, which all end up prohibiting primarily individual efforts while large firms have far less difficulty navigating the patent arena,\(^10\) patents are often only limited monopolies for a shorter term of years.\(^9\)

These of course are only 'problems' from the perspective of the IPR holders, who want to increase the effectiveness of current IPR regimes. The perspective of the individuals and the creative communities is the other side of the coin; infringement is oftentimes confusing or unclear, while offending traditional IP laws by creating an object that may be under patents by unilateral efforts seems counter-intuitive.\(^10\) The original purposes of the current IP regimes was to encourage investment and innovation by way of protecting some expected return, but because the primary options are so far apart both in substance, availability, and access, there is a rather large void created in the middle ground which threatens to swallow up individual efforts if it is bridged by expanding current IP schemes.\(^11\) In essence, the current structure if left unmodified, or worse yet, made to overreach current restrictions, may have the opposite of the intended effect which motivated the creation of IP regimes in the first place by empowering more

---

\(^9\)US Copyright office [www.copyright.gov/circs/circ01.pdf](http://www.copyright.gov/circs/circ01.pdf)

\(^{10}\)Besides the obvious advantage of greater capital to invest in strong IP protections, firms often have greater resources in the form of contracted patent attorneys, experience generating and pursuing patent protection, and, perhaps most importantly, the time needed for the process—something that can be the sole factor inhibiting individuals.
'patent trolls,'\textsuperscript{11} limiting innovation for fear of legal ramifications, and overall limiting the natural expanding of the market as a whole by preventing easy (or even any) access by any but the largest, strongest competitors.\textsuperscript{12}

The future stands to bear a completely different world of IPR law in which, I hope, we will see creative developments of protection that allow for enforcement of real and significant infringement while offering protection and generally wide leeway to developers, individuals, and inventors. All one has to do is analyze these identical issues faced by the music industry not even ten years ago: after all of the money was spent on fighting the new technologies that kept popping up one after the other, the music industry is only recently beginning to embrace them, opening themselves up to entirely new markets, even competing with their free competition (something that was supposedly going to 'crush' the industry is turning into a money-making machine for the industry).\textsuperscript{(12)} One possible solution is to change how we view goods, and in particular how they are sold/transfered under the UCC. Since we have in place methods for protecting the transformation of ideas and products in the physical space to digital media, similar protections could be created for the movement of digital media into the physical space vis-a-vis physical object licensing through the transfer/sale of digital blueprints. Manufacturers would receive a great benefit in the ability to drastically reduce or even completely eliminate their distribution costs, as well as most of their manufacturing costs. This cost savings would transfer to the consumers, justifying their agreement to the limited use of such licenses of these products. We could even see the possibility of combining licensing with regular sale governed by the UCC with more complex products. Imagine ordering a laptop from an online retailer. You could

\textsuperscript{11}Ramello explores the natural existence of de facto property rights and specifically how modernizations of existing property law should not alter the behaviors of property owners.\textsuperscript{(13)}

\textsuperscript{12}The fears of an overbearing IP regime are direct reasons supporting 3D printer proliferation because this technology empowers individuals to create more easily unilaterally, thereby encouraging innovation and investments (initial primary goals of the current IP regime).
receive the electronic blueprints to print out the physical case and internal structure of the laptop while the company ships to you the electronic internals and LCD display. Products could be designed as to easily snap together, and such methods would clearly be greatly reduced in costs all around, but simultaneously provide for greater customization by the individual users--the user could decide the color or pattern to print their new laptop in for example. Unfortunately, there are quite a few hurdles involved in this existing legal scheme as it is remarkably underdeveloped and includes great variations across jurisdictions. Only in unifying these policies under new and modified articles of the UCC would protection for producers be ensured, and only when those protections are ensured will we see this kind of product distribution and development advancement.

Naturally, there would also be problems on the other side as individuals attempt to break and cheat this system, much as they have done so with existing DRM solutions in music, film, and television industries. Some such proposed restrictions include a DRM-like system built into the printers themselves, requiring users to acquire license verification for every object they print. (14) Yet another restriction aimed at solving this problem for the traditional industries is in limiting the use of these digital blueprints, a 'solution' that would be complex and enforcement of violations would prove difficult. However, these problems already exist in our current state of IPR law, specifically enforcement against the masses on an individual level in an attempt to discourage infringement—a solution proven over and over again not to work. (15) This technology is here and it is only getting easier and cheaper to obtain. Our current protections and enforcement solutions for IPR law are woefully insufficient to withstand this developing technology and the laws will adapt and change in order to keep our manufacturers in business. It will be up to the individual voters and small groups to ensure that in protecting these giant
lobbyists our lawmakers don't completely undercut and imprison our inventiveness and ingenuity.

II. What is 3D additive layer printing?

3D printing has been around since the mid-80's, but recent advancements, mostly in computer technology, have empowered the industry to reach a wide audience. The progress has been not unlike the exponential expansion of computers, from slow development in the 80's to their current position in practically every home, making up one of the largest industries in the world. The concept of layer manufacturing is a simple one: take a computer-aided-design 'blueprint' of an object, slice it into many cross sections along the same plane, and then print each thin layer, one on top of the other. The current process that is rapidly becoming more widely available to the individual in both cost and simplistic operation is additive layer manufacturing utilizing fused deposition processes. A typical non-commercial, inexpensive 3D printer includes a small heated print bed which controls the vertical axis of the print area, and a small, heated nozzle which extrudes molten plastic (typically nylon off of spools) along the x and y axises.

The entire process is controlled with minimal electronics, the brain of which is often an open source, simple microcontroller which individually costs under $100. Of course the printer itself is only as good as the data that it runs off of, so a separate home computer sends the CAD files to the printer in the same way that an individual prints from their computer at home. The CAD files can be built using free and open source software available online, or professional grade architectural design software suites, or alternatively the design files can be downloaded

---

13All layer manufacturing runs off of this basic process, however the method for creating the individual layers has many iterations including stereolithography (a laser hardens light-sensitive liquid resin one layer at a time), fused deposition (a heated print-head extrudes melted plastic through a small nozzle), and selective laser sintering (a laser etches each slice into a thin layer of powder material, another layer of powder is deposited on top of the previously sintered layer to build the next slice).(19)(20)

14This technology is becoming so simplified that 3D printer and design software creators are beginning to target children.(21)(22)
(for free) from many sources online, or emailed, sent via USB drive, CD, or any other way regular data is shared.

