IP IN A WORLD WITHOUT SCARCITY

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Things are valuable because they are scarce. The more abundant they become, the cheaper they become. But a series of technological changes is underway that promises to end scarcity as we know it for a wide variety of goods. The Internet is the most obvious example, because the change there is furthest along. The Internet has reduced the cost of production and distribution of informational content effectively to zero. More recently, new technologies promise to do for a variety of physical goods and even services what the Internet has already done for information. The role of intellectual property (IP) in such a world is both controverted and critically important. Efforts to use IP to lock down the Internet have so far failed to stem the unauthorized distribution of content. But contrary to the predictions of IP theory, the result of that failure has not been a decline in creativity. To the contrary, creativity is flourishing on the Internet as never before despite the absence of effective IP enforcement. That is a problem for IP theory, which may not be the main driver of creativity in a world where creation, reproduction, and distribution are cheap. That is increasingly the world in which we will live.

 Thanks to Yochai Benkler, Ryan Calo, Julie Cohen, Deven Desai, Graeme Dinwoodie, David Engstrom, Paul Geller, Paul Goldstein, Rose Hagan, Dan Ho, Martin Kretschmer, Mike Linksvayer, Mark McKenna, Lisa Larrimore Ouellette, Josh Walker, and participants in workshops at Yale Law School, Stanford Law School, Notre Dame Law School, Hastings Law School, WIP-IP, and the EPIP conference for comments on an earlier draft.

INTRODUCTION

Economics is based on scarcity. Things are valuable because they are scarce. The more abundant they become, the cheaper they become. But a series of technological changes is underway that promises to end scarcity as we know it for a wide variety of goods. The Internet is the most obvious example, because the change there is furthest along.[1] The Internet has reduced the cost of reproduction and distribution of informational content effectively to zero. In many cases it has also dramatically reduced the cost of producing that content. And it has changed the way in which information is distributed, separating the creators of content from the distributors. On the Internet today, a variety of intermediaries like search engines and Web hosts enable access to information for free or at a very low cost. Those intermediaries are agnostic about (and quite often ignorant of) the content they are distributing. In short, the Internet has not only slashed the cost of creation, production, and distribution; it has also disaggregated creation and distribution. I can create without distributing, secure in the knowledge that my works will be disseminated by others who distribute without creating.

More recently, new technologies promise to do for a variety of physical goods and even services what the Internet has already done for information. 3D printers can manufacture physical goods based on any digital design.[2] While home 3D printers are so far quite limited in size and materials, there are tens of thousands of printing designs available on the Internet already, and larger commercial-scale printers can print anything from circuit boards to rocket engines to human organs on site for the cost of the raw materials and some electricity. Synthetic biology has automated the manufacture of copies of not just existing genetic sequences, but also any custom-made gene sequence, allowing anyone who wants to create a gene sequence of their own to upload the sequence to a company that will "print" it using the basic building blocks of genetics.[3] And advances in robotics generalize the

[1] *See infra* Part I.B.
[2] *See infra* Part I.C.1.
[3] *See infra* Part I.C.2.

principle beyond goods, offering the prospect that many of the services humans now supply will be provided free of charge by general-purpose machines that can be programmed to perform a variety of complex functions.[4] While none of these technologies are nearly as far along as the Internet, they share two essential characteristics with the Internet: They radically reduce the cost of production and distribution of things, and they separate the informational content of those things (the design) from their manufacture. Combine these four developments—the Internet, 3D printing, robotics, and synthetic biology—and it is entirely plausible to envision a not-too-distant world in which most things that people want can be downloaded and created on site for very little money—essentially the cost of raw materials. Jeremy Rifkin calls this the "zero marginal cost society."[5]

The role of IP in such a world is both controverted and critically important. IP rights are designed to artificially replicate scarcity where it would not otherwise exist. In its simplest form, IP law takes public goods that would otherwise be available to all and artificially restricts their distribution. It makes ideas scarce because then we can bring them into the economy and charge for them, and economics knows how to deal with scarce things. So on one view, the classical view of IP law, a world in which all the value resides in information is a world in which we need IP everywhere—controlling rights over everything—or no one will get paid to create.[6]

That has been the response of IP law to the Internet so far,[7] but that response is problematic for a couple of reasons. First, it doesn't seem to be working. By disaggregating creation, production, and distribution, the Internet democratized access to content. Copyright owners have been unable to stop a flood of piracy even with fifty thousand lawsuits, a host of new and increasingly draconian laws, and a well-funded public education campaign that starts in elementary school.[8] They might have more success targeting the intermediaries rather than the individuals consuming content, but because those intermediaries distribute content without regard to what it is, IP law can block piracy there only at the cost of killing off what is good about the Internet. Utility patent and design patent owners may soon face the same conundrum: Unless they strictly control and limit the sale and manufacture of 3D printers and gene printers, they may find

[4] *See infra* Part I.C.3.

[5] JEREMY RIFKIN, THE ZERO MARGINAL COST SOCIETY 9 (2014).

[6] *See infra* notes 104–06 and accompanying text.

[7] *See infra* notes 111–14 and accompanying text.

[8] For a discussion of the copyright owners' response to the Internet, see *infra* notes 110–14 and accompanying text.

themselves unable to prevent the production of unauthorized designs. And even targeting the intermediaries may prove futile; among the things you can print with a 3D printer is another 3D printer.[9] The world of democratized, disaggregated production may simply not be well-suited to the creation of artificial scarcity through law.

Second, even if we could use IP to rein in all this low-cost production and distribution of stuff, we may not want to. The rationale for IP has always been not to raise prices and reduce consumption for its own sake, but to encourage people to create things when they otherwise wouldn't. More and more evidence casts doubt on the link between IP and creation, however. Empirical evidence suggests that offering money may actually stifle rather than encourage creativity among individuals.[10] Economic evidence suggests that quite often it is competition, and not the lure of monopoly, that drives corporate innovation.[11] The Internet may have spawned unprecedented piracy, but it has also given rise to the creation of more works of all types than ever before in history, often by several orders of magnitude. Perhaps the Internet has so reduced the cost of creation that more people will create even without an obvious way to get paid. Or perhaps they never needed the motivation of money, just the ability to create and distribute content. Either way, if the goal of IP is to encourage the creation of new works, the example of the Internet suggests that for an increasingly important range of creative works, radically reducing the cost of production decreases rather than increases the need for IP law.

Some scholars have responded to doubts about the traditional justification for IP by offering alternative justifications for IP. But the most common alternatives fare no better than the incentive story in this new world. Commercialization theory, which postulates that we need IP not to encourage creation but to encourage production and distribution of works,[12] is particularly vulnerable to disruption by cost-reducing technologies like the Internet, 3D printers, and gene printers. It may once have been true that even if a book was cheap to write, printing and distributing it took a substantial investment that had to be recouped. But the development of technologies that disag-

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[9] Lauren Orsini, *10 Crazy Things 3D Printers Can Make Today*, READWRITE (Feb. 14, 2014), http://readwrite.com/2014/02/14/3d-printing-printers-projects-applications-prints.

[10] *See infra* note 163 and accompanying text.

[11] *See, e.g.*, Kenneth J. Arrow, *Economic Welfare and the Allocation of Resources for Invention*, *in* THE RATE AND DIRECTION OF INVENTIVE ACTIVITY: ECONOMIC AND SOCIAL FACTORS 609, 619–20 (Richard Nelson ed., 1962), *available at* http://www.nber.org/chapters/c2144.pdf ("[T]he incentive to invent is less under monopolistic than under competitive conditions.").

[12] *See infra* note 167.

gregate creation from production and distribution, and reduce the cost of the latter to near zero, mean that commercialization-based theories cannot justify IP in the face of new technologies. And the theory that we need IP rights to prompt disclosure of things that would otherwise be kept secret also seems rather quaint.[13] Perhaps it made sense in a world where transmission of information was difficult, but in a world in which information flows freely keeping secrets becomes the exception rather than the rule.

Far from necessitating more IP protection, then, the development of cost-reducing technologies may actually weaken the case for IP. If people are intrinsically motivated to create (as they seem to be),[14] then the easier it is to create and distribute content, the more content is likely to be available even in the absence of IP. And if the point of IP is to encourage either the creation or the distribution of that content, cost-reducing technologies may actually mean we have less, not more, need for IP.[15]

None of this is to say that IP will, or should, disappear entirely or overnight. The cost of producing and distributing content has fallen (and will continue to fall) at uneven rates. Some content, like blockbuster action movies and video games, may be expensive to make for years to come. Other content, like pharmaceuticals, may remain

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[13] For discussion, see, for example, Jeanne C. Fromer, *Patent Disclosure*, 94 IOWA L. REV. 539, 542 (2009) (explaining disclosure theory and its role in the patent system); Mark A. Lemley, *The Myth of the Sole Inventor*, 110 MICH. L. REV. 709, 745 (2012) (critiquing the theory for being unable to justify the modern patent system); Lisa Larrimore Ouellette, *Do Patents Disclose Useful Information?*, 25 HARV. J.L. & TECH. 545, 557 (2012) (explaining that many patent scholars are critical of disclosure theory).

[14] *See infra* notes 159–60 and accompanying text.

[15] To be sure, there are some who make nonconsequentialist moral claims for IP ownership. *See, e.g.*, ROBERT P. MERGES, JUSTIFYING INTELLECTUAL PROPERTY 3 (2011) (noting a tendency of courts to talk about IP rights as rights, despite the use of current economic tools); Adam Mossoff, *Who Cares What Thomas Jefferson Thought About Patents? Reevaluating the Patent "Privilege" in Historical Context*, 92 CORNELL L. REV. 953 (2007) (arguing that patent rights were historically defined using social contract doctrine and the labor theory of property). There is also literature that makes moral claims for some limits on IP. *See, e.g.*, Anupam Chander & Madhavi Sunder, *Copyright's Cultural Turn*, 91 TEX. L. REV. 1397, 1404 (2013) (reviewing JULIE E. COHEN, CONFIGURING THE NETWORKED SELF: LAW, CODE, AND THE PLAY OF EVERYDAY PRACTICE (2012)) (hoping to supplement the traditional economic approach to IP by looking at the social sciences and humanities); Madhavi Sunder, *IP*^{3}, 59 STAN. L. REV. 257, 313–15 (2006) (elaborating on a cultural analysis of IP law in the hopes of offering normative guidance); *cf.* Amy Kapczynski, *The Cost of Price: Why and How to Get Beyond Intellectual Property Internalism*, 59 UCLA L. REV. 970 (2012) (attempting to move beyond price, though not necessarily beyond utilitarianism, in evaluating IP). Because those theories treat having an IP right as an end in itself, and one whose value cannot be measured on a utilitarian scale, their advocates may not be swayed by evidence that IP will in the future do more harm than good. While I find those theories thoroughly unpersuasive, it is not my intention to address them here.

expensive because regulatory barriers raise the cost even as design and manufacturing become cheap. 3D printing, too, may work cheaply and easily for some kinds of goods but less well for others, at least at first. And the case for IP is at its strongest for things that are very expensive to make but cheap to copy. But increasingly, those justified instances of IP will become islands in a sea of cheap goods, content, and even services delivered to your home in the form of digital information.

I have argued elsewhere that IP rights are a form of government regulation of market entry and market prices.[16] We regulated all sorts of industries in the twentieth century, from airlines to trucking to telephones to electric power, often because we couldn't conceive of how the industry could survive without the government preventing entry by competitors. Towards the end of that century, however, we experimented with deregulation, and it turned out that the market could provide many of those services better in the absence of government regulation.[17] The same thing may turn out to be true of IP regulation in the twenty-first century. We didn't get rid of all regulation by any means, and we won't get rid of all IP. But we came to understand that the free market, not government control over entry, is the right default position in the absence of a persuasive justification for limiting that market. The elimination of scarcity will put substantial pressure on the law to do the same with IP.

A world without scarcity requires a major rethinking of economics, much as the decline of the agrarian economy did in the nineteenth century.[18] How will our economy function in a world in which most of the things we produce are cheap or free? We have lived with scarcity for so long that it is hard even to think about the transition to a post-scarcity economy. IP has allowed us to cling to scarcity as an organizing principle in a world that no longer demands it. But it will no more prevent the transition than agricultural price supports kept us all farmers. We need a post-scarcity economics, one that accepts rather than resists the new opportunities technology will offer us. Developing that economics is the great task of the twenty-first century.[19]

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[16] Mark A. Lemley, *Taking the Regulatory Nature of IP Seriously*, 92 TEX. L. REV. SEE ALSO 107, 107 (2014); Mark A. Lemley, *The Regulatory Turn in IP*, 36 HARV. J.L. & PUB. POL'Y 109, 110–11 (2013).

[17] *See infra* note 216 and accompanying text (providing several examples of successful deregulation).

[18] *See infra* notes 249–53 and accompanying text (describing the need to devote less labor and capital to food production as the first move towards a post-scarcity world).