III. How does existing IPR Law apply to this technology?

“Intellectual Property Rights are legally imposed monopolies, which limit the fundamental right to copy, if certain conditions are met. All of these IPRs have the same effect: they exclude a bit of knowledge or invention from the Public Domain.”(23)\textsuperscript{15} Perhaps the reason that at this point there is very little in the way of analysis on this topic in general is because current IP legal schemes seem to simultaneously overlap and not apply to much of what is being done with new access to this technology. The biggest conflicts to arise so far are two DMCA take down requests to one of the current internet forums for sharing 3D designs. Both were complied to without hesitation or debate on the part of the forum owners, and hotly contested by members of the creative community associated with the forum. I will cover both in detail in the next section, however it's worth noting here that in spite of immediate acquiescence by the forum, they were likely not obligated to comply in the second case, and certainly not in the first.(24)(25)

The problem of overlap should be instinctive from the overlap in the general principles of patent law and copyright law themselves. The struggles between the two have always been fought where functionality and design clash, intermingle, and divide. Separating design from function is a source of constant litigation (see: Apple v Samsung for a current example), so it naturally follows that turning an electronic design into a tangible, perhaps functional object in physical space exacerbates this existing conflict. These issues are further magnified by the limited and often outdated language used in the USCA itself. This is exemplified in one of the most confusing factors of title 17; “In no case does copyright protection for an original work of

\textsuperscript{15} This paper hinges on the theory that we want to drive invention, increase innovation, and empower the public domain to our cultural benefit. Hardly a new concept, as this is an original motivating factor for the initiation of Federal Copyright Law.
authorship extend to any idea, procedure, process, system, method of operation, concept, principle, or discovery, regardless of the form in which it is described, explained, illustrated, or embodied in such work.” 17 U.S.C.A. § 102 (West). This section of legalese is complicated enough when applied to literary or dramatic IP conflicts, yet now an individual can express an 'idea' that is otherwise lacking any legal protection by creating a physical manifestation of it utilizing 3D printing. 1617

1. Patent Law

Patents are perhaps the most applicable form of IP in regards to 3D printing technology. Nearly any kind of object can be considered a product or article of manufacture, the issue comes about in that objects must be both useful and obvious to be available for patents. While usefulness is a rather low threshold to meet, the 'obvious' requirement is foundation for nearly infinite litigation. (26)(27)(28) Multiply that complexity by differentiating ornamental features as restricted to design patents, and functional features as restricted to utility patents, and the whole scheme seems even more daunting as applied to 3D printed objects in the garages of individual designers. Surely if an individual were to make a mold of a patented ornamental vase and then from that mold cast another vase, they have infringed the patent by directly copying the ornamental features. Now, give them a 3D printer and design software, which they use to create a CAD design of a vase with similar features on their own, they have infringed to the same degree

16Trademark is perhaps noticeably absent from this section of the paper, and I will briefly explain why. The fact that trademark seems to be the best candidate for protecting a printed object—being a sort of between copyright/patent concept—suffers from two primary weaknesses. First, because the design of the object being printed is easily manipulated, any aspects of trademark such as logos or design elements can be easily omitted from the final product. Secondly, trademark infringement is characterized by its use in commerce, where it may dilute the mark, and the direct copying and individual use of any trademarked item will not likely be held to dilute the mark unless that individual attempts to sell copies made.(29)

17Also perhaps noticeably absent is the effect of trade secrets on 3D printer technology. Essentially, it does not apply except in unique and rare scenarios. The idea of taking an object and 'drawing' it in a computer program would consist of simply matching the dimensions of the various aspects of the object to be copied with the CAD drawing. The height and width of a model train for example could be divined by ruler, without the need of uncovering secret design attributes (to be secret it would practically have to be invisible, and by that alone unnecessary). (30)
in the eyes of the law. The difference here that raises issue is that the second 'infringement' was entirely unilateral.\textsuperscript{18} The reason that patents do not differentiate unilateral creation from direct copying is that prior to 3D printing technology, unilateral creation that was similar enough in ornamental features of a patentable object was a rare occurrence, simply because the types of objects that are patentable were previously difficult to replicate at even a basic level. With the proliferation of 3D printers, that is no longer the case, and current patent law does not care. This is troublesome because to the average person designing something on their computer and printing it out, all of their own efforts, does not even bring infringement into question, which creates a culture of accidental infringement that may be surprisingly easy to be a part of yet subject to some stiff penalties.

2. Copyright Law

Copyright laws offer easier access and unilateral creation protection, however, their application to 3D printed objects themselves is extremely limited, if possible at all. Copyright can cover sculptural works of 3-dimensional art and design, but only insofar as the work is not useful. \textit{"... [T]he design of a useful article, … shall be considered a … sculptural work only if, and only to the extent that, such design incorporates … sculptural features that can be identified separately from, and are capable of existing independently of, the utilitarian aspects of the article."} 17 U.S.C.A. § 101 (West). This eliminates a vast majority of 3D printed objects from copyright application so long as it is the object itself in question. One directly available copyright protection could very well be in the CAD design file used to print the object, in much the same way that architectural blueprints can be copyright protected. Of course, the problem here should be apparent: these individuals are not stealing CAD files from IP holders, they are creating these

\textsuperscript{18}"... copyright allows for independent creation, even if the same work was independently created twice (or even more than twice)." (31)
files themselves and sharing them with each other for free and on a large scale. (32) This asks the question of what we consider unilateral creation—is it satisfactory to argue that designing a CAD blueprint that may be strikingly similar to a copy-written one is not infringement if there was never access to the protected work itself?

IV. The problem of enforcement – the biggest hurdle

Many legal regimes fall to technology simply because of the increased difficulty in enforcement. (33) These advances make our world smaller, make sharing of content easier, and make it more difficult to trace, if for nothing more than the fact that it gets lost in the ocean of data available to everyone online. (19) Combine the massive quantity of data with the unlimited jurisdictions that source the data for users and you have an enforcement nightmare that turns into a black hole for resources. We can look at the recent example of the music industry—initial fights against Napster and Grokster cost the industry millions of dollars. (20) “[Enforcement by litigation of] formal intellectual property rights, … foster[s] a legal regime that has imposed additional costs and risks on innovators that are extrinsic to the costs and risks inherent in R&D undertakings.” (34) (21)

The development of Digital Rights Management technology has also cost millions to develop and now is all but abandoned by the major players in music distribution. (22) DRM is a system built into content distribution products which controls access to copyrighted work—examples include MP3/CD music players and DVD players, where if copied media is used, they will not play properly. The problem with these DRM systems is clear: “The DMCA thereby

---

19 This paper does not fully address the problem of international enforcement issues; they pose a significant and complex labyrinth of different IP regimes, various international agreements, and a wide variety of recognition or indifference between many countries’ different schemes. (35)
20 (36)(37)
21 The goal as described by Rao, Klein, and Chandra should be to create a mutually beneficial regime that encourages and empowers socially useful innovation. (38)
22 “The success of [legal online content distribution] is no accident. Why fight piracy by bringing down the legal hammer? Make it easy and appealing to purchase your content digitally and people will flock in droves.” (39)
restores to today's copyright owners the same combination of technological and legal control over the publication and dissemination of works enjoyed by the Stationers' Company more than three hundred years ago.”(40)

Already large firms are showing an interest in pursuing this failed system of restriction for 'protecting' their content from infringement by 3D printers.(41)

A patent was issued in October of this year for a DRM-like system which would make 3D printers “...obtain authorization before they are allowed to print items requested by the user.”(42)

This system would function in much the same way that many internet content providers automated infringement detection software functions: when asked to print a file, the printer will first run the data against a database of protected works and identify how similar those files are to the one being printed. This would result in false positives in the form of one-off designs that might be structurally similar to a protected work.