[19] To be sure, economics has a variety of tools for analyzing markets that differ from the norm. We have economic theories to deal with public goods and natural monopolies in

In Part I, I discuss the traditional economics of scarcity and outline the new technologies that are poised to create an economics of abundance. In Part II, I explore how IP will and should react to those new technologies, using evidence from the Internet as an example. Finally, in Part III, I offer some speculations both as to what an economics of abundance would look like and what role IP might play in such a world.

I
BEYOND SCARCITY

A. The Traditional Economics of Goods and Information

Our economy is based on scarcity. We pay for things because it takes resources—land, raw materials, human labor—to produce them. In general, the more resources it takes to produce them, the more we pay.[20] The most fundamental graph in economics shows a supply curve and a demand curve.[21] The supply curve slopes up because resources are scarce, and the demand curve slopes down because money too is scarce. Generally speaking, markets meet in the middle—when it costs more to make something than people are willing to pay for it, manufacturers stop making it. When there are exceptions—when customers are willing to pay a great deal for something that is cheap to make—the producer may make a substantial profit in the short term. But in the long run, other producers, attracted by the high profit margin, enter and offer the cheap product at a lower price, competing away the extra profit margin. Price settles at marginal cost.[22]

The economics of information are somewhat different. Information is a public good; that is, "one that is non-rivalrous and difficult to

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which the marginal cost of producing and distributing goods is zero or very small in relation to the fixed cost of creating those goods. *E.g.*, PAUL A. SAMUELSON & WILLIAM D. NORDHAUS, ECONOMICS 173–75, 272 (19th ed. 2010). But to date those theories have taken the form either of attempts to raise the marginal cost through mechanisms like IP or having the government provide the good on the assumption that private parties won't. *See, e.g.*, J. Bradford DeLong & Lawrence H. Summers, *The "New Economy": Background, Historical Perspective, Questions, and Speculations*, ECON. REV., Fourth Quarter 2001, at 29, 51, *available at* http://www.kc.frb.org/publicat/econrev/Pdf/4q01delo.pdf (defending IP as a way to "give producers the right incentives"); Harold Hotelling, *The General Welfare in Relation to Problems of Taxation and of Railway and Utility Rates*, 6 ECONOMETRICA 242, 242 (1938) (discussing the need for government regulation of public goods).

[20] *See* SAMUELSON & NORDHAUS, *supra* note 19, at 4 (explaining how the price of goods is dependent on the limited resources we have to produce them).

[21] *Id*. at 55 fig.3-7.

[22] *See, e.g.*, DeLong & Summers, *supra* note 19, at 16 ("[T]he most basic condition for economic efficiency [is] that price equal marginal cost.").

exclude non-payers from using."[23] Unlike, say, ice cream, my consuming information doesn't prevent you from also consuming it. Accordingly, the marginal cost of producing information approaches zero (though the physical goods in which information has traditionally been encapsulated, such as books, do cost money to produce and distribute).

Economists worry that things—goods or information—that cost a lot to develop but little or nothing to copy will be underproduced because the ease of copying means producers won't be able to charge enough to recoup their investment in making the thing in the first place.[24] For most public goods, the traditional solution is to regulate market entry, designating one company as the exclusive provider of, say, electric power or telephone or cable service, for a particular region and allowing that company to make up its fixed costs by charging its captive customers a price above marginal cost.[25] The IP laws take a similar approach, creating a right to exclude competition in a particular piece of information so that the creator can make up its fixed costs by charging customers a price above marginal cost.[26] Unlike more traditional regulated industries, however, the government does not regulate the price IP owners can charge, but instead relies on some combination of the temporary duration of the IP right and imperfect competition from other inventions to keep prices in line.[27]

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[23] Tim Wu, The Law & Economics of Information 1 (2013) (unpublished manuscript) (on file with the *New York University Law Review*); *see also* ROBERT P. MERGES ET AL., INTELLECTUAL PROPERTY IN THE NEW TECHNOLOGICAL AGE 12–13 (6th ed. 2012) ("Selling information requires disclosing it to others. Once the information has been disclosed outside a small group, however, it is extremely difficult to control."). *But see* Wu, *supra*, at 5 ("Some scholars, like Christopher Yoo, Amy Kapczynski, and Talha Syed argue that non-excludability shouldn't be considered a defining feature of information at all.").

[24] WILLIAM M. LANDES & RICHARD A. POSNER, THE ECONOMIC STRUCTURE OF INTELLECTUAL PROPERTY LAW 11 (2003); *see also* F.M. SCHERER, INDUSTRIAL MARKET STRUCTURE AND ECONOMIC PERFORMANCE 444 (2d ed. 1980) ("If pure and perfect competition in the strictest sense prevailed continuously . . . incentives for invention and innovation would be fatally defective without a patent system or some equivalent substitute.").

[25] *See* SAMUELSON & NORDHAUS, *supra* note 19, at 175 (discussing how governments give franchise monopolies to utilities).

[26] LANDES & POSNER, *supra* note 24, at 11; Mark A. Lemley, *The Economics of Improvement in Intellectual Property Law*, 75 TEX. L. REV. 989, 993–97 (1997).

[27] On imperfect competition in IP, see, for example, Michael Abramowicz, *An Industrial Organization Approach to Copyright Law*, 46 WM. & MARY L. REV. 33, 45–48 (2004) (explaining how imperfect competition arises in copyright); Christopher S. Yoo, *Copyright and Product Differentiation*, 79 N.Y.U. L. REV. 212, 218–19 (2004) (noting that copyright law does not necessarily confer monopoly power, but rather limited power to differentiate products); Christopher S. Yoo, *Copyright and Public Good Economics: A Misunderstood Relation*, 155 U. PA. L. REV. 635, 706–14 (2006) (treating copyright as an

In effect, the point of IP laws is to take a public good that is naturally nonrivalrous and make it artificially scarce, allowing the owner to control how many copies of the good can be made and at what price. In so doing, IP tries to fit information into the traditional economic theory of goods. The fit is imperfect, though, both because IP's restriction on competition creates a deadweight loss to consumers who would have bought the good at a lower price and because the very existence of the IP right means that competition cannot discipline pricing in the same way it does for goods.

A series of technological changes promise to remake this basic economics in the coming decades. They will do so not by repealing the basic laws of economics, but by fundamentally changing both the cost and the nature of the supply side of the equation.

B. The Internet and Information Economics

I begin with the most familiar example: the Internet. It has become trite to observe that the Internet has remade the economics of information. Many lament the risk to old business models,[28] while others praise the benefits of instant access to almost all the world's information.[29] I will discuss the effects of these changes below. For now, though, it is worth focusing attention on what exactly the Internet changed about content distribution.

1. Content Creation and Distribution Before the Internet

Before the Internet, the creation and distribution of content was a large-scale business operation. While anyone could write a song or a movie script, actually producing a record or a movie required commercial facilities. Further, even for industries where the creation of content was fairly cheap (say, writing a book, which didn't require much more than a typewriter), distributing that work to a wide audience required a commercial network. Writing a book may have been cheap, but printing that book required a substantial factory, and distributing it to the masses required a fleet of trucks and a network of brick-and-mortar stores. And the companies that owned those

impure public good). For an argument that more IP rights confer more power over price than previously suspected, see Mark A. Lemley & Mark P. McKenna, *Is Pepsi Really a Substitute for Coke? Market Definition in Antitrust and IP*, 100 GEO. L.J. 2055, 2081–91 (2012).

[28] *See, e.g.*, JARON LANIER, WHO OWNS THE FUTURE? 51 (2013) ("Copying a musician's music ruins economic dignity.").

[29] *See, e.g.*, LAWRENCE LESSIG, THE FUTURE OF IDEAS: THE FATE OF THE COMMONS IN A CONNECTED WORLD 265 (2001) ("I think we should embrace the era of plenty, and work out how to mutually live in it." (quoting John Gilmore)).

factories, trucks, and stores invested the most in producing and distributing a work and accordingly took the lion's share of the revenue from the sale of that work (often 80% or more, as with major label record and book publishing contracts).[30]

Notably, it was not just the distribution of legitimate copyrighted content that required a substantial investment; counterfeiting did too.[31] Anyone who wanted to sell fake records or counterfeit books in the 1970s had to invest in a facility to manufacture the physical goods, a network to distribute those copies to "retailers," and a group of people to sell the goods—all while avoiding the watchful eyes of the police. True, the retailers may have had lower overhead operating from a card table on a street corner than they would operating from a permanent store. But as counterfeiters grew in scale, they faced increased costs and a greater chance of detection.

Copying other types of works, like movies, was virtually impossible until the development of the VCR in the late 1970s. In the 1980s, the development of audiocassette tapes allowed individual consumers to copy music from each other or over the airwaves. Both technologies prompted dire warnings that counterfeiting would cause the collapse of the content industries.[32] In fact, however, both technologies suffered from many of the same limitations as previous ones. They may have allowed end users to engage in small-scale personal copying more easily, but they did nothing to change the fundamental economics of counterfeiting as a business.

2. The Internet Changes Things

The Internet (and digital media more generally) brought two related changes that fundamentally altered this dynamic. First, the rise of digital media permitted the separation of the act of creation from the acts of production and distribution. A new creative work could now be instantiated entirely as information, rather than as a physical product that itself had to be reproduced. Creative works had (mostly) always existed as conceptual things separate from their physical form; the 1976 Copyright Act makes it clear that the copyrighted "work" is

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[30] *See, e.g.*, Courtney Love, *Courtney Love Does the Math*, SALON (June 14, 2000), http://www.salon.com/2000/06/14/love_7/ (explaining how the economics of record label contracts are stacked against artists, and noting that getting even 20% of revenues before recoupment is unlikely). As Love puts it, "[t]he system's set up so almost nobody gets paid." *Id.*

[31] *See* Mark A. Lemley & R. Anthony Reese, *Reducing Digital Copyright Infringement Without Restricting Innovation*, 56 STAN. L. REV. 1345, 1373–74 (2004) (documenting this shift in costs).

[32] For discussion of this history, see Mark A. Lemley, *Is the Sky Falling on the Content Industries?*, 9 J. ON TELECOMM. & HIGH TECH. L. 125 (2011).

separate from a "copy" that embodies that work, even if (as with an oil painting) the only embodiment of the work is in that physical copy.[33] Buying a physical copy of something—even the only physical copy—doesn't give you rights in the copyrighted work embodied in that copy. But with the rise of digital technology, the work could be created entirely as information. This happened first with text; books have been written in computers rather than on paper for some time. Today, music, movies, and art can all be made entirely of information.[34]

This led to a second, related change: the democratization of content distribution. Once a work could be instantiated entirely in information, the copying of that work no longer required a factory to produce it or a fleet of trucks and stores to distribute it. The work could be transmitted to others with no loss of quality and at virtually no cost. The fact that distribution was so cheap, in turn, meant that anyone could do it. Artists didn't have to distribute their own work (or have book publishers or record companies do it for them). Anyone can (and almost everyone does) distribute content in digital form.

The combined effect of these changes was to fundamentally alter the economics of the creative industries.[35] Existing content is no longer scarce. Once created, it costs virtually nothing to reproduce, and anyone can copy and distribute it. On the one hand, this is an enormous boon to artists. You no longer need to turn over 80% of your revenues to a major label record company in exchange for the company mass-producing hundreds of thousands of plastic discs and shipping them to retail stores around the country. Want your music available to a global audience? Click a few buttons and it's done.

On the other hand, the democratization of content distribution has also fundamentally changed the nature of IP infringement. Counterfeiters too no longer need to build factories or hire trucks and teams of retailers. Indeed, counterfeiting as a business seems in just as

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[33] 17 U.S.C. § 101 (2012) (defining both "fixed" and "literary work" by distinguishing the intellectual creation from its tangible physical embodiment). For a discussion of the history of copyright as moving further and further away from protecting physical embodiments toward protecting more abstract information concepts, see David Nimmer, *Copyright and the Fall Line*, 31 CARDOZO ARTS & ENT. L.J. 803, 811–13 (2013).

[34] Notably, some kinds of creative works, like choreography or sculpture, are harder to instantiate in digital form. What is captured in information is usually a representation of the thing that differs in certain respects from the thing itself. But works of that sort have always been the hardest to copy.

[35] *See* John M. Newman, *Copyright Freeconomics*, 66 VAND. L. REV. 1409, 1412 (2013) (describing how readily available, zero-price content has given rise to an era of "copyright freeconomics").

much jeopardy as the major record labels from the rise of the amateur copyist. The democratization of copying and distribution has made it far easier than ever before in history to communicate content to others. But by eliminating scarcity, it may have made it harder than ever before to get paid for doing so.[36]

C. The Coming Information Economics of Things

While the changes the Internet has wrought in digital content are well known, what is less well known is that a similar set of changes is poised to sweep through the economy of goods and even services. In this section, I discuss three new technologies that promise the same sort of changes for goods and services that the Internet has brought for content.[37] Each of these technologies is at an early stage; there are many obstacles on the path to success. But each has the potential to revolutionize a sector of our economy—not next year, but certainly in our lifetimes.

1. 3D Printing

Perhaps the best known of these new technologies is 3D printing. As the name suggests, 3D printing is a developing technology that converts information into a physical item, just as regular computer printing does—with the twist that the physical item exists in three dimensions rather than only two. A typical 3D printer will use as input a form of extruded plastic. The user loads a blueprint into the computer attached to the 3D printer, and the printer deposits the plastic, layer by layer, until it has made a 3D object.[38]

3D printing is in its infancy as a technology, but already the potential for transformation is clear. Cheap, home 3D printers can already print spare parts, small sculptures, and a variety of household goods. 3D printers can print operable mechanical objects, including

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[36] Harry Surden argues that the true scope of IP law is a function not only of the law on the books, but also of the technological cost of creation and copying. Harry Surden, *Technological Cost as Law in Intellectual Property*, 27 HARV. J.L. & TECH. 135, 137 (2013). Thus, as the cost of reproduction changes and technology exceeds its past limits, the implicit constraints of positive law can dissipate, and "activities can become dramatically more expansive in capacity and can acquire entirely new and expansive properties that were previously infeasible." *Id.* at 139.

[37] Rifkin offers other examples, notably crowd-sourced production of renewable energy, the sharing economy, and the "Internet of Things." RIFKIN, *supra* note 5, at 69–88, 234–40.

[38] For a discussion of the basics of 3D printing, see, for example, Daniel Harris Brean, *Asserting Patents to Combat Infringement via 3D Printing: It's No "Use,"* 23 FORDHAM INTELL. PROP. MEDIA & ENT. L.J. 771 (2013); Charles W. Finocchiaro, *Personal Factory or Catalyst for Piracy? The Hype, Hysteria, and Hard Realities of Consumer 3-D Printing*, 31 CARDOZO ARTS & ENT. L.J. 473 (2013).

clocks and (infamously) a plastic gun.[39] Larger, more expensive 3D printers, though once mostly in use at manufacturing facilities or at foundries like Shapeways,[40] are also available for consumer use at Staples.[41] They can print from a variety of different raw materials, including metal powders, fabrics,[42] and even paper that can simulate wood products,[43] and can therefore make much more complicated devices.[44] People print anything from clothes to kayaks.[45] 3D printers are even printing functional electronic equipment.[46] Some manufacturing facilities have switched to making complex devices such as jet turbines and rocket engines on 3D printers because the printers replicate things exactly every time and therefore reduce error tolerance.[47] The ground-up assembly process makes it possible to print shapes that

[39] *See, e.g.*, Nora Freeman Engstrom, Essay, *3-D Printing and Product Liability: Identifying the Obstacles*, 162 U. PA. L. REV. ONLINE 35, 36 (2013) (describing 3D-printed guns); MAKERBOT (May 12, 2014), http://www.thingiverse.com/thing:328569 (showing images of 3D-printed clocks). For a catalog of other remarkable 3D printing successes, see Matthew Adam Susson, Watch the World "Burn": Copyright, Micropatent and the Emergence of 3D Printing 12–18 (April 2013) (unpublished manuscript), *available at* http://works.bepress.com/cgi/viewcontent.cgi?article=1005&context=matthew_susson (describing other 3D-printed objects such as small-scale Aston Martins, a prosthetic beak, and jet engines).

[40] SHAPEWAYS, http://www.shapeways.com (last visited Sept. 12, 2014).

[41] Sean Buckley, *Staples Is Launching an In-Store 3D Printing Service*, ENGADGET (Apr. 10, 2014, 11:05 PM), http://www.engadget.com/2014/04/10/staples-is-launching-an-in-store-3d-printing-service/.

[42] *Category Archives: Fashion*, 3D PRINTING INDUSTRY, http://3dprintingindustry.com/fashion (last visited Nov. 4, 2014).

[43] RIFKIN, *supra* note 5, at 95 ("Staples, the office supply company, has introduced a 3D printer, manufactured by Mcor Technologies, in its store in Almere, the Netherlands, that uses cheap paper as feedstock. The process, called selective deposition lamination (SDL), prints out hard 3D objects in full color with the consistency of wood.").

[44] *See* Brean, *supra* note 38, at 780 (citing more examples like food-safe ceramics for dishware and a titanium replacement jaw).

[45] Paul Ridden, *World's First 3D-Printed Kayak Takes to the Water*, GIZMAG (Mar. 24, 2014), http://www.gizmag.com/3d-printed-kayak/31343/.

[46] *See, e.g.*, Lucas Mearian, *This 3D Printer Technology Can Print a Game Controller, Electronics and All*, COMPUTER WORLD (Apr. 25, 2014, 5:09 PM), http://www.computerworld.com/s/article/9247934/This_3D_printer_technology_can_print_a_game_controller_electronics_and_all (describing a 3D-printed game controller).

[47] *See, e.g.*, Leslie Langnau, *3D Printer Helps Window Treatment Maker Reduce Design Cycle*, MAKE PARTS FAST (Nov. 13, 2011), http://www.makepartsfast.com/2011/11/2756/3d-printer-helps-window-treatment-maker-reduce-design-cycle/ (noting that 3D printers reduce manufacturing errors and rework); Jason Paur, *NASA Fires Up Rocket Engine Made of 3-D Printed Parts*, WIRED (Aug. 28, 2013, 4:28 PM), http://www.wired.com/autopia/2013/08/nasa-3d-printed-rocket-engine/ (describing how NASA used a 3D printer to create an injector for a rocket engine).

cannot be cut or shaped from a block of existing material.[48] Companies today even 3D print artificial human limbs and body parts.[49]

While the current state of 3D printing makes it useful only for certain types of products, there is reason to think that 3D printing will become both cheaper and better in the not-too-distant future.[50] 3D printers look right now like the computer industry did in 1976—a set of large, expensive machines used by businesses and a fringe of cheap, homemade computers used primarily by hobbyists.[51] But computers rapidly joined the mainstream in the 1980s as processing power increased and size and cost decreased, making a personal computer a plausible investment.[52]

We should expect similar trends in 3D printing. The raw materials for most applications are relatively cheap. Printer designs and products that can be designed on them are increasingly available.[53] The

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[48] 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 2 (Nov. 2010), *available at* http://www.publicknowledge.org/files/docs/3DPrintingPaperPublicKnowledge.pdf.

[49] *See, e.g.*, Harrison Jacobs, *A UK Surgeon Successfully 3D Printed and Implanted a Pelvis*, BUSINESS INSIDER (Feb. 17, 2014, 8:21 AM), http://www.businessinsider.com/uk-surgeon-implanted-a-3d-printed-pelvis-2014-2 (describing a 3D-printed pelvis); Martin LaMonica, *3D Printer Produces New Jaw for Woman*, CNET (Feb. 6, 2012, 12:59 PM), http://news.cnet.com/8301-11386_3-57372095-76/3d-printer-produces-new-jaw-for-woman (describing a 3D-printed titanium jaw); ROBOHAND, http://www.robohand.net (last visited Sept. 12, 2014) (describing a company that has printed and attached more than two hundred 3D-printed artificial hands).

[50] Even a relative skeptic like Vivek Wadhwa acknowledges that "[w]e will surely see Star Trek-like replicators and large-scale 3D manufacturing plants one day. But this won't be until sometime in the next decade." Vivek Wadhwa, *Let's Curb Our 3D-Printer Enthusiasm, Folks*, WASH. POST (Aug. 2, 2013), http://www.washingtonpost.com/blogs/innovations/wp/2013/08/02/lets-curb-our-3d-printer-enthusiasm-folks/.

[51] *See* N.V., *Difference Engine: The PC All Over Again?*, ECONOMIST (Sept. 9, 2012, 7:31 AM), http://www.economist.com/blogs/babbage/2012/09/3d-printing ("In many ways, today's 3D printing community resembles the personal computing community of the early 1990s." (internal quotations omitted)). I actually think a better analogy is the Homebrew Computer Club of DIY computer enthusiasts in the 1970s. *See Homebrew Computer Club*, WIKIPEDIA, http://en.wikipedia.org/wiki/Homebrew_Computer_Club (last visited Nov. 4, 2014) (describing a group of amateur computer hobbyists that spawned many of today's high-profile computer entrepreneurs).

[52] *See History of Personal Computers*, WIKIPEDIA, http://en.wikipedia.org/wiki/History_of_personal_computers (last visited Nov. 4, 2014) (describing "an explosion of low-cost machines known as home computers that sold millions of units before the market imploded in a price war in the early 1980s").

[53] 3D printers are available now for less than $1000—comparable to what a laser printer cost in 1985. Cyrus Farivar, *California's First 3D Printer Retail Store to Sell $600 Model*, ARS TECHNICA (Sept. 21, 2012, 6:45 PM), http://www.arstechnica.com/business/2012/09/californias-first-3d-printer-retail-store-to-sell-600-model. There are dozens of repositories for 3D printer designs. *37 Marketplaces to Share, Buy and Sell Designs for 3D Printing*, MAKING SOCIETY (July 11, 2013), http://makingsociety.com/2013/07/37-3d-printing-marketplaces-to-share-buy-and-sell-3d-designs/. Just one of those repositories,

range of things that can be 3D printed will grow rapidly; one company began 3D printing human organs in 2013,[54] and there is even a prototype of a 3D printer that can print a house.[55] Researchers are working on 3D printers that can print food.[56] The development of commercial printers and their increase in use should reduce the cost of manufacturing more sophisticated printers, and as demand grows, economies of scale should bring the cost down even further. Most notably, 3D printers can even print the parts for assembling new 3D printers,[57] which suggests that 3D printers can effectively improve themselves over time.[58]

A world in which sophisticated 3D printers are widely available would change the economics of things in a fundamental way.[59] 3D printers, like the Internet, separate things into their information content and their manufacturing.[60] By doing so, they eliminate the cost of distribution (since the thing of interest can be printed on site) and substantially reduce the cost of manufacturing (since the only costs will be the raw materials and electricity). Like the Internet, the democratization of production of things can be both good and bad. A world in which everyone has advanced 3D printers at home or avail-

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Autodesk 123D, has over ten thousand designs. AUTODESK 123D, http://www.123dapp.com/ (last visited Mar. 18, 2015).

54 Lucas Mearian, *The First 3D Printed Organ—a Liver—Is Expected in 2014*, COMPUTERWORLD (Dec. 26, 2013, 7:05 AM), http://www.computerworld.com/s/article/9244884/The_first_3D_printed_organ_a_liver_is_expected_in_2014.

55 Ryan Bushey, *Researchers Are Making a 3D Printer That Can Build a House in 24 Hours*, BUSINESS INSIDER (Nov. 20, 2013, 9:53 AM), http://www.businessinsider.com/3d-printer-builds-house-in-24-hours-2014-1; Lucas Mearian, *3D Printer Constructs 10 Buildings in One Day from Recycled Materials*, COMPUTERWORLD (July 2, 2014, 4:12 PM), http://www.computerworld.com/article/2489664/emerging-technology/3d-printer-constructs-10-buildings-in-one-day-from-recycled-materials.html; Laura Secorun Palet, *Who Built My Home? A 3-D Printer*, OZY (May 7, 2014), http://www.ozy.com/fast-forward/3-d-printed-houses/31179.

56 Adam Clark Estes, *3D Printing Now Lets Us Manufacture Blood Vessels, Organs, Food*, ATLANTIC WIRE (Sept. 16, 2011, 6:02 PM), http://www.theatlanticwire.com/technology/2011/09/3d-printing-blood-vessels/42608/.

57 *See 3D Printer Parts*, MAKERBOT THINGIVERSE, https://www.thingiverse.com/explore/newest/3d-printing/3d-printer-parts/ (last visited Nov. 10, 2014) (cataloging designs for 3D printer parts to be printed on a 3D printer).

58 Researchers have already developed self-assembling robots that use 3D printers. Loren Grush, *MIT Researchers Develop 3D-Printed Robots that Self-Assemble when Heated*, DIGITAL TRENDS (May 31, 2014), http://www.digitaltrends.com/cool-tech/mit-researchers-developed-3d-robots-self-assemble-heated/. If we can print devices that can assemble themselves into functioning pieces, we are a long way towards allowing 3D printers to print their own replacements.

59 For a skeptical view that 3D printers are unlikely to pose the same challenges as the Internet, see Finocchiaro, *supra* note 38, at 491–92.