Software is another area where enforcement cannot keep up with the technology. There are free and open source communities competing with private industry programs by dealing in the building blocks of programs that perform the same function.(43) There are entire communities of 'hackers' who spend mere hours cracking the securities of privately developed commercial software immediately after its release, taking products developed with hundreds of thousands of dollars of private investment and making them freely available to all, even with minimal computer skills. Immeasurable investment has gone into registration key restrictions, online user authentication systems, and software that communicates regularly with the manufacturer's servers for updates, which in turn verify authenticity of the software. All of these

23Lunny describes a time when the Stationers' Company owned all of the printing presses, effectively completely controlling content distribution, to the extent that English law permitted only Stationers to own printing presses.
24“Apple's iTunes dropped DRM for music in 2009 after consumers complained their songs wouldn't play on non-Apple devices.”(44)
25“But there is a big caveat to [DRM for 3D printers], says Weinberg: “Nothing says manufacturers have to use DRM.””(45)
provisions are bypassed with relative ease and on a regular basis. The problem of course is that enforcement of IP rights in software is nearly impossible, which forces companies to focus on developing and investing in preventative measures.\(^{26}\) A secondary reason that enforcement is difficult is that those willing to use illegal software are mostly individuals looking to use the software themselves, making the download or DRM system breach likely a one-time event.

1. **Costs and limited resources**

   The specific costs involved in enforcement depend upon the targets of the enforcement. Infringement can be attacked at the level of the individual infringer or at a larger distributor of infringing material. Both have basic litigation costs so the motivating factors for who should be targeted may not be immediately obvious. One main factor however is vulnerability—individuals are certainly more vulnerable and even accessible than larger distribution channels. When analyzing a host for infringing materials, many factors must be looked at individually, including where the physical servers are located (this can be multiple places in multiple countries), how much content do they distribute and how much of it is or likely is infringing on IP, where the company or owner is located (does not need to be the same place as the servers), the sources of their content (individual users from where), etc. Furthermore, the Online Copyright Infringement Liability Limitation Act (OCILL) provides a legal safe house for online service providers that comply with very minimal requirements.\(^{46}\) As long as alleged infringement is blocked by the OSPs and so long as they maintain an agent to receive notices of infringing material, the site may be protected by the safeguards of the OCILL, making it very easy for large-scale distributors to

---

\(^{26}\)This is naturally only applicable to the large quantity of software that is developed for individual use, such as word processing, spread sheet creation, photo editors, etc. More commercial software may be easier to enforce because the commercial use (both in scale and in quantity of user interactions) tends to be more readily detectable than an individual editing a photograph of their dog on their home computer using illegally copied software.
Individuals are not so lucky. An individual posting or sharing infringing content has no legal safeguards beyond fair use. Fair use has flexible limits however, especially when applied to individuals printing 3D objects. Under the assumption that educational purposes of printing objects as fair use would remain the same as it is for other copyrighted works, and since none of the suggested fair uses within the statute clearly apply directly to individuals printing 3D objects, the issue will likely hinge on the four factors, specifically the substantiality test and the effect on potential markets for the copyrighted works.

Firstly, focusing on the substantiality of the infringement, we must consider both the printing of the object itself, along with the implications that are attached to any CAD design files. If an individual creates a CAD design based on the copyrighted work and prints the work without disseminating the file, have they used a substantial portion of the copyright in their printed work? They likely created the CAD file using the entirety of the protected work—either from memory or from observation—but the CAD file is entirely their own design. This could fall under a derivative work theory in that the object being expressed through a digital drawing is original and different enough from the object itself to evade infringement. It's important to note that only the expression itself, and not the idea being expressed, is protected by copyright, so theoretically the expression of the same/similar idea in a completely different medium may not be

---

27. The act goes even further in that it protects the OSPs from liability to their users, should they remove user content in response to a notice of violation, regardless on whether or not the content is actually infringing. This aspect of the act doesn't make it easier for websites to seek safe harbor under its rules, but it removes the need for responsible analysis of notices, and takes away any legal responsibility to stand up for individual users and their content.

28. The four fair use factors are 1. purpose and character of use, 2. the nature of the copyrighted work (published or unpublished), 3. the amount and substantiality of the portion used as related to the whole copyrighted work, and 4. the effect on the market for or potential value of the copyrighted work.

29. A direct scan of an object in physical space and using computers to convert that to a CAD design file has different implications than a CAD file constructed from scratch by a designer from memory or observation. This paper focuses on the more complicated questions and avoids the 'easier' calls—likely, using a scanner to copy an object, in much the same manner as a photocopier functions, would constitute infringement.
infringement at all.\textsuperscript{30} This is also important when considering the distribution of that 3D CAD file itself as possible infringement on a copyright. This is all with the assumption that the object itself being copied is actually copyrightable at all—utility and functionality are notoriously easy to read into a design.

The more interesting fight here lies in the significance of the infringement to the market for or value of the copyrighted object. Here is where one of the true battles over the heart and soul of 3D printing accessibility to individuals lies; where it could be empowered to take off as an everyday technology, inspiring innovation and inventiveness, or where it could suffer a crippling blow, instituting and reinforcing fears of infringement as a choke collar on innovation. In analyzing this fourth factor of fair use, the courts consider the immediate case, and, more importantly, the possible consequences of widespread use in a similar manner.(51)\textsuperscript{31} Clearly, the impact on a market for widgets will be generally unaffected by an individual designing and printing out his own widget for personal use—that's perhaps the loss of one sale, presuming the IPR holder can prove that the defendant would have otherwise purchased a widget. The gravamen of infringement complaints as described here will be whether or not widespread use in a similar manner is found to impact the value of the IPR holders copyright. Without direct legislation on the matter, it's going to be determined by the proof shown by the IPR holders in cases against (likely under-represented) individuals, ruled on, and converted to law. This is not a scenario conducive to empowering development and innovation utilizing new technologies, rather it lends to the possibility of causing stagnation, limited diversity, and hurdles to creativity. (52). This could further degenerate as described by Katz: “The U.S. should be a world leader in

\textsuperscript{30}“Using a different file to create the same object would probably not be a violation of the copyright of the original file as some sort of derivative work. As a result, the copyright on the file itself would be of limited value.”(53)

\textsuperscript{31}If the significant hindrance to court access posed by the DMCA (further described infra) were lifted, we could see how these rationales would play out in real court conflicts. However, that could prove fatal for the legal private printing arena, which is explained further in section VI of this paper.
technological innovation but current law and proposed amendments to copyright law make the common consumer an infringer, discourage innovation, and protect only a narrow segment of American industry, removing any incentive for established copyright holders to innovate and adapt.”(54)

2. **Limited enforcement mechanisms – the Failure of the DMCA**

The Digital Millennium Copyright Act is, thus far, the only enforcement mechanism for 'combating' copyright infringement by individuals using 3D printers.(55) The direct tool of enforcement within the DMCA is that of the takedown notice. A takedown notice is essentially exactly as it sounds: a party affirms under penalty of perjury that they have the right to enforce a copyright, that the party on notice is distributing content that infringes that copyright, and that they must take down the infringing material.(56). This is a simple process and it is streamlined by the safe harbor conditions provided to Online Service Providers; specifically that they must have an agent designated to receive these notices and they must comply immediately. There have so far only been two reported claims of copyright infringement in the 3D printing arena, both were 'enforced' by takedown notices filed regarding 3D printing, both were filed with the forum Thingiverse, and both were complied with (resulting in heated community debate).(57)(58)

The first ever takedown notice filed in this arena came from Dr. Ulrich Schwanitz regarding his design of the Penrose triangle.(59) The Penrose triangle is an illustration of an 'impossible' 3D shape—impossible in that it creates an optical illusion of a shape that is geometrically impossible—that exists in the public domain.(60) Schwanitz had created a CAD file for an object that, when viewed in the correct perspective, would appear to be a complete physical version of the geometrically impossible. (see fig 1):
Soon after Dr. Schwanitz published a video of his printed version of the Penrose triangle, Artur Tchoukanov created his own CAD file for a similar version of the Penrose triangle and posted it to the Thingiverse 3D printing community forums, prompting Dr. Schwanitz to file his takedown notice with Thingiverse. It was unclear from the takedown notice what Dr. Schwanitz was claiming as copyright. The notice was later retracted, and part of why it would have been invalidated if challenged is because, “... the takedown notice did not specify whether Schwanitz was asserting copyright in the structure itself, the 3D design file, or just the image of the Penrose triangle,” and because Dr. Schwanitz did not state 'under penalty of perjury' that he could enforce the copyright.(61) Furthermore, had Dr. Schwanitz specified the CAD design file as his copyright (the only original authorship by himself in this case), the 'infringing' designs were made independently, and thus a copyright here would hold no value.(62).