60 Indeed, Jeremy Rifkin refers to the production of goods in a 3D printer economy as "infofacturing." RIFKIN, *supra* note 5, at 89.

able in a public facility is a world in which manufactured goods no longer have to be produced in bulk and are no longer scarce.[61] But it is also a world in which the manufacture and sale of newly-designed things becomes harder and harder to control. All someone needs to do is download a design from the Internet and they can print that design without paying. Deven Desai and Gerard Magliocca have already described the resulting "Napsterization,"[62] but while the Napster music file-sharing service and the Internet implicated copyright law, 3D printing is likely to affect the owners of utility patents and design patents, which cover the making of physical things.

2. *Synthetic Biology and Bioprinting*

If manufacturing things in your own home with 3D printers sounds a bit like science fiction, how about the automated manufacturing of new genes? The emerging discipline of synthetic biology promises to take what has been a craft—combining gene fragments from two different species to create genetically modified organisms—and make it into a true engineering discipline.

Traditional biotechnology is a hit-or-miss discipline. Scientists try to figure out what existing genes do, and then take snippets of genes from one organism and splice them into another in hopes of generating a modified organism with some of the characteristics of both sources.[63] This has led to some dramatic successes, from the cheap production of human growth hormone (HGH) in bacteria[64] to the

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[61] *See* Neil Gershenfeld, *How to Make Almost Anything: The Digital Fabrication Revolution*, 91 FOREIGN AFF. 43, 56 (2012) (describing how digital design and production of physical goods can reduce scarcity).

[62] Deven R. Desai & Gerard N. Magliocca, *Patents, Meet Napster: 3D Printing and the Digitization of Things*, 102 GEO. L.J. 1691, 1692, 1718 (2014) (describing the "digitization" of things and comparing 3D printing sites to Napster); James Grimmelmann, *Indistinguishable from Magic: A Wizard's Guide to Copyright and 3D Printing*, 71 WASH. & LEE L. REV. 683, 696 (2014) ("Music and movies have had enforcement problems in spades since Napster . . . . Now that the world of bits is colonizing the world of atoms, the makers of things are about to learn that they are less special than they may have thought. They confront exactly the same enforcement challenges . . . .").

[63] *See* Drew Endy, *Foundations for Engineering Biology*, 438 NATURE 449, 449 (2005) (describing some applications of synthetic biology and noting that each has "uncertain times to completion, costs and probabilities of success"). For a discussion of the IP issues synthetic biology presents, see Sapna Kumar & Arti Rai, *Synthetic Biology: The Intellectual Property Puzzle*, 85 TEX. L. REV. 1745 (2007).

[64] *See The Big Story Behind Synthetic Human Growth Hormone*, NAT'L MUSEUM OF AM. HISTORY (Oct. 18, 2012), http://americanhistory.si.edu/blog/2012/10/human-growth-hormone.html (describing how the use of gene splicing "turned . . . bacteria into little factories to pump out HGH, leading to a limitless source of pure HGH with little risk of contamination").

development of disease-resistant crops.[65] But it is at its base guesswork, and it has produced many more failures than successes, particularly in the area of human gene therapy.[66]

Synthetic biology offers something much more radical: the opportunity not just to take genetic pieces already created in nature and move them around, but the ability to build something entirely new. At its most extreme, synthetic biology involves engineering a genome from the ground up to create new characteristics.[67] But even modifications to existing organisms represent something different than traditional biotechnology has given us so far. Scientists have already engineered E. coli bacteria to change their smell—not just by replacing the gene that causes the odor, but by creating an if-then statement in the genetic code, causing the bacteria to give off a different smell depending on whether it is reproducing.[68] Potential applications include medical diagnostic tests that can alert people to diseases or health risks by changing the color or smell of their urine or feces.[69] Scientists have also programmed genes to do things unrelated to their own functions, such as storing bits of information or acting as a logic gate to perform a simple mathematical calculation.[70] More radically, they have made entirely new forms of bacteria different than anything found in nature.[71] Genes might become not only computers,

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[65] *See, e.g.*, Bowman v. Monsanto Co., 133 S. Ct. 1761, 1763 (2013) (adjudicating a dispute over a patent on genetically modified soybean seeds).

[66] *See, e.g.*, Adam J. Kolber, *Will There Be a Neurolaw Revolution?*, 89 IND. L.J. 807, 828 (2014) ("[G]ene therapies have been slower to develop than many expected . . . ."); Stephen J. Morse, *Avoiding Irrational Neurolaw Exuberance: A Plea for Neuromodesty*, 62 MERCER L. REV. 837, 837 (2011) ("The genome was fully sequenced in 2001, and there has not been one resulting major advance in therapeutic medicine since.").

[67] *See, e.g.*, Andrew Pollack, *Scientists Add Letters to DNA's Alphabet, Raising Hope and Fear*, N.Y. TIMES, May 8, 2014, at A1 (describing the addition of two new nucleotides, X and Y, to the normal A, C, G, and T).

[68] *See, e.g.*, Steve Darden, *MIT's Drew Endy on Synthetic Biology*, SEEKERBLOG (Jan. 8, 2007), http://seekerblog.com/2007/01/08/mits-drew-endy-on-synthetic-biology/ ("[MIT students] engineered the E. coli to smell like mint while it was growing and to smell like banana when it was done.").

[69] Tanya Lewis, *Incredible Tech: How to Engineer Life in the Lab*, LIVE SCIENCE (Nov. 18, 2013, 2:49 PM), http://www.livescience.com/41287-incredible-technology-how-to-engineer-life.html.

[70] *See, e.g.*, Nicolas Koutsoubelis, Quantitative in Silico and in Vivo Characterization of the Recombinase Addressable Data Storage 7 (July 16, 2012) (unpublished B.S. thesis, Albert-Ludwigs University of Freiburg), *available at* http://openwetware.org/images/c/cb/Koutsoubelis_BS_Thesis_Stanford_Freiburg.pdf ("Notable achievements, including . . . the engineering of cells that can perform behavior like logic gates, have been reached within the last years.").

[71] *See Synthetic Genomics Applauds the Venter Institute's Work in Creating the First Synthetic Bacterial Cell*, SYNTHETIC GENOMICS (May 19, 2010), http://www.syntheticgenomics.com/media/press/051910.html (announcing the creation of the first synthetic bacteria cell).

but builders. Imagine a plant genetically modified to grow into the shape of a building. Voila: cheap, organic, self-constructing housing.[72]

These new technologies depend on a completely different form of biotechnology manufacturing. Rather than taking genes from existing organisms, a scientist who wants to create, say, a NAND logic gate in genetic material that will return a positive signal unless both of the input signals are positive, must start from scratch. Accordingly, at the base of all new synthetic biology is a gene assembler.[73] This is a machine that serves as a sort of 3D printer for genes, drawing from streams of the four base pairs that make up all genetic material (As, Cs, Gs, and Ts) and linking them together into a new, synthetic strand of genetic material.[74] Write the (genetic) code you want, and the machine assembles it, base pair by base pair. Gene assemblers already exist, and their cost is falling substantially.[75] And with a gene assembler and bottles of each of the four base pairs, you can "print" any gene you want, whether an existing one or one you have just made up.

Gene assemblers promise to do what 3D printers will do and the Internet already does: separate design from manufacturing, eliminate the need for distribution, and put manufacturing in the hands of the masses. The design of an organism, like the design of a rocket engine or the notes of a song, is just information.[76] That information is already being stored in open-source databases from which anyone can download it.[77] Plug that information and a stream of simple raw materials into a gene assembler, and you can make the basic components of any living thing you can imagine.[78] And as the Internet has

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[72] *See, e.g.*, Tom McKeag, *Will Synthetic Biology Lead to Truly Living Buildings?*, GREENBIZ (June 16, 2010, 8:00 AM), http://www.greenbiz.com/blog/2010/06/16/will-synthetic-biology-lead-truly-living-buildings (suggesting that emerging trends are already on the trajectory toward growing buildings).

[73] *See generally* Monya Baker, *De Novo Genome Assembly: What Every Biologist Should Know*, 9 NATURE METHODS 333 (2012) (describing gene assemblers).

[74] *Id.* at 333.

[75] *Id.*

[76] *See* Ass'n for Molecular Pathology v. Myriad Genetics, Inc., 133 S. Ct. 2107, 2118 (2013) (noting that the value of DNA is its informational content).

[77] The BioBricks Foundation, for instance, collects available gene sequences, cataloged by function. *About*, BIOBRICKS FOUND., http://biobricks.org/about-foundation/ (last visited Nov. 10, 2014); *see also Registry of Standard Biological Parts*, iGEM FOUNDATION, http://parts.igem.org/Main_Page (last visited Nov. 10, 2014) ("The iGEM Registry is a growing collection of genetic parts that can be mixed and matched to build synthetic biology devices and systems.").

[78] To be sure, the gene you print isn't ready to use; it still needs to be put into a living organism. But that too is increasingly easy to do. *See, e.g.*, Jennifer Schuchert, *Insertion of Foreign Genes and Vectors*, http://filebox.vt.edu/users/chagedor/biol_4684/Methods/genes.html (last visited Nov. 10, 2014) (describing a new method for inserting foreign genes into an organism).

shown, information in its pure form is cheap and easy to copy and notoriously hard to control.[79] As genetic information becomes just that—information—and as manufacturing becomes cheap and distributed, the economics of biotechnology will begin to look more and more like the economics of content distribution. One application of this technology is copying existing genes.[80] But the more interesting applications involve creating entirely new organisms.

Developing an organism from scratch is likely to be hard. But there is a second way in which the separation of information from production will drive advances in synthetic biology. Scientists can develop individual, modular building blocks that others can assemble into organisms that serve a desired function. If I want a gene component that stores data, I shouldn't have to recreate one from scratch; someone has probably already coded such a component.[81] Synthetic biologists are developing collections of "biobricks"—individual modules that can be put together in organisms. Because these bricks are information, they can be shared and recombined in numerous ways.

Combining this technology with 3D printing has a synergistic effect. We have already seen that 3D printers can generate artificial human limbs and body parts,[82] but add in the ability to generate biological material and you get the possibility of bioprinting—the automated generation of living cells with whatever genetic material you desire. Bioprinters are already generating human cartilage tissue,[83] and in 2014 doctors implanted a 3D printed skull in a person.[84] And scientists are working on bioprinting machines—devices based on cellular tissue that can move on their own.[85] Further, we have seen the development of do-it-yourself biolabs,[86] suggesting that as the cost of

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[79] *See supra* Part I.B.2.

[80] *See* Andrew Pollack, *Developing a Fax Machine to Copy Life on Mars*, N.Y. TIMES, Nov. 18, 2013, at B1 (discussing Craig Venter's project—based on the idea that "the genetic code that governs life can be stored in a computer and transmitted just like any other information"—to copy and transmit DNA information before transposing it into a blank cell).

[81] Not yet, it turns out, but they're working on it. *See* Koutsoubelis, *supra* note 70, at 5 (taking "a first step" towards engineering cells to store information).

[82] *See supra* notes 49, 54 and accompanying text.

[83] Henry Fountain, *At the Printer, Living Tissue*, N.Y. TIMES, Aug. 20, 2013, at D1.

[84] James Eng, *Medical First: 3-D Printed Skull Successfully Implanted in Woman*, NBC NEWS (Mar. 27, 2014), http://www.nbcnews.com/science/science-news/medical-first-3-d-printed-skull-successfully-implanted-woman-n65576.

[85] Henry Fountain, *Printing Out a Biological Machine*, N.Y. TIMES, Aug. 20, 2013, at D2 (discussing bioprinted machines that can behave autonomously after being printed).

[86] *See, e.g.*, Melissa Pandika, *The Biopunk Revolution*, OZY, http://www.ozy.com/fast-forward/the-biopunk-revolution/30060 (last visited Nov. 23, 2014) (discussing the development of do-it-yourself biology "hackerspaces").

these technologies declines they will be widely accessible, if not in the home then in a variety of locations for public use.

Synthetic biology is at an earlier stage than 3D printing; I don't expect to be printing my own organisms any time soon. But it is certainly possible to imagine a time in which every doctor's office can generate custom genes to order. The ability to manipulate organisms to do anything imaginable may lead to new products that are currently unimaginable. We allow the patenting of newly-created organisms,[87] and of shorter DNA sequences so long as they are not taken from nature.[88] But those patents are essentially directed to the informational content of the genes, and their owners will face many of the same issues copyright owners face on the Internet.

3. Robotics

Both 3D printing and synthetic biology promise to revolutionize the making of various types of things. But the revolution will not end there. Advances in robotics may bring the same sorts of disruption to the service economy, and for similar reasons. Robots have already remade substantial sectors of the industrial economy by replacing human workers for certain sorts of repetitive tasks.[89] And certain very simple robots like the Roomba vacuum cleaner have made it into the mass consumer market.[90] But robots are poised to greatly expand the number and complexity of tasks they can perform, a fact that has significant implications for both industrial and consumer services. Robots may clean our houses, but they may also serve us meals and drive our cars.[91] Though these tasks were traditionally thought to be beyond machine capabilities because they required judgment, Google's driverless cars have demonstrated that machines can engage in adaptive learning of complex tasks.[92] Some studies have suggested

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[87] Diamond v. Chakrabarty, 447 U.S. 303, 318 (1980) (holding that human-made microorganisms are patentable subject matter).

[88] Ass'n for Molecular Pathology v. Myriad Genetics, Inc., 133 S. Ct. 2107, 2111 (2013).

[89] *E.g.*, David J. Hill, *1 Million Robots to Replace 1 Million Human Jobs at Foxconn? First Robots Have Arrived*, SINGULARITYHUB (Nov. 12, 2012), http://singularityhub.com/2012/11/12/1-million-robots-to-replace-1-million-human-jobs-at-foxconn-first-robots-have-arrived/ (discussing a Chinese manufacturer's implementation of ten thousand robots as part of its plan to replace one million human workers with robots within three years).

[90] *See generally Roomba*, IROBOT, http://www.irobot.com/us/learn/home/roomba.aspx (last visited Nov. 10, 2014) (providing information on the Roomba).

[91] *See, e.g.*, Anne Eisenberg, *More Roles for Robots as Prices Fall*, INT'L N.Y. TIMES, Mar. 3, 2014, at 16 ("[R]obots could help with tasks like folding laundry and dispensing medications . . . .").

[92] *See, e.g.*, Aaron M. Kessler, *Technology Takes the Wheel*, N.Y. TIMES, Oct. 5, 2014, at B1 (noting that driverless cars are "no longer the stuff of science fiction" and that they will "radically reshape[ ]" "the very nature of driving"). Chunka Mui, *Will the Google Car*

that in twenty years nearly half of today's jobs could be performed by robots.[93]

The robots mentioned above have one thing in common: They are special-purpose machines designed to achieve a single goal. A car-body-welding robot welds car bodies; a Roomba cleans the floor.[94] By contrast, the coming generation of robots will be general-purpose machines that can be programmed to achieve a variety of goals. And that programming will be updatable; as people design new programs for a robot to run, the robot will be able to download that new programming and learn new tasks.[95]

That is a critical difference for two reasons. First, it means that consumers and small businesses need not buy a different robot for each task. The ability to buy a robot that will perform multiple functions will help robots break into the consumer and retail-service markets. Indeed, we have already seen robots make substantial inroads into logistics, retail, and even white-collar service industries.[96] Second, the updatability of general-purpose robots means that the technology can advance with the speed of software, not hardware.[97] New features can be implemented and bugs fixed without having to buy and ship a

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Force a Choice Between Lives and Jobs?, FORBES (Dec. 19, 2013, 9:52 AM), http://www.forbes.com/sites/chunkamui/2013/12/19/will-the-google-car-force-a-choice-between-lives-and-jobs/.

[93] *E.g.*, *Coming to an Office near You*, ECONOMIST, Jan. 18, 2014, at 9. Honda projects that it will sell as many robots in 2020 as it does cars. Juha Ainoa et al., *The Digital Evolution—from Impossible to Spectacular*, *in* BIT BANG: RAYS TO THE FUTURE 8, 31 (Yjrö Neuvo & Sami Ylönen eds., 2009), *available at* http://lib.tkk.fi/Reports/2009/isbn9789522480781.pdf.

[94] Ryan Calo refers to this as closed robotics. Ryan Calo, *The Need to Be Open: U.S. Laws Are Killing the Future of Robotics*, MASHABLE (Jan. 1, 2014), http://mashable.com/2014/01/01/us-law-robotics-future/.

[95] *See* M. Ryan Calo, *Open Robotics*, 70 MD. L. REV. 571, 574 (2011) (explaining that open robots will run third-party software and therefore can be altered and extended). While the distinction between open-source and proprietary code is related to that between general-purpose and special-purpose machines—open source systems tend to be general purpose—the two issues are distinct. A system can be proprietary yet general-purpose, as the Apple computer architecture is. Calo uses the term "open robotics" to refer to general-purpose robots not dedicated to a particular use, whether they run proprietary or open-source software. *Id*. For a discussion of the general-purpose nature of computers, see, for example, JONATHAN ZITTRAIN, THE FUTURE OF THE INTERNET—AND HOW TO STOP IT 19–20 (2006).

[96] *See* RIFKIN, *supra* note 5, at 125–27 (discussing Amazon's roboticized warehouses, self-driving cars, and the rise of vending machines and self-checkout terminals at stores and airports).

[97] *See* Calo, *supra* note 94 ("Consumer robotics started off closed, which helps to explain why it has moved so slowly."). Calo argues that we need a form of legal immunity for the designer of open robots, just as we do for providers of general-purpose computers or Internet service providers. *Id*. Like those technologies (and like 3D printers and gene assemblers), the maker of the device in this world is divorced from the uses to which the device might be put.

new device. Anyone can develop the software tools to customize their own robots.[98] When combined with 3D printers, robots may eventually even be able to upgrade their own hardware.[99]

The nature of a general-purpose robot has much in common with the previous three technologies.[100] As with the Internet or 3D printing, we are in the process of separating the informational content of a design (here, software for performing a service) from the physical implementation of that design in a general-purpose robot. Once we do that, the automation revolution that has already hit factories and distribution centers[101] will expand to other sectors of the economy. Services that once required specialized expertise in stores or factories will increasingly be performed by robots in homes or small businesses.[102] The marginal cost of implementing that design drops towards zero because for many services all that is required is to program an existing robot with data over the Internet. Services, like content, products, and biologics, will cease to be scarce.

Robotics implicates a range of IP rights, including copyright, patent, and design patent. Robots are a combination of hardware and software, and the hardware must still be manufactured, although there are intriguing prospects for using 3D printers to help generate robots.[103] But the ability to upgrade robots by downloading information will present many of the same challenges the Internet has presented for content. Some of those challenges are to IP; general-purpose robots could replace the copyrighted software and patented methods of many special-purpose tools. Other challenges are not so much to IP as to the economics of the service industry, as general-purpose robotics begins to displace cab drivers, construction workers, doctors, and the like.

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[98] *See* CHRIS ANDERSON, MAKERS: THE NEW INDUSTRIAL REVOLUTION 17–18 (2012) (explaining how the creation and design of physical goods is becoming increasingly software based).

[99] *See* Grush, *supra* note 58 (describing self-assembling robots).

[100] For an explicit comparison, see Ryan Calo, *Robotics and the New Cyberlaw*, 103 CALIF. L. REV. (forthcoming 2015) (manuscript at 103), *available at* http://www.roboticsbusinessreview.com/pdfs/roboticscyberlaw.pdf (discussing the legal parallels between the development of Internet law and the coming law of robotics).

[101] *See* David Rotman, *How Technology Is Destroying Jobs*, 116 MIT TECH. REV. 28, 32 (2013), *available at* http://www.technologyreview.com/featuredstory/515926/how-technology-is-destroying-jobs/ (discussing Amazon's use of robots to select, pack, and ship goods from warehouse shelves).

[102] For example, a restaurant in China is now using robot chefs to prepare and serve food. Arrun Soma, *Robot Chefs Take Over Chinese Restaurant*, BBC NEWS CHINA (Apr. 22, 2014, 3:43 AM), http://www.bbc.com/news/world-asia-china-27107248.

[103] *See* Grush, *supra* note 58 (describing an early self-assembling robot and noting the possibility of a robot hardware compiler). Self-assembling robots: What could possibly go wrong?

II
IP IN A POST-SCARCITY WORLD

A. The Internet Experience

If technology offers a world in which goods and services are no longer scarce, how should IP law respond? Basic IP theory suggests a clear answer: A world in which content is separated from production needs more and stronger IP to restore the scarcity we have lost. The logic goes like this. IP is designed to solve a public goods problem that arises because it is cheaper to be an imitator than an inventor. The greater the disparity between the cost of inventing or creating and the cost of copying, the more need there is for IP to encourage people to be creators rather than imitators.[104] In effect, IP law artificially raises the cost of imitation in order to make it at least as costly as creation.

The technologies I described in Part I separate the act of creation from the acts of reproduction and distribution, and dramatically reduce the cost of the latter two. Accordingly, they exacerbate the public goods problem of IP theory by making it *much* cheaper to imitate than to create. Standard IP theory predicts that lots of people will engage in illegal copying but no one will create under those circumstances,[105] so we must artificially increase the cost of production and distribution by strengthening IP rights to rebalance incentives. And because the technology makes reproduction and distribution so cheap and easy, we must increase the cost a lot in order to restore the scarcity that is the foundation of our economic order. As Rob Merges puts it, "[i]n an economy where intangible assets are more valuable than ever, IP is more important than ever."[106]

We have seen these arguments play out with the Internet, the technology that is furthest advanced of the four I have discussed. Consistent with IP theory, as the cost of reproduction and distribution dropped to zero, piracy became rampant on the Internet.[107] The companies that produced content in the pre-Internet world worried that

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104 For discussions of this classic economic theory of IP, see, for example, LANDES & POSNER, *supra* note 24, at 40–41; Wendy J. Gordon, *An Inquiry into the Merits of Copyright: The Challenges of Consistency, Consent, and Encouragement Theory*, 41 STAN. L. REV. 1343, 1435–38 (1989); Lemley, *supra* note 26, at 993–97.

105 LANDES & POSNER, *supra* note 24, at 40–41; Lemley, *supra* note 26, at 993–97.

106 MERGES, *supra* note 15, at 290.

107 The U.S. government estimates the cost of pirated products for G20 nations at as much as $650 billion per year. U.S. DEP'T OF JUSTICE, PROSECUTING INTELLECTUAL PROPERTY CRIMES 2–3 (4th ed. 2013), *available at* http://www.justice.gov/criminal/cybercrime/docs/prosecuting_ip_crimes_manual_2013.pdf. But those numbers are almost certainly wildly inflated, because the government assumes that every item copied for free and every $20 Rolex knockoff would in fact have been purchased at full price. As one report put it, that number "is as fake as an imitation Tommy Hilfiger T shirt." Adam L.

they could not make money in an environment where copying was so easy. Many have lamented the Internet as the end of the content industries,[108] and indeed some (though not all) of those industries saw their revenues decline as consumers switched from buying content in physical form to downloading it, often for free.[109]

The content industries responded just as IP theory said they should. They persuaded Congress to pass a multitude of new laws, criminalizing copyright infringement on the Internet even if done for no financial gain[110] and ramping up the penalties for copyright infringement to an extreme degree.[111] They filed tens of thousands of lawsuits against people who posted copyrighted content online.[112] They sued anyone with even a vague connection to the pirates, from sellers of software to content-hosting services, to search engines, to providers of Internet access, to the lawyers and venture capitalists who supported those intermediaries.[113] They even sought to change

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Penenberg, *Cops, Cash and Counterfeits*, FORBES (Dec. 28, 1998, 12:00 AM), http://www.forbes.com/global/1998/1228/0120038a.html.

[108] *See, e.g.*, Lemley, *supra* note 32, at 125 (inquiring whether the Internet has "doomed" the content industries).

[109] Music industry revenues have declined from nearly $20 billion to only $7 billion per year. Glynn S. Lunney, Jr., *Copyright's Mercantilist Turn: Do We Need More Copyright or Less?* 2 (Tulane Univ. Sch. of Law Pub. Law & Legal Theory Working Paper Series, Working Paper No. 12-20, 2012), *available at* http://ssrn.com/abstract=2158874. Newspapers have also seen declining revenues. Mark Cooper, *Structured Viral Communications: The Political Economy and Social Organization of Digital Disintermediation*, 9 J. TELECOMM. & HIGH TECH. L. 15, 38 (2011). By contrast, book publishers are making record revenues. *See* Joel Waldfogel & Imke Reimers, Storming the Gatekeepers: Digital Disintermediation in the Market for Books 28 tbl.5 (June 11, 2014) (unpublished manuscript), *available at* http://imkereimers.weebly.com/uploads/2/7/9/9/2799121/storming_the_gatekeepers.pdf (showing peak revenues from 2008 to 2012 occurring in 2012). Movie studios are a more mixed bag; total revenues are down somewhat, but so are costs, and profit margins are up. Cynthia Littleton, *Major Film Studios Prosper on the Margins*, VARIETY (Apr. 18, 2013, 3:00 PM), http://variety.com/2013/biz/news/major-film-studios-prosper-on-the-margins-1200376494/.

[110] *See* 17 U.S.C. § 506(a)(1)(B) (2012) (criminalizing willful infringement without requiring financial gain).

[111] Criminal copyright infringement is a felony that carries a sentence of up to ten years in prison. 18 U.S.C. § 2319(b)(2) (2012). By contrast, a Justice Department study in the 1990s found that the average prison sentence for rape was 9.75 years. LAWRENCE A. GREENFELD, BUREAU OF JUSTICE STATISTICS, PRISON SENTENCES AND TIME SERVED FOR VIOLENCE 1 (1995), *available at* http://www.bjs.gov/content/pub/pdf/PSATSFV.pdf. Of course, the fact that a copyright infringer *can* be sentenced to ten years in prison doesn't mean he will be.