The second takedown notice was filed on behalf of Games Workshops, a UK-based modeling company that makes figurines for tabletop wargames.(63) This takedown notice carried far more force behind it since the object itself was covered by copyrights owned by a large, well-lawyered company. It contained everything required of a legal takedown notice and was complied with immediately by Thingiverse.(64) The issue arising in this case is that they demanded the removal of a CAD design file created by an individual for a model they designed themselves, based off of a Games Workshop design. They did not hold any copyright in the CAD file itself, but only in the original expression of the idea conveyed by the users creation—a
miniature model of a humanoid robot. There were similar design elements, however specific
details and embellishments were not included in the file posted to Thingiverse. Though clearly
based on the Games Workshop model and its overall design, this was designed and built in a
CAD program by a separate individual; it was not cast from a mold of the original or even
designed using 3D scanning of the original work, but merely the general shape of the original
was used to express the individuals take on the design (in much the same way that Dr. Schwanitz
and Tchoukanov copied the Penrose triangle from the public domain).(65) It could be argued that
perhaps parts of the general shape were utility and that therefore the CAD file constituted a work
based on the uncopyrightable aspects of the Games Workshop creation: a humanoid robotic
vehicle with clawed arms is hardly an original concept created by Games Workshop. Again, what
is problematic about this analysis is not the many arguments that could be made one way or the
other, but rather that the arguments never had a chance to be made.

These notices are complied with immediately and completely for fear of losing safe
harbor provisions, and barring great effort on the part of the individual whose content has been
removed to challenge the takedown notice, they are, for all intents and purposes, industry
controls over what is or is not infringement. This enforcement regime empowers itself by
creating safe harbor provisions that can only be enjoyed if entities execute blind compliance of
any basic notice of 'violations,' creating a self-sustaining and exponentially increasing arena of
restriction and censorship. This is a terrible mode of 'protection' for IP, and not just because it
arms IP holders with an unregulated beast of limitless content blocking power, but more
importantly because of the consequences to creative communities. Large gatherings of creative
individuals, arguably generating ideas that will drive our future, can now be felled by a simple,
template-created takedown notice, without a chance to defend their conversation, or else face the
threat of losing the very forum that they use for this societal benefit. Either they comply and lose their contributions and the conversation that is the target of a single individual's wrath, or they lose the forum and all of the conversations therein. This is the definition of a lose-lose scenario, no matter what the outcome society loses creativity and idea proliferation, and it is currently both legal and happening already.

It is not just a matter of having ineffective and inefficient enforcement methods. Indeed it takes a sinister turn; more than half of these takedown notices are actually filed in order to attack competing businesses, and many were not even valid copyright infringement claims. So the lackluster enforcement methods in place are actually being used strategically by business, playing on the extreme one-sidedness of the DMCA favoring IP holders (or in many cases, people that merely claim to be IP holders). The DMCA not only limits protections to OSP's who comply with notices immediately, but it also takes away any liability to users whose content has been removed incorrectly. In other words, in cases where a business wants to hamper a competing business by submitting a phony claim of copyright infringement and demanding a takedown of their content by Google, not only does Google have to comply immediately in order to maintain its safe harbor provisions, but the content owners have no remedy even after the claim is proven false. While most cases under the DMCA concern application of the safe harbor provisions to parties, Lenz v. Universal Music Corp is an ongoing bit of litigation which deals with an individual fighting for compensation for a bad-faith takedown notice filing. If

---

32“Google notes that more than half (57%) of the takedown notices it has received under the US Digital Millennium Copyright Act 1998, were sent by business targeting competitors and over one third (37%) of notices were not valid copyright claims.”

33Of course they would still have a remedy by seeking damages from the group that submitted the false takedown notice, however these notices could be filed rather easily while still hiding real identity, not to mention the fact that there is no duty to disclose on the part of the OSP the notice itself.

34The plaintiff Lenz submitted a video to Youtube of her children dancing to a Prince song, which clearly qualifies as fair use under copyright law. Universal filed a takedown notice with Youtube and it was complied with. Lenz got her video back up six weeks after it was removed by Youtube (they are required to comply within two weeks.
Lenz can succeed in this case, it will force large firms submitting takedown notices to either be more careful that they are accurate claims, or take more claim in hiding their identity when making the claim.35

3. Lessons from the music industry

We can stand to learn from the music industry and their battle with music 'piracy' by teenagers ten years ago. If the parallels are made now, history will not have to repeat itself with the waste of millions on litigation, which could instead be redirected into investing on accessing these potential new markets, and profiting off of new 3D printing technology while simultaneously encouraging innovation and future development. (67) After villainizing the general public that downloaded music, after prosecuting individuals for hundreds of thousands of dollars, and after attacking new technological advancements that arguably brought access that was previously unavailable to any but a few, the end result was a culture of 'infringers' that ended up changing the direction of the industry completely. (68) The interesting affect of these infringers was that they essentially created a new market for the IP holders' content, and if the IP holders had decided to attack that market (as opposed to the infringers), they would have only had to compete with a few tech-savvy teenagers and would have dominated the market, greatly expanding their profitability. Instead, they invested in expensive DRM technology meant to limit sharing of music, which had the direct result of driving more business to these illegal markets for alternatives. This ended up hurting the music industry's attempt at targeting the online market, forcing them to abandon DRM nearly entirely. (69)

under the DMCA) and so she proceeded to go after Universal for failing to use good faith when reviewing/issuing infringement claims. The case is ongoing, but it has been thoroughly complicated by the fact that the attorneys for Lenz cannot seem to stop their client from talking to anyone and everyone about the case. (70)

35 Those false claims Google receives every day from competing businesses will likely just get more creative when submitting the false claims, in order to continue to practice these arguably shady business moves.
Even worse still, the industry is trying to redirect enforcement resources to fund from taxpayer money, forcing the 'infringers' to pay for their own prosecution. As previously stated, the DMCA has only increased penalties and levied impossible fines on individuals in an attempt to redefine infringement intended to shift the resource burden on to already limited government agencies. These individuals are no more IP Pirates than they are felons, and the original intention of IP law to stop counterfeiting operations and industrialized stealing of ideas for commercialization is so far removed from the current state of affairs that we are making criminals out of a morally inculpable culture of sharers, because of our own lack of understanding. A failure to make this differentiation in IP law enforcement could damn this developing technology before it has a chance to really take off.