[112] *See* Mark F. Schultz, *Reconciling Social Norms and Copyright Law: Strategies for Persuading People to Pay for Recorded Music*, 17 J. INTELL. PROP. L. 59, 72–73 (2009) (noting the lawsuits filed by the Recording Industry Association of America (RIAA)). For a discussion of that strategy, *see, e.g.*, Lemley & Reese, *supra* note 31, at 1395–405.

[113] Lemley & Reese, *supra* note 31, at 1346–47, explain that copyright owners have sued direct facilitators like Napster; makers of software that can be used to share files; those who provide tools to crack encryption that protects copyrighted works; providers of search

the basic nature of the Internet itself, seizing entire Internet domains and proposing legislation that would have prevented Internet sites from connecting to each other.[114]

It didn't work. Copyright infringement remains rampant on the Internet.[115] The reason is simple: the democratization of content distribution.[116] The content industry sued tens of thousands of file sharers, and may well have deterred those it sued, but there were tens of millions of people sharing files. It persuaded the government to seize thousands of Internet domains, but many more were beyond the government's reach.[117] It sued and shut down dozens of software providers, but there were always more who stepped in to take their

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engines that help people find infringing material; "quasi internet service providers" such as universities, eBay, and Yahoo! Auction; and even credit card companies that help individuals pay for infringing activity. And that was in 2004; many more suits against facilitators have been filed since that time. *E.g.*, Viacom Int'l, Inc. v. YouTube, Inc., 676 F.3d 19 (2d Cir. 2012).

[114] The government has seized hundreds of domain names in the United States, effectively shutting down entire websites. *See* John Blevins, *Uncertainty as Enforcement Mechanism: The New Expansion of Secondary Copyright Liability to Internet Platforms*, 34 CARDOZO L. REV. 1821, 1861 n.247, 1856–64 (2013) (discussing the government's domain name seizure campaign). For a more detailed description of the government's domain name seizure campaign, see Karen Kopel, Note, *Operation Seizing Our Sites: How the Federal Government Is Taking Domain Names Without Prior Notice*, 28 BERKELEY TECH. L.J. 859 (2013). Legislative proposals in 2011 and 2012 would have gone further, allowing the government to block legitimate websites from passing Internet traffic through to sites on a blacklist. Mark Lemley, David S. Levine, & David G. Post, *Don't Break the Internet*, 64 STAN. L. REV. ONLINE 34 (2011).

[115] The RIAA estimates that 24% of global Internet traffic is pirated content. *Scope of the Problem*, RIAA, https://www.riaa.com/physicalpiracy.php?content_selector=piracy-online-scope-of-the-problem (last visited Nov. 18, 2014). Although this figure may be inflated given the RIAA's interest in suppressing digital copyright infringement, it nevertheless suggests that a significant amount of Internet traffic is related to pirated content.

[116] *See, e.g.*, Rebecca Giblin, *The P2P Wars: How Code Beat Law*, IEEE INTERNET COMPUTING, May/June 2012, at 92–94 (arguing that law enforcement strategies against digital copyright infringement are ineffective because the law is unable to adequately regulate illegal behavior based on virtual technologies).

[117] Studies of the shutdown of Megaupload, a cyberlocker where users uploaded files to share with others, found that although the site accounted for almost 3% of global Internet traffic at its peak, shutting down the site had only a minor and temporary effect on Internet piracy. Kevin Fogarty, *MegaUpload Takedown Didn't Slow Pirate Downloads, Just Moved Them Offshore*, IT WORLD (Feb. 7, 2012), http://www.itworld.com/article/2732230/security/megaupload-takedown-didn-t-slow-pirate-downloads—just-moved-them-offshore.html. Similarly, attempts by some countries to block access to the Swedish BitTorrent site The Pirate Bay also failed to dramatically reduce Internet piracy. *See, e.g.*, Joost Poort et al., *Baywatch: Two Approaches to Measure the Effects of Blocking Access to The Pirate Bay*, 38 TELECOMM. POL'Y 383, 391 (2014) (noting no lasting impact on illegal downloads). *But see* Brett Danaher & Michael D. Smith, *Gone in 60 Seconds: The Impact of the Megaupload Shutdown on Movie Sales*, 33 INT'L J. OF INDUS. ORG. 1, 7 (2014) (finding that while piracy may not have declined, lawful movie sales increased after the Megaupload shutdown in countries with higher Megaupload usage).

places. And while it is possible that some of the more draconian measures the content industry has tried—suing the people who provide Internet service, or passing legislation to prevent interconnection altogether—would have eliminated that democratization, those measures have so far failed, simply because they would destroy so much social value along with reducing copyright infringement. The result was that as marginal costs for online content declined to zero, prices too dropped to zero—first for pirated content, but increasingly for legitimate content.[118]

According to IP theory, the result is predictable: With rampant infringement and no effective way to block it, the Internet should have dramatically weakened the incentive to create new content.[119] But the Internet carries a surprising lesson for IP theory: Despite the prevalence of infringement and the teachings of IP theory, people are creating and distributing more content now than ever before, by at least an order of magnitude.[120] Economic scholarship suggests that while recording industry revenues have declined substantially from their high in 1999,[121] there are more songs being released than ever before, more new artists than ever before, and more purchases of music than ever before, and the songs released seem to be of at least as high quality as before the Internet.[122] The rise of sites like YouTube

118 *See, e.g.*, Greg Lastowka, *Digital Attribution: Copyright and the Right to Credit*, 87 B.U. L. REV. 41, 54–55 (2007) (discussing the growth of zero-price models on the Internet); Newman, *supra* note 35, at 1411–12, 1437 (2013) ("Today, the array of legitimate, 'professional' content that is accessible at zero or negligible prices is truly incredible.").

119 *See supra* note 24 and accompanying text (describing the inadequacy of traditional IP theories for explaining the continuous creation and proliferation of content on the Internet).

120 RIFKIN, *supra* note 5, at 21 (observing that collaborative creation on the Internet, 3D printing, and other new tools have produced "a surge in creativity that is at least equal to the great innovative thrusts experienced by the capitalist market economy in the twentieth century").

121 Lunney, *supra* note 109, at 2 (reporting that sales dropped from $20 billion to $7 billion per year). The 1999 number was itself much higher than the long-run average. *See id*. at 31 fig.1. This could reflect not only the presence of a booming economy, but also higher sales from people replacing vinyl records and cassette tapes with CDs. *Cf.* BART CAMMAERTS ET AL., LONDON SCH. OF ECON. & POL. SCI., MEDIA POLICY BRIEF NO. 9, COPYRIGHT & CREATION: A CASE FOR PROMOTING INCLUSIVE ONLINE SHARING 7 (2013), *available at* http://www.lse.ac.uk/media@lse/documents/MPP/LSE-MPP-Policy-Brief-9-Copyright-and-Creation.pdf (finding that while revenue from recorded music dropped substantially from 1998 to 2011, revenue from other segments of the music industry grew during that period).

122 *See, e.g.*, Lunney, *supra* note 109, at 2 (reporting that the number of albums released rose from 38,900 in 1999 to 76,875 in 2011, and that more new artists broke into the top fifty songs after file sharing than before); Joel Waldfogel, *Copyright Protection, Technological Change, and the Quality of New Products: Evidence from Recorded Music Since Napster*, 55 J.L. & ECON. 715 (2012) (describing the results of a study that found no decline in the quality of music released since widespread file sharing began). The fact that

has led to an astonishing outpouring of videos from outside Hollywood, to such an extent that more than 300 hours of new content is uploaded to YouTube every *minute*;[123] more content is added to YouTube every month than the major TV networks created in sixty years.[124] At the same time, the movie industry is faring better than ever before in history, with profits at an all-time high and more movies being released.[125] People are buying more books than ever before, thanks in substantial part to Internet downloads.[126] And while the price of those books has declined somewhat,[127] writers are also publishing more books than ever before, including a surprising number of successful self-published books.[128] Print newspapers have seen revenues decline because of the Internet,[129] but that doesn't mean news reporting has declined; more news is reported more quickly from more sources as individual citizens are increasingly capable of documenting the world around them. Nor has the quality of journalism necessarily fallen; indeed, one recent study finds that "newspaper content appears to be getting more sophisticated in

revenues are declining can coexist with the fact that more people are purchasing music because people used to buy music in bundles called albums, and now primarily buy individual songs.

123 *Statistics*, YOUTUBE, http://www.youtube.com/yt/press/statistics.html (last visited Mar. 9, 2015).

124 *Great Scott! Over 35 Hours of Video Uploaded Every Minute to YouTube*, YOUTUBE OFFICIAL BLOG (Nov. 10, 2010), http://youtube-global.blogspot.com/2010/11/great-scott-over-35-hours-of-video.html.

125 *See* Felix Oberholzer-Gee & Koleman Strumpf, *File Sharing and Copyright*, 10 INNOVATION POL'Y & ECON. 19, 20, 49 (2010), *available at* http://www.nber.org/chapters/c11764.pdf (finding a substantial increase in movie production since file sharing began).

126 *E-Reading Rises as Device Ownership Jumps*, PEW RES. CTR., Jan. 16, 2014, at 1, *available at* http://www.pewinternet.org/files/2014/01/PIP_E-reading_011614.pdf (reporting a Pew study documenting the growth in e-reading); Hannibal Travis, *Myths of the Internet as the Death of Old Media*, 42 AIPLA Q.J. 1, 8 (2014) ("Copies of books sold more than doubled from one billion in 1993 to 2.3 billion in 2007. The number of titles produced increased to more than seventy thousand in 2002 and to almost three-hundred thousand in 2012." (footnote omitted)). When we factor in self-published and print-on-demand books, that number rose to "more than three million in 2010." *Id*. (manuscript at 8).

127 *See* United States v. Apple, Inc., 952 F. Supp. 2d 638, 647–48 (S.D.N.Y. 2013) (holding that book publishers violated antitrust laws by trying to force an increase in eBook prices from $9.99 to $14.99).

128 *See* Oberholzer-Gee & Strumpf, *supra* note 125, at 20 (finding a substantial increase in book publishing since file sharing began); Waldfogel & Reimers, *supra* note 109, at 15–16 (finding that more books are published now than ever before, and a majority of all books and many of the best-selling ones are now self-published).

129 Rick Edmonds et al., *Newspapers: By the Numbers*, *in* THE STATE OF THE NEWS MEDIA 2012 (Amy Mitchell & Tom Rosenstiel eds., 2012), http://www.stateofthemedia.org/2012/newspapers-building-digital-revenues-proves-painfully-slow/newspapers-by-the-numbers/ (showing a 50% decline in newspaper ad revenue from 2006 to 2011).

response to increased Internet penetration."[130] And despite piracy, both the film and publishing industries reported higher profit margins in 2012 than they did a decade before.[131] Live music and shows have also reached unprecedented levels of revenue and profit.[132] Overall, the picture of the entertainment industry is far from bleak; the overall industry grew from $449 billion in 1998 to $745 billion in 2010.[133]

Perhaps most surprising, people are creating an astonishing array of content specifically for the purpose of giving it away for free on the Internet. Early on, scholars worried that no one would create content for the Internet because they couldn't see a way to get paid,[134] but it is hard to think of a prediction in all of history that has been more dramatically wrong. People spend hundreds of millions—or even billions—of hours a year creating content online for no reason other than to share it with the world. They create and edit Wikipedia pages, post favorite recipes, create guides to TV shows and video games, review stores and restaurants, and post information on any subject you can imagine.[135] If, as Doctor Johnson famously suggested, "[n]o man but a blockhead ever wrote except for money,"[136] we are a world of blockheads, gleefully creating and sharing all sorts of content with the world.

Why are people creating so much content without the incentive of IP rights? And why hasn't the sky fallen on the content industries?

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130 Abdallah Salami & Robet Seamans, *The Effect of the Internet on Newspaper Readability* (NET Inst. Working Paper No. 14-13, 2014), *available at* http://ssrn.com/abstract=2506422.

131 JONATHAN BAND & JONATHAN GERAFI, POLICYBANDWIDTH, PROFITABILITY OF COPYRIGHT-INTENSIVE INDUSTRIES 3 (2013), *available at* http://infojustice.org/wp-content/uploads/2013/06/Profitability-of-Copyright-Industries.pdf.

132 Travis, *supra* note 126 (manuscript at 10).

133 *Id*. (manuscript at 13).

134 *See, e.g.*, Jane C. Ginsburg, *Putting Cars on the "Information Superhighway": Authors, Exploiters, and Copyright in Cyberspace*, 95 COLUM. L. REV. 1466, 1467 (1995) ("One can build the highway, but it does not follow that the cars will choose to come. Unless they can become author-friendly, digital media may remain just that: media, without content.").