V. Reconstructing the world of IP

It should be apparent by this point that the world of IP law is going to change, the only questions relate to how. Who will spearhead the changes; the courts or the people? What will be the motivation behind the changes; will it be to protect innovation and to keep value in the public domain, or will the motivation come from large IP holders who want greatly expanded IP protections at the expense of individual creativity and inventiveness? And perhaps the hardest question: how will the balance between protecting the innovators and encouraging further innovation be struck? Too much protection either way could spell economical disaster for these manufacturing industries, either resulting in a flood of counterfeit goods to market, crushing manufacturers, or creating IP legal schemes that are entirely overbearing, confusing, and discouraging to any and all interest in innovating. Just the right amount of IP regulation

36“Copyright holders have asked the [Department of Justice] to extend a program of enforcement that even the copyright holders themselves say is a failure. Instead of realizing that their approach is ill suited to modify consumer behavior or protect their own assets, these actors are attempting to redefine copyright infringement as more damaging than violent crime and have pressed Congress to use government resources to vigorously expand their filed approach.”
could lead to benefits across the board and to all players in industry.\(74\) The bottom line: we need to ensure that the upcoming changes to the IP legal regime do not stifle 3D printing technology, because it stands to encourage innovation and provide great societal benefits.\(37\) I will analyze the first part of how in the next section on why we cannot trust the courts to fix IP legal schemes, so the following analyzes what changes are needed, the industry/business motivations for seeking these changes, and possible solutions.

1. **Why is reconstruction necessary – the move to the public domain**

   “... patents and open source can co-exist quite well and provide a framework that combines the best of both worlds, producing a mutually reinforcing climate to bring about more socially useful innovation.”\(75\) The public domain has infinite value to us as a society as it encourages development of all manner of technologies in a cooperative environment as opposed to a competitive one. In order to support mutual innovation, the public domain needs to be protected from overreaching IP legal regimes, and individuals must be free to invent, innovate, and share without fear of litigation. “Individuals and companies can use the flexibility of digital fabrication to more easily bootstrap product development.”\(76\) Essentially this emerging technology brings individuals and larger firms to more even terms when it comes to developing products. When this technology was entirely cost prohibitive to the individual, firms had the clear advantage in the middle stages of product development in that they could afford to make early fabrications/models, as well as test alternative forms without much added cost.\(38\) Further moves to the public domain will actually make firm innovation more important than it is now,\(39\)

---

\(^{37}\)Mellis and Buechley agree with me: “if we can teach people to fabricate their own devices from digital files, we connect them to broader possibilities for collaboration and business.”\(^{(77)}\)

\(^{38}\)“Using the same technology for both prototyping and production makes it easier to transition from one to the other. Additionally, the ability to order parts as needed from digital fabrication services and the increasing availability of low-cost machines lowers the initial investment required compared to more traditional mass manufacturing processes.”\(^{(78)}\) These are more ways in which affordable 3D printing levels the playing field between individuals and firms, overall a greater societal benefit than would be offered by squelching this technology in the interest of protecting IP holders' interests.
because rather than struggling to enforce and empower their IPR, they will be competing with open and public IP—limiting access to your innovations in an open market is equivalent to shooting yourself in the foot. (79) Examples are found in the music industry, where initial fights were for DRM and enforcement, but as access to the IP became so prevalent, they had to abandon those schemes of controlling IP and shift profits to live performances and had to compete in the online market by offering far higher quality music for little cost. 39 "In many industries, there are signs of collaborative communities, copying the open source software approach to share innovation, and ultimately, push it into the Public Domain." (80) Working in conjunction with the community of innovators and inventors will only benefit businesses by offering access to essentially free development teams and test groups, at the cost of forcing them to in turn maintaining the open source nature of their end result. This clearly has huge societal benefits, but it also is beneficial to business ends as well, striking that balance I discussed as necessary in order to continue to foster development while encouraging firm investment and protecting the economy from piracy.

**The Issues**

The primary problem with the gap that exists in the current structure of IP law—in which 3D printing sits squarely—is that there is no differentiation made between innovators or independent inventors and actual IP pirates and counterfeiters. The current legal regimes do include commercial use attributes, but those have become so convoluted and misused that they are practically dicta. Fixing that issue alone would help to eliminate a large area of 'infringement' that only suffices to hamper invention and innovation by using the fear of expensive litigation to prevent an individual from creating something great just because it may be based on a protected

39 "The Return of the Public Domain will increase the importance of innovation in business models, rather than reduce it, and will probably have a very positive effect on the amount of innovation we will see applied in business models that will properly take into account that Return of the Public Domain." (81)
The next problem that needs to be addressed is the reason for this gap in IP coverage in the first place: no one legal scheme fits 3D printing completely. Patents cover the most completely however they are limited in both the time protected and the access to patents themselves (cost, expertise, etc). This combination of good coverage but limited access puts all of the power into firms that are IP holders. Other smaller innovators and independent inventors are not in the same position to protect their inventions/ideas if they do not have the same ease of access as these firms do. On the other hand, copyright, while easier to access, offers confusing and limited coverage in the 3D printing realm. Sculptural protection only extends to the decorative attributes of these objects, separating any functionality from them, which effectively dulls the blade copyright offers. Simultaneously, copyright offers the extremely over-inclusive enforcement power of the DMCA, so that even with confusing and inaccurate copyrights, challenging them and resolving the conflicts they create become secondary motives to brushing the conflict aside entirely. I'll get to possible solutions in a moment, but it should be readily apparent that we cannot in good conscience expand either existing scheme to such a degree that it becomes overbearing, but clearly something needs to change to cover this rather large gap in our legal system.

The final reason reconstruction is necessary in IP law is a result of what I've identified here as limited and inefficient enforcement mechanisms made available under current law. So far, the only method of enforcement to be utilized has come in the form of the legislative mechanism

40While many independents and innovations come as a result of financial motive, many come simply from the drive to improve individual life. An expensive and time-consuming process of protecting an innovation does not fit that mode of operation. The large firms with the capital to invest in innovation that they predict to be profitable have a financial focus, and are therefore more motivated to pursue IP protections.

41And the motive to defend against them may be minimal due to prohibitive cost and time required to litigate, considering the added barriers to the courtroom.

42Doing so, as noted by Ramello, would be overextending into the realm of 'natural' property rights, and would impact the behavior of all players involved in the intellectual property world.
in the DMCA of takedown notices, and we have covered why these are completely inefficient. However, it serves repeating that not only is this method inefficient in that it is too heavy-handed, without any enforceable good-faith requirements, and entirely lopsided in favor of the entity claiming infringement, but it is also likely not a legal enforcement of a proper copyright infringement claim against 3D printing of an object for personal use.\(^{(86)}\)

**What We Learned From Music**

Without reconstruction with attention paid to correcting enforcement failures, of course, other methods of targeted enforcement will likely be utilized, but against largely open and beneficial public domain forums. Innovators and inventors may become the targets of lawsuits empowered by the inflated damages provisions of the DMCA. Rather than fight against powerful groups of attorneys representing the IP holders, individuals will likely cave in to their demands and cease all of their inventive efforts in that particular arena, to avoid future conflicts.

Mechanical enforcement methods will also continue to develop, akin to DRM if not identical to the antiquated remnant of the music IP war. Because many of the 3D printer creators are themselves members and proponents of the public domain, and because there is already increasing competition in the industry, they will likely not all agree to include DRM or other IP protection mechanisms built into their machines. Even if they would agree that a system to help prevent piracy would be beneficial, there is no doubt that they would have a difficult time establishing an industry standard.\(^{(87)}\)

Finally, legislative enforcement would be another remedy sought by the major IP holders.

---

\(^{43}\)This would only matter if any of these issues actually made it to a court of law. However, hopefully no court would enforce a copyright infringement claim when the claim fails to specify what the claim is actually against. It would be educational to witness a court arguing issues of severability in many of these cases when it comes to decorative versus utility features.

\(^{44}\)A DRM process for 3D printers was patented this past October by a known patent troll firm. While this may seem to help encourage the development of such a system, even beyond the basic problems already mentioned, a database of content that the printers would have to identify as 'protected' would still have to be built, something that would take both time and money to do, but lack any real motivating reasons to do so.
Much as the DMCA changed the world of copyright at the behest of powerful lobbying, similar acts could be put forward from strong pressure from the manufacturing industry. The issue will be one-sided and with the lofty goal of 'stopping piracy,' yet with the direct effect of squelching innovation and inventiveness. Any legislative action pushed for by IP holders will likely be as overbearing and inefficient as the DMCA is at stopping internet piracy.\(^{45}\)

2. **Business motivations**

The business motivations for resolving the issues discussed in this paper are strong. Whether or not major IP firms want to admit it, they are faced with a choice; face the large expense of fighting technological progress early only to end up delaying the inevitable, finding themselves then scrambling to harness the technology they fought bitterly to blockade, or to skip the expensive fight and start to harness the market earlier.\(^{46}\) More generally and perhaps more importantly, thanks to technologies like the 3D printer, easy computer-aided design, and open-source software solutions for creating nearly any kind of thing out there, we are seeing a renewed shift towards the public domain in the private sector.\(^{88}\) … “any business that does not anticipate working with the public domain, and integrating it into its business model, will most likely, have a severe competitive disadvantage.”\(^{89}\) Instead of focusing on the fight to empower their IP, firms should focus on harnessing the advantages provided by an increase in the scope of the public domain. The efforts of PD entities will challenge their ability to strive for and enforce their IP, regardless of how they combat it (and combating it is expensive).\(^{47}\)

\(^{45}\)These are the consequences if the industry does not learn from the mistakes made by the music industry however, hence the doom and gloom. If instead they learn from the past, their motivations (as discussed infra) may encourage seeking a legislative aid that targets the problem of enforcement, or perhaps narrowing the definition of infringement enough to exclude productive invention and instead focus on actual piracy.

\(^{46}\)This is certainly a losing battle, as we’ve seen from the music industry and indeed nearly major technological development over the past half century. No matter how strongly a new technology is opposed, if it is progressive and people want it, it will find traction, even if it has to shift to the private endeavors of underground tech pirates.

\(^{47}\)Or; “… [IP firms will] have to think about how the disappearance or unenforceability of all or part of that IPR will affect [their] business.”\(^{90}\).
**Accessing The PD Themselves**

Being cost effective in a market where a strong public domain exists is even more important because of that competition. The effects of the PD will be felt regardless of systemic changes to the IP legal regime, forcing companies to abandon costly protection procurement and enforcement methods. As a result of this shift towards the PD, IP firms will face greater challenges in competing with it, however, they can easily overcome those challenges by instead incorporating into it. The benefits provided when acting within a PD market are many, including free, limitless research and development pools, endless market access and testing resources, and marketing tools with a reach far greater than their costs belie.

There are other, more traditional benefits that come from a progression in this technology as well. Namely, if, instead of hindering the advancement of 3D printing technology, manufacturers invest in and focus on encouraging further advancement in the field, they stand to gain powerful manufacturing tools at exponential savings over traditional methods. As the technology improves with the focus on individual users, production methods simplify. When those simplifications then translate into commercial production, finishing products becomes easier and a more cost-sensitive process.

3. solutions

Legal solutions that could form a compelling reconstruction of IP regimes in consideration of this emerging technology might not even be necessary if IP holders and the manufacturing industries pursue the business advantages that could be had here unilaterally.

---

48 The primary "cost" is the cost of entry into the PD: surrender property rights to what you develop from within the PD realm. It is unlikely to see companies do so willingly (even though many already do with marked success), but with the shift we are seeing now, the choice in reality is to give up some reliance on the very IP that is already fading as it faces greater and greater challenges as the PD expands.

49 Obviously the use of this technology in such a way is already in effect, however, product-quality machines are still rather costly, even for large firms, and when technology seeps into individual use, we see real significant gains in efficiency and reduced cost in the hopes of tapping that market, which in turn transitions back into commercial uses.
Perhaps the best method could be to modify the UCC, rather than to attempt to fix the DMCA, to better protect this technology as it develops, as well as to provide for an easy transition into this market by industries. Of course, there are also some things the community of inventors and innovators could do to help grow and empower this advancement, rather than waiting for the future to be determined for them.

**Legal Modification**

The first avenue is perhaps the easiest to accomplish—modifying the UCC to empower click-shrink wrap trade. With the increasing awareness and acceptance within the courts of software licensing, it would not be too far fetched to see licensing extended to the sale of something you print at home. Seeking to modify the UCC preemptively could be beneficial, as courts often are unwilling to expand the scope of licensing in particular without direct guidance. Also, rather than relying on the slow process of legislation, changes to the UCC could be initiated by proposals to the American Law Institute. While it would not result in a necessarily hard rule, it would certainly help to guide courts should future legal issues arise from infringement on a click-shrink wrap product.

A second avenue for legal modification is through the DMCA. The DMCA could primarily benefit from redefining its goals from preventing general 'infringement' to actually stopping piracy. That would necessarily require defining piracy, and hopefully that could be done in such a way as to focus on legitimate IP piracy for commercial gain, causing actual and significant harm to the IP holders, while avoiding bringing the entire hammer of the DMCA.

---

50Click-wrap (also known as copyleft) refers to software sales online, where there is no physical product but a download of the software with a use license rather than a traditional sale. Shrink-wrap refers to the traditional sale of products you buy in a store. A combination could exist with this new technology, where manufacturers provide the design file for users to print, with a license for personal use, one print per download, etc (hence click-shrink wrap).
down on incidental or minimal infringement.\textsuperscript{51} "Congress should limit the definition of copyright piracy to complete copying or unlicensed use for industrial-scale, purely commercial use. Doing so will focus resources on those actually stealing ... [from] the copyright holder. Defining consumers as infringers and treating them as criminals for putting available technology to good use has not and will not work."(93) More emphasis should be placed on commercial gains/loses of infringers/holders, when it is appropriate. Obviously, incidental, individual infringement is not the same as willful piracy of IP for profit, yet current legal regimes do not make the distinction often enough.

Alternatively, the DMCA could lay out explicitly what it protects, and individually-created 3D CAD files could be excluded.\textsuperscript{52} While a more labor-intensive solution, it would make sense that something that provides for unparalleled enforcement would have strict and clear guidelines for its use. The type of infringement that the DMCA seeks to stop needs to be made more specific, and not stand as just general 'infringement'--the meaning of which remains a topic already in constant debate. And guidelines on what the DMCA protects are not the only area where clarifications are needed, the requirements for takedown notices also need to be expanded to more accurately reflect the power of enforcement that they have. To call down the enforcement power provided by the DMCA, someone claiming infringement should need to do more than merely send a form letter that requires no verification whatsoever.\textsuperscript{53} The inclusion of a good-faith requirement on behalf of the holder or the recipient would help alleviate some of

\textsuperscript{51}One of the primary failures of the DMCA is it's overwhelming punishment of infringement without any analysis of the scope of the infringement.
\textsuperscript{52}Naturally, there would need to be an exception for 3D CAD files being used commercially which are either based off of a copyright or patent, or were created by directly scanning a copyrighted/patented object.(94)
\textsuperscript{53}A made-up name with a statement satisfying the 'penalty of perjury' requirement, and the 'infringement' identification are all that are required to effectively generate a bad-faith takedown notice--one that would be complied with.
these bad takedown notices, but not all.\textsuperscript{54} An additional provision that requires the inclusion of a minimum standard of proof with each notice for each infringement claim, in conjunction with a good faith requirement on the recipient would be better, as it would make filing of false claims more difficult without putting too much of a burden on the recipient of the claims.