135 *See, e.g.*, YOCHAI BENKLER, THE WEALTH OF NETWORKS: HOW SOCIAL PRODUCTION TRANSFORMS MARKETS AND FREEDOM 5–6 (2006) (discussing the social production of websites like Wikipedia and other Internet content); Yochai Benkler, Lecture, *Freedom in the Commons: Towards a Political Economy of Information*, 52 DUKE L.J. 1245, 1255–58 (2003) (same). The challenge posed to traditional notions of copyright by collective production sites like Wikipedia is not just one of the need for incentives. Collective production challenges the whole concept of authorship. *See* Matthew Rimmer, *Wikipedia, Collective Authorship and the Politics of Knowledge*, *in* INTELLECTUAL PROPERTY POLICY REFORM 172–84 (Christopher Arup & William van Caenegem eds., 2009).

136 JOHNSONIANA: LIFE, OPINIONS, AND TABLE-TALK OF DOCTOR JOHNSON 310 (R.W. Montagu ed., 1884).

There are at least six reasons. The first is the very reduction in reproduction and distribution cost that created the infringement problem in the first place. Twenty years ago, most of the costs associated with generating content were not from paying artists to create. Indeed, as noted above, artists normally got only a small fraction of the sales price of their work.[137] The Internet makes most of that cost disappear. As a result, content owners can charge a much lower price online and still be profitable. An eBook may retail for quite a bit less than a hardcover book, but it also costs a lot less to produce. Alternatively, content companies may decide (as the music industry has) to jack up their profit margins on digital content by charging the same price online as they would offline.[138] If they do that, they will make fewer sales, but they will make more profit on the sales they do make, since they don't have to pay much for reproduction and distribution of that content. Companies that take this strategy can remain profitable even with a much higher level of piracy, simply because their costs have declined so dramatically.

Second, many of the same technologies that reduced the cost of reproducing and distributing content also reduced the cost of producing that content. High quality music recording no longer requires a trip to a sound studio in Hollywood or Nashville; online tools enable emerging artists to produce a professional recording at a fraction of the previous cost.[139] Producing videos is no longer the province of professionals; most people now carry a sophisticated video camera in their pockets, and video production tools enable amateurs to make at least medium-quality video content quickly and cheaply.[140] Digital technologies have similarly reduced the cost and complexity of photography and the ease of generating original content on the web in the form of blogs and other websites. If the cost of creation drops along-

137 *See supra* note 30 and accompanying text.

138 Songs typically retail on iTunes for $0.99 or $1.29, roughly the same price per song a physical CD with 14 songs cost ten years ago. *See* Christopher Sprigman, *The 99¢ Question*, 5 J. ON TELECOMM. & HIGH TECH. L. 87, 88 (2006) (describing the efficiency of the 99¢ per song pricing structure for digital music when compared to legacy formats such as CDs). At the same time, the move from sales of albums to sales of songs has reduced revenue, as fewer people buy all the songs on an album.

139 *See* Lunney, *supra* note 109, at 3 ("[Digital technologies have] radically reduced the costs and risks associated with the production of new music and the introduction of new artists. Instead of expensive studio and production time, we can now use inexpensive software on a home computer.").

140 *See, e.g.*, Richard Quinlan, *How Much Does a Video Cost?*, Q MEDIA SOLUTIONS (Sept. 29, 2013), http://qmediasolutions.com/how-much-does-a-video-cost/ (finding that today "[a] young film school grad with 5K worth of gear can shoot and rival the quality of a professional crew using 150K worth of gear").

side the cost of distribution, IP theory should worry less about the latter.[141]

Third, "fewer sales" does not mean "no sales." One of the lessons of the Internet is that a surprising number of people will pay for content they like even when they don't have to.[142] While the increased efficiency of the Internet has driven marginal cost towards zero,[143] there are still many purchases of digital content. For example, people made more music purchases in 2010 than they ever did before the Internet,[144] whether because it is more convenient, because it is legal, or because people actually want to support musicians they like.[145] Indeed, the fact that music is available illegally for free may encourage people to try more music, and many of those people then end up paying for music they like.[146] Even those creators who depend on copyright revenues for incentives don't need to make money from every copy. A hybrid ecosystem in which sales coexist with piracy may provide sufficient incentive to keep those artists creating, even if they make less money than they would in a world without piracy. Artists are also finding new (or sometimes old) ways to get paid, from musicians touring and selling T-shirts to writers turning to serialized con-

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[141] *See supra* notes 23–26 and accompanying text (providing the economic justification for IP).

[142] *See, e.g.*, Tobias Regner, *Why Consumers Pay Voluntarily: Evidence from Online Music*, J. OF BEHAV. & EXPERIMENTAL ECON. (forthcoming 2014) (manuscript at 27), *available at* http://ideas.repec.org/p/jrp/jrpwrp/2010-081.html (describing the results of an empirical study demonstrating that people are strongly influenced by social norms to pay a suggested price even if they could get that content for free).

[143] RIFKIN, *supra* note 5, at 19.

[144] The number of music sales transactions increased from 845 million in 2000 to 1.5 billion in 2010 and to 1.65 billion in 2012. Travis, *supra* note 126 (manuscript at 12).

[145] *See* David Gerard, *Culture Is Not About Aesthetics. Punk Rock Is Now Enforced By Law.*, ROCKNERD (Sept. 13, 2013), http://rocknerd.co.uk/2013/09/13/culture-is-not-about-aesthetics-punk-rock-is-now-enforced-by-law/ ("I was actually surprised iTunes works at all, ever, for anyone—people paying $1 for something of zero marginal cost. Every sale is made because the people *wanted* to pay for the unit in question. Convenience is worth more than I'd thought.").

The rise of streaming services like Spotify changes this calculus somewhat, as consumers switch from buying individual songs to paying a monthly fee for access to an unlimited number of songs. It does not, however, change the fact that people are paying for music, just the way in which they are doing so (and the rights that come along with it).

[146] *See, e.g.*, Ram D. Gopal & Sudip Bhattacharjee, *Do Artists Benefit from Online Music Sharing?*, 79 J. BUS. 1503, 1529 (2006) (finding that when individuals are able to sample music for free they are more likely to purchase the music that they like later); Felix Oberholzer-Gee & Koleman Strumpf, *The Effect of File Sharing on Record Sales: An Empirical Analysis*, 115 J. POL. ECON. 1, 38 (2007) (finding that illegal downloading did not cut into music sales); *cf.* George Barker & Tim Maloney, *The Impact of Free Music Downloads on the Purchase of Music CDs in Canada* 12 (Ctr. for Law and Econ., Austl. Nat'l Univ. Coll. of Law, Working Paper No. 4, 2012), *available at* http://ssrn.com/abstract=2128054 (finding that a 10% increase in P2P downloads reduces CD demand by roughly 0.4%).

tent.[147] And offering content to others for free radically expands the number of consumers of that content by eliminating financial transactions, enhancing social welfare.[148]

Fourth, the combination of reduction in the costs of creation, reproduction, and distribution has opened the doors to numerous new creators who could not find an audience in the pre-Internet world, either because creation was too costly or because they were not identified by the content-distributing intermediaries like record companies, publishing houses, or movie studios.[149] Even if traditional content creators had less incentive to create after the development of the Internet, the Internet enabled the rise of a mass of amateur, semiprofessional, and small-scale professional creators that more than made up the difference.[150] Chris Anderson refers to this as the "Long Tail"—a vast multitude of works that are not hits, but which collectively are consumed by more people than blockbuster content.[151] Notably, a major study by Peter DiCola finds that professional musicians make over 75% of their earnings from sources unrelated to copyright.[152] Kate Darling finds something similar in adult entertainment: Despite the losses professional creators have suffered from

147 *See, e.g.*, David Streitfeld, *Web Fiction, Serialized and Social*, N.Y. TIMES, Mar. 24, 2014, at B1 (describing how authors use free, serialized content to develop a fan base that can be leveraged to pitch work to publishers).

148 Economic research suggests that zero is not simply a price like any other; people behave differently when faced with free things. *See, e.g.*, DAN ARIELY, PREDICTABLY IRRATIONAL: THE HIDDEN FORCES THAT SHAPE OUR DECISIONS 49–65 (2008) (discussing "the zero price effect"); Newman, *supra* note 35, at 1444 ("[U]tility does not map linearly onto prices; rather, the positive affect [sic] associated with zero prices causes an outsized increase in valuation as indicated by consumers' revealed preferences."); Kristina Shampanier et al., *Zero as a Special Price: The True Value of Free Products*, 26 MARKETING SCI. 742, 742 (2007) (proposing that people's decisions about zero-price products differ from other products).

149 *See, e.g.*, CHRIS ANDERSON, THE LONG TAIL: WHY THE FUTURE OF BUSINESS IS SELLING LESS FOR MORE 77, 128 (2008) (describing how most authors are not attractive to the commercial publisher, and most films are not going to get major distribution).

150 For a discussion of new kinds of production these trends enable, such as networked collaboration and peer production, see, for example, BENKLER, *supra* note 135, at 5, 8–9, 63, 66, 70, 74, 82 (discussing advantages of networked collaboration and peer production); Julie E. Cohen, *Copyright as Property in the Post-Industrial Economy: A Research Agenda*, 2011 WIS. L. REV. 141, 154–55 (2011) (describing copyright as facilitating combination and coordination).

151 ANDERSON, *supra* note 149, at 6–10, 15–26, 121.

152 Peter DiCola, *Money from Music: Survey Evidence on Musicians' Revenue and Lessons About Copyright Incentives*, 55 ARIZ. L. REV. 301, 304–05 (2013). Only composers make most of their money from copyright-related sources. *See id.* (noting that, although musicians in general earn only a small portion of their revenue directly from copyright, composers earn 68% of their revenue directly from copyright); *see also* Martin Kretschmer, Does Copyright Law Matter? An Empirical Analysis of Creators' Earnings 33–34 (May 21, 2012) (unpublished manuscript), *available at* http://ssrn.com/abstract=2063735 (finding that most copyright revenues go to a few superstars).

widespread piracy, there is more content generation than ever before.[153] Any decline in professional production has been more than made up for by the entry of new content providers as the cost of photo and video production technology dropped precipitously.

Studies by Eric von Hippel have found that even before the Internet, the amount of amateur user innovation dwarfed that by professional research and development facilities.[154] He argues that technology permits more and more democratization of innovation.[155] If the goal of IP is to encourage new creation, the fact that we have opened new avenues to implement and distribute that creativity may serve that goal even as traditional paid content creation jobs decline. When it comes to creation, the evidence suggests that we want many different eyes on a problem, not just a few, no matter how concentrated their incentives.[156]

Fifth, opening the door to new creators by reducing costs and barriers to entry doesn't just give us the new works those creators make; it may actually encourage creativity by others. A growing body of economic literature finds that "spillovers"—third-party benefits provided by a work that its creator can't capture—actually drive further innova-

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It is possible that creators create in hopes of being one of the few superstars whose work is actually rewarded by copyright law. It is well known that people systematically overvalue the prospect of a large but unlikely reward; that's why they buy lottery tickets. Some scholars have suggested that the same effect may be at work in IP. *E.g.*, F.M. Scherer, *The Innovation Lottery*, *in* EXPANDING THE BOUNDARIES OF INTELLECTUAL PROPERTY: INNOVATION POLICY FOR THE KNOWLEDGE SOCIETY 3, 3 (Rochelle Cooper Dreyfuss et al. eds., 2001) (discussing the lottery-like effect of the patent system); Dennis D. Crouch, *The Patent Lottery: Exploiting Behavioral Economics for the Common Good*, 16 GEO. MASON L. REV. 141, 142 (2008) (same); Mark A. Lemley, *What's Different About Intellectual Property?*, 83 TEX. L. REV. 1097, 1102–03 (2005) (same). But if so, the incentive on which we rely is, as Kretschmer puts it, "based on a systematic cognitive mistake." Kretschmer, *supra*, at 1. In effect, we are coaxing works out of these creators by lying to them about their chances of getting paid.

153 *See, e.g.*, Kate Darling, *IP Without IP? A Study of the Online Adult Entertainment Industry*, 17 STAN. TECH. L. REV. 709, 727, 739 (2014) (noting how the Internet and related technology provided opportunities for new market entrants in the adult entertainment industry).

154 *See, e.g.*, Eric von Hippel et al., *Comparing Business and Household Sector Innovation in Consumer Products: Findings from a Representative Study in the United Kingdom*, 58 MGMT. SCI. 1669, 1669 (2012) (finding that consumers' annual product development expenditures are 1.4 times larger than product R&D expenditures of all U.K. firms combined).

155 *See* ERIC VON HIPPEL, DEMOCRATIZING INNOVATION 121–24 (2005) (discussing the accessibility of design and creation given new available technologies).