\textbf{Business Models}

Many of the modifications that could be made by the business world have already been mentioned, however accessing/utilizing the PD is only one of many routes they may take.\textsuperscript{55} Perhaps one of the more futuristic solutions would be for manufacturers and distributors to prepare to provide click-shrink wrap options for their customers.\textsuperscript{56} The amount of business currently done by Amazon is testament to how successful such a business model can be--more and more people want to buy things online and have them instantly. Even outside of the click-shrink wrap model, general traditional distribution can clearly benefit from 3D printing.

Distribution can be greatly increased at minimal cost, not only of machinery but also in space requirements as the technology gets smaller, reducing overall overhead exponentially. Even a traditional brick-and-mortar facility could benefit from utilizing 3D printers by printing products, replacement parts, or customizations right in the store, ready for sale. Manufacturing jobs that have escaped the domestic market for reduced cost internationally could come right back home as the technology proliferates. Copying could become more prevalent, however the market is far more inclined to favor high quality original products than lesser quality prints at home, especially when the cost savings from international manufacture, shipping, and other distribution

\textsuperscript{54}A bad faith effort on the part of the party filing the takedown notice would still be unenforceable so long as they maintained anonymity. A way to combat that further would be some form of required identification confirmation.(95)

\textsuperscript{55}See section V.2. supra for more on how business should seek access and participate in the PD.

\textsuperscript{56}As previously mentioned, the technology is not yet ubiquitous, and because of that this solution would be ahead of its time. However, building a business model that supports this kind of distribution would, with enough support, encourage further advancements in printing materials, overall cost, and improved print quality, all of which would in turn increase the value of a click-shrink wrap business model.
Cultural Modifications - Individuals and Communities are not Helpless

Clearly 'sit and wait' is not the right strategy if we hope to see this technology advance to the levels discussed in this paper. "... for now, the 3D printing community should focus on expanding the use of Creative Commons licenses and fighting the expansion of traditional intellectual property norms into 3D printing. This will ensure the vibrancy and innovation of the nascent 3D printing community is not crippled by legal interference."(96) The first thing that the 3D communities can do is to continue as they are; by continuing to expand the PD in leaps and bounds, offering creative commons licenses on everything the produce, keeping design files open to the world. The industrial revolution described by Rideout that will come with proliferate usage of this emerging technology will be powered and fueled by communities of developers and individual efforts more than anything else in the legal or business world, so long as it happens soon, before it gets crushed by those slower, larger entities.(97) This advancement won't be stopped, but hurdles can appear quickly as businesses who feel threatened struggle for legal interference.

VI. Why we can’t rely on the courts

There are multiple rationales for a legislative change to the current state of IP legal schemes before the increased accessibility of 3D printer technology is challenged in court. First of all, the primary rational for representative law making on this subject is the gross imbalance in any legal conflict that arises from this technology. Small groups of innovators, individual inventors, and even 14-year old children are going to be the infringers targeted by the IP

---

57A look at iTunes or any other online music distributor will show the merits of just that claim. If the songs cost around a dollar each, why wouldn't someone just purchase the high quality option from the original artist? We also see similar success in distribution companies like Steam--a computer client that provides video games to users via download, many free, and most at well below the cost of a traditional shrink-wrap option.
A complete reversal of the current manufacturing hierarchy will generate massive solidarity on the opposing side—traditional industries will spend fortunes pursuing litigation and every enforcement option available to them in order to shut down any perceived threat to their margins, rather than invest in accessing these potential new markets themselves to generate huge returns previously unavailable. \(^{58}\) With such lopsided resource allocation, it is unlikely that any court rulings will end up defending innovation, supporting the little guy, but will instead chain down the countless avenues of creation and invention enabled by this emerging technology, thanks to the guiding hands of the well-paid industry lawyers. \(^{59}\)

Of course, legislative attention is as susceptible to industry influences by way of subcommittee access, strong lobbyist firms, and pressure from political contributors within the industries. \(^{99}\) However, generally the individual should receive greater respect in a representative-directed legal regime change thanks to the greater public access and pressure from media attention during the development as opposed to after a ruling. \(^{60}\) Also supporting this venue for change is the simple procedural fact that legislative changes take greater time to garner support, go under review and amendment, and earn approval from the multiple required sources before finally becoming law. Stagnation of the law in many arenas seems counterproductive, however the current gap in IP law leaves a small advantage to the individual innovators as they will remain below the radar of these large firms and allowed to continue their innovations rather unhindered. \(^{61}\) Naturally, that depends on how focused the industry players become on shutting

---

\(^{58}\)While the hope should be that the mistakes of the past are not repeated, the manufacturing industry will unfortunately follow the same path as the music industry, and fight this emerging technology rather than utilize it. \(^{100}\)

\(^{59}\)The court history of enforcement against individual music 'pirates' provides ample examples of this problem.

\(^{60}\)This media attention causing public pressure to address the issue can be seen in the sunset of music industry litigation against teenagers and parents. Suits of the kind began to vanish the moment they became widely known, and the industry began to shift their focus to accessing the market rather than battling it.

\(^{61}\)The relative attitude of many 'makers' in this arena can be described as basically apathetic to the laws when it comes to their independent endeavors. In fact, many feel that regulations goings against the developments and
down the online sharing of designs and innovative ideas by way of DMCA takedown notices. That would necessitate immediate action by the legislature to rectify this hole in the IP legal scheme. Hopefully the current Lentz case will help reduce these takedowns to a degree, but as I discussed it's more likely that it will merely encourage firms to better hide their identities, and since there is no good-faith requirement or even basic analysis of claims required of OSP's who receive these notices the affect of Lentz will likely be superficial. (101)

VII. Conclusion

Existing IP legal regimes are woefully insufficient to deal with this emerging technology, and without direct attention could in fact stifle this positive advancement. IP law could not foresee this method of production and in fact that is the main reason that no existing framework seems to fit 3D printing quite right. The holes in the various IP schemes all seem to apply to 3D printing, so it makes sense to expect that IP firms will strive for expansion of those schemes to cover the variety of inefficiencies. This would further hinder development and likely stifle many forms of invention by way of fear of infringing on any number of confusing, overlapping, over-reaching legal systems. Too much IP performs in opposition to the foundational goals for the creation of the system in the first place; to support and encourage the development of ideas.

The most difficult aspect of this technology that relates directly to those legal issues, is the issue of enforcement. With no accurate, direct method of protection applying 100% to 3D printing, holders are left using whatever they can. Of course, they have an easy kill-switch in the form of the DMCA--its excessive punishments, vague definitions, and complete lack of ideas that empower their projects are evils, and that the appropriate response is to rebel against them in willful violation. This can be seen throughout the comments on any of the blogs or articles related to 3D printer DRM or other anti-piracy measures. For example: “This is just too funny! :P I am laughing my ass off...so hard. You idiots, I'll print whatever the hell I want whenever I want, no DRM is going to stop me! :P” or, “Lol, like I care about DRM and U.S. Patents. I'll print whatever I want whenever I want and in quantity I want,” or, “DRM isn't going to stop 3D printing -- all you need are the plans to print a DRM-free 3D printer.” (102)(103)(104)

62For all of the reasons supra, this is their most likely attack method based on both the zero/minimal cost and high probability of success.
limitation or measure of accountability make it the perfect weapon against this technology, especially considering that the primary driving force behind this new emergence comes from online communities. Actual willful infringement by piracy enterprises is not targeted any differently by the current regime than individual and incidental infringement, or even if it constitutes actual infringement at all. An important shift in focus from general 'infringement' to targeting willful infringement on a larger scale than personal use (or even small scale infringement for commercial gain) would help improve enforcement immensely while protecting the individuals that are the driving force behind this technology.

In section V on what I call reconstructing the world of IP, I discussed solutions for helping to deal with the problems this emerging disruptive technology causes in the legal and business worlds. Near the completion of this paper, I was able to do a brief phone interview with Terry Wohlers, President of Wohlers Associates.63 I asked him in general about the issues that I discussed within this paper, but he does not share my vision of the future of 3D printing. He believes that most consumers will engage with 3D printing on the web by buying products from sites like Shapeways and Amazon, custom products to be delivered. He also said that it is fine for do-it-yourselfers but it's not user-friendly enough for mainstream use, and even if you have a home-based system, it wouldn't make the kinds of parts you want to make because of color, material, and surface limits. I disagree. I feel that his statements regarding the current state of affairs within the industry, especially the user-friendliness issue, precisely mirror statements made in the late 1980's about computers, or internet usage itself in the early 1990's. This sort of belief is typical of emerging technologies just as they begin to break into individual uses, and as we have seen, they only become exponentially more affordable, more effective, and

---

63 Wohlers Associates are an independent consulting firm in the 3D printing and additive manufacturing industry. They have been in the business for over twenty years and release a yearly report on the state of the industry that is considerably relied on by all industry participants.
easier to use. He did however mention the fact that while 3D printing has been used since the late 1980's as a prototyping platform, it has been more recently by the aerospace and medical industries as a seed for actual production parts.\(^{(107)}\) This exemplifies the advancements made more than any other statistic in the industry because of the accuracy and quality required of production parts in the aerospace and medical fields.\(^{64}\)

In the interview, Wohlers also described the three biggest problems within the legal arena that this technology affects; the first is the challenge to IP law, which has been discussed here at length, but the other issues I had not considered.\(^{65}\) The first issue is that of product liability. This technology is not only disruptive to IP regimes, but it also disrupts the concept of a defined supply chain. Wohlers said that while today we have a defined supply chain where if a product fails and causes damage, it is pretty easy to point to the source. In the future it will be more difficult to track that chain because someone can design it, it can be sold, then that design can get modified by someone else and sold again, resulting in a nontraditional and undefined supply chain.\(^{108}\) The second issue brought to light by Wohlers is that of insurance, and the confusion and problems that will come from the disruption in traditional supply chains he described earlier.\(^{109}\)

In summary, 3D printing technology needs to be encouraged and protected, rather than attacked and vilified. If IP regimes are not expanded to become even more confusing and

\(^{64}\)This fact Wohlers believes is the greatest sign of advancement the industry has seen in the past three years. While I agree that usage in those high-demand industries is testament to how far a technology has come, I believe that it goes even further in showing how far the technology has yet to go. The advancements that have come out of both industries once they begin to really harness a specific technology are developments that resound through the market. Improvements to a method utilized in both fields directly result in improvements to methods outside them, increasing the viability and proliferation of the method at ever level from individual to commercial manufacturer.

\(^{65}\)He did mention that in terms of IP systems, we will see even more infringement in the future. The ease at which someone can copy a design and print it is really changing the rules to product design and manufacture. It used to take great expense to copy something, but it has never been easier, and that will only become more possible in the future."

\(^{(110)}\)
overlapping, but rather are more narrowly defined in consideration of the variety of types of infringement related to the use of 3D printers, inventiveness will be encouraged and this technology will continue to advance. The future possibilities are endless; from remotely printing food in developing nations or in response to emergencies, to printing replacement organs out of living tissue, all that and more will be a result of rampant development and use of 3D printing.

The business benefits alone are astounding--imagine companies suddenly finding themselves with drastically reduced (or even zero) shipping costs, distribution costs, and development/R&D costs. Outsourced manufacturing could become outdated, replaced with national manufacturing once again. Empowering this technology will result in exponential improvements to everyday life as we know it.
REFERENCES


3. Laurent Bach, Patrick Cohendet, Julien Penin, Laurent Simon, Creative industries and the IPR dilemma between appropriation and creation: some insights from the videogame and music industries, 14(3) Management International 59, 60 (2010).


5. Bach et al, supra.


8. Bach et al, supra.


10. Id.


13. Ramello, supra.


16. Weinberg, supra.
17. Johnson, supra.
18. Regalado, supra.


29. Weinberg, supra.
30. Weinberg, supra.
31. Weinberg, supra.
32. Rideout, supra.
33. Katz, supra.
34. Rao et al, supra, at 83.

36. A&M Records, Inc. v. Napster, Inc., 239 F.3d 1004 (9th Cir. 2001) (Record companies and music publishers brought copyright infringement action against Napster, an Internet service that facilitated the transmission and retention of digital audio files by its users).


39. GK Workbench, supra.


42. Id.
43. Bach et al, supra.
44. Regalado, supra.
45. Regalado, supra, citing Weinberg.
48. DMCA, supra.
50. Rideout, supra.
51. Katz, supra.
52. Bach et al, supra.
53. Rideout, supra, at 167.
55. DMCA, supra.


57. Rideout, supra.
58. GK Workbench, supra.
59. Rideout, supra.
60. Id.
61. Id. at 166.
62. Id.
63. GK Workbench, supra.
64. Id.
65. Rideout, supra.
67. Katz, supra.
68. Id.
69. Regalado, supra.
71. Katz, supra.
72. Bach et al, supra.
73. Katz, supra, at 45.
74. Bach et al, supra.
75. Rao et al, supra, at 84.
77. Id. at 268.
78. Id. at 275.
79. Wachter, supra.
80. Id. at 5.
81. Id. at 9.
82. Katz, supra.
83. Weinberg, supra.
84. Bach et al, supra.
85. Ramello, supra.
86. Rideout, supra.
87. Maxwell, supra.
88. Wachter, supra.
89. Id. at 11
90. Id.
91. Wachter, supra.
94. Rideout, supra.
95. Id.
96. Id. at 10.
97. Rideout, supra.
98. Vance, supra.
100. Id.
101. Lenz, supra.

102. thedude321, comment to 3D Printer DRM Patent To Stop People Downloading a Car, supra.

103. Anime 4 PSP, comment to 3D Printer DRM Patent To Stop People Downloading a Car, supra.

104. AJ84, comment to 3D Printer DRM Patent To Stop People Downloading a Car, supra.

106. Id.
107. Id.
108. Id.
109. Id.
110. Id.