156 *See, e.g.*, Arrow, *supra* note 11, at 619–20 (arguing that the threat of competition, not the lure of monopoly, is the primary driver of invention); ORLY LOBEL, TALENT WANTS TO BE FREE 9 (2013) ("[M]ovement and competition are good for innovation.").

tion.[157] Being around people with good ideas, whether geographically or in a product space, actually makes it more likely that you will have good ideas of your own.[158] So opening up creativity to newcomers may actually make existing creators more productive.

Finally, it may simply be that IP theory is wrong about what motivates people to create. There is substantial evidence in the innovation and psychology literatures that motivation to create is largely internal or problem driven.[159] People create because they have an inspiration, because they are driven to do so, or because they want to solve a problem.[160] They seem to be motivated more by rights of attribution

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157 *E.g.*, Brett M. Frischmann & Mark A. Lemley, *Spillovers*, 107 COLUM. L. REV. 257, 268–71 (2007).

158 *See id.* at 259–61 and sources cited therein; *see also* LOBEL, *supra* note 156, at 9 ("[A] touchstone of talent mobility is the interaction between inventive people. New data continue to reveal that when innovators collaborate they become greater than the sum of their parts.").

159 LOBEL, *supra* note 156, at 170–79. For a discussion of the neuroscience of creativity, see generally NEUROSCIENCE OF CREATIVITY (OSHIN VARTANIAN ET AL. EDS., 2013); Erez Reuveni, *Copyright, Neuroscience, and Creativity*, 64 ALA. L. REV. 735 (2013).

160 The literature on this in IP is recent, but growing. *See, e.g.*, Henry Biggs, *Towards a More Comprehensive Approach to the Promotion of Creativity*, 38 U. DAYTON L. REV. 401 (2013) (exploring the various things besides money that motivate creativity); Chander & Sunder, *supra* note 15, at 1402–03 (listing numerous works that show creation being motivated by something other than just money); Julie E. Cohen, *Creativity and Culture in Copyright Theory*, 40 U.C. DAVIS L. REV. 1151, 1178, 1183, 1190 (2007) (discussing some of the factors affecting creative output other than monetary incentives); Jeanne C. Fromer, *A Psychology of Intellectual Property*, 104 Nw. U. L. REV. 1441, 1443–44 (2010) (discussing the creative process as being made up of problem finding and problem solving); Eric E. Johnson, *Intellectual Property and the Incentive Fallacy*, 39 FLA. ST. U. L. REV. 623, 627 (2012) (discussing the flaws of the incentive theory, and the tendency for creativity to flourish even without external rewards); Gregory N. Mandel, *Left-Brain Versus Right-Brain: Competing Conceptions of Creativity in Intellectual Property Law*, 44 U.C. DAVIS L. REV. 283, 285–86 (2010) (discussing the intuitive and analytical elements of artistic and inventive creativity); Gregory N. Mandel, *To Promote the Creative Process: Intellectual Property Law and the Psychology of Creativity*, 86 NOTRE DAME L. REV. 1999, 2000 (2011) (discussing experimental cognitive research that reveals intrinsic motivation is highly conducive to creative production, while purely extrinsic motivation tends to be the opposite) [hereinafter Mandel, *Promote*]; Jessica Silbey, *Harvesting Intellectual Property: Inspired Beginnings and "Work-Makes-Work," Two Stages in the Creative Processes of Artists and Innovators*, 86 NOTRE DAME L. REV. 2091, 2092–93 (2011) (discussing the role of intrinsic and serendipitous forces and pleasure in work); Sara K. Stadler, *Incentive and Expectation in Copyright*, 58 HASTINGS L.J. 433, 478 (2007) (discussing the circularity of expectations and incentives in copyright); Rebecca Tushnet, *Economies of Desire: Fair Use and Marketplace Assumptions*, 51 WM. & MARY L. REV. 513, 515 (2009) (discussing how creativity is often grounded in a desire for creation, sometimes beyond rationality and economic incentives); Diane Leenheer Zimmerman, *Copyright as Incentives: Did We Just Imagine That?*, 12 THEORETICAL INQUIRIES IN L. 29, 35–36 (2011) (describing examples of innovation influenced by pragmatism, spirituality, and other noneconomic incentives). *But see* Daniel J. Hemel & Lisa Larrimore Ouellette, *Beyond the Patents-Prizes Debate*, 92 TEX. L. REV. 303, 353–55 (2013) (challenging the idea that creation is driven by nonmonetary motivations by noting that they often coexist with monetary ones). *Cf.* Laura

and recognition than by money.[161] Free riding doesn't seem to stop them from innovating.[162] Indeed, there is even evidence that monetary incentives can reduce creativity: Works created because of a demand or promise of payment are less creative than those created for other reasons, because "doing it for the money" seems to dampen intrinsic motivation.[163] And the *way* they create seems to rely on net-

G. Pedraza-Fariña, *Patent Law and the Sociology of Innovation*, 2013 WIS. L. REV. 813, 813 (2013) (documenting the various sociological factors that play into scientific discovery and how quickly that discovery is accepted).

One might view the idea that creators aren't primarily motivated by money as a rejection of economics, but I don't think it is. Economics, properly understood, is about understanding the incentives that motivate human behavior. Sometimes that is money, but not always. Evidence that people are motivated to create by things other than money may mean the classic IP incentive story is wrong, but it doesn't mean that economics is wrong.

[161] *See* MIHALY CSIKSZENTMIHALYI, CREATIVITY: FLOW AND THE PSYCHOLOGY OF DISCOVERY AND INVENTION 107–08 (1996) (finding that creative people often value enjoying their work more than money); JESSICA SILBEY, THE EUREKA MYTH: CREATORS, INNOVATORS, AND EVERYDAY INTELLECTUAL PROPERTY 14 (2015) (surveying creators about their motivations); Jeanne C. Fromer, *Expressive Incentives in Intellectual Property*, 98 VA. L. REV. 1745, 1777 (2012) ("[C]reators' beliefs in their moral rights typically seem to dominate their pecuniary interests in creating."); Fromer, *supra* note 160, at 1483 (noting that people are most creative when intrinsically motivated, although creators require extrinsic support to publicize and distribute their work); William Hubbard, *Inventing Norms*, 44 CONN. L. REV. 369, 369 (2011) (stating that inventors are motivated to invent because of societal norms that result in personal satisfaction and esteem from friends for successful invention); Rebecca Tushnet, *Naming Rights: Attribution and Law*, 2007 UTAH L. REV. 789, 822 (2007) (noting that attribution is a powerful incentive for creative production).

[162] *See, e.g.*, Christoph Engel & Marco Kleine, *Who Is Afraid of Pirates? An Experiment on the Deterrence of Innovation by Imitation*, 44 RES. POL'Y 20, 30 (2015) (finding in an experimental study that there is more imitation than expected, but that that imitation does not deter innovation).

[163] *See* TERESA M. AMABILE, CREATIVITY IN CONTEXT 171 (1996) (noting that research indicates that the offer of rewards undermines creativity); LOBEL, *supra* note 156, at 190–95 (explaining that people are most productive and creative at work when they feel useful and connected to their work and workplace); Beth A. Hennessey & Teresa M. Amabile, *Reward, Intrinsic Motivation, and Creativity*, 53 AM. PSYCHOLOGIST 674, 675 (1998) (noting that extrinsic motivation can sometimes improve motivation and creativity, but usually only under limited conditions or with specialized training); Mandel, *Promote*, *supra* note 160, at 2010 ("As motivation moves from the extrinsic toward the intrinsic side of the motivation spectrum, individuals' work product tends to become more creative."); John Quiggin & Dan Hunter, *Money Ruins Everything*, 30 HASTINGS COMM. & ENT. L.J. 203, 214–15 (2008) (discussing the role of noncommercial motivations for amateur content creation in the privacy of homes); *cf.* Yuval Feldman & Orly Lobel, *The Incentives Matrix: The Comparative Effectiveness of Rewards, Liabilities, Duties, and Protections for Reporting Illegality*, 88 TEX. L. REV. 1151 (2010) (discussing the efficacy of monetary incentives in a non-IP context). For an empirical test of this question, see Christopher Buccafusco et al., *Experimental Tests of Intellectual Property Laws' Creativity Thresholds*, 92 TEX. L. REV. 1921, 1972–73 (2014) (finding that high creativity thresholds for monetary rewards did not impede creativity and may have enhanced it).

There is another factor at work here: People in any occupation traditionally work less as they are paid more, because they substitute leisure time for additional money.

works of people and information that creators draw on as inputs.[164] Collaboration may be inherently more productive than isolated work.[165] If this is true, the Internet may have spurred an unprecedented outpouring of creativity for the simple reason that many people are now free to create and share their works with the world for the first time. More input plus more minds at work means more creative works.

This last hypothesis, if true, does not mean that IP never played a role in the creative process, or that it cannot continue to do so in some ways. It may be that even if artists and inventors are not primarily motivated by money, corporations are.[166] Those corporations might pay the artists and inventors to create, or acquire their work and do the costly job of bringing it to the masses. A number of scholars have suggested that what IP truly encourages is not the act of creation but the act of commercialization.[167] I have elsewhere been critical of the

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Economists call this the "income effect." *Nice Work if You Can Get Out*, ECONOMIST, Apr. 19, 2014, at 71, 71, *available at* http://www.economist.com/news/finance-and-economics/21600989-why-rich-now-have-less-leisure-poor-nice-work-if-you-can-get-out. That is true of creators as well as other kinds of employees. Thus, Mike Scherer finds that Italian composer Giuseppi Verdi substantially reduced the number of operas he wrote each decade once copyright was introduced in Italy and his earnings increased. F.M. Scherer, *The Emergence of Musical Copyright in Europe from 1709 to 1850*, 5 REV. ECON. RES. COPYRIGHT ISSUES, no. 2, 2008, at 3, 11. Lunney makes this point more general: Beyond a certain point, artists will create less as they are paid more. Lunney, *supra* note 109, at 16–18. That is particularly true with copyright, which provides a continuing revenue stream for past works rather than conditioning payment on future creativity.

Interestingly, however, one corollary of the income effect—that rich people should enjoy more leisure time than poor people—has recently stopped being true. *Nice Work*, *supra* (reporting evidence on this "substitution effect"). I discuss some of the implications of that fact in the final Part of this Article.

164 *See* Reuveni, *supra* note 159, at 747–55 (discussing the internal and external information networks that form the cognitive architecture of creativity).

165 *See* YOCHAI BENKLER, THE PENGUIN AND THE LEVIATHAN: THE TRIUMPH OF COOPERATION OVER SELF-INTEREST (2011) (making this argument).

166 Julie Cohen suggests that IP is fundamentally about generating property rights for corporations, not creators. Cohen, *supra* note 150, at 142–43.

167 *See* Michael Abramowicz & John F. Duffy, *Intellectual Property for Market Experimentation*, 83 N.Y.U. L. REV. 337, 405, 408 (2008) (arguing for a system that allows "commercialization" patents, which would provide for patents in cases where commercialization is daunting, although traditional patentability requirements are not strictly met); Michael Abramowicz, *The Danger of Underdeveloped Patent Prospects*, 92 CORNELL L. REV. 1065, 1106–10 (2007) (discussing how to encourage further development of an invention towards commercialization with patent incentives); Jonathan M. Barnett, *Copyright Without Creators*, 9 REV. L. & ECON. 389, 404–14 (2013) (discussing copyright's role in efficient distributing and marketing of content); F. Scott Kieff, *Property Rights and Property Rules for Commercializing Inventions*, 85 MINN. L. REV. 697, 710 (2001) (discussing incentives from patent law to commercialize); Ted Sichelman, *Commercializing Patents*, 62 STAN. L. REV. 341, 345 (2010) (discussing possible changes to improve patent law's commercialization incentives).

idea that we should give one company control over investing in bringing a product to market.[168] And the empirical evidence suggests that IP rights actually impede rather than encourage commercialization.[169] But even those who believe that IP law traditionally served the goal not of encouraging creation but of encouraging its distribution should acknowledge that the Internet renders that justification irrelevant. An IP regime based on the idea that reproduction and distribution are costly and need to be encouraged becomes unnecessary in a world where reproduction and distribution become costless.

Related justifications focus on the value of the commercializer as an intermediary, picking the valuable books and songs so the consumer doesn't have to.[170] But that justification too collapses with the arrival of the Internet. Crowds do a surprisingly good job of picking

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168 *E.g.*, Mark A. Lemley, *Ex Ante Versus Ex Post Justifications for Intellectual Property*, 71 U. CHI. L. REV. 129, 142–48 (2004); Lemley, *supra* note 13, at 738–45. There is good empirical evidence that patent rights do not drive technology transfer and may in fact impede it. *See, e.g.*, Rochelle Cooper Dreyfuss, *Double or Nothing: Technology Transfer Under the Bayh-Dole Act*, *in* BUSINESS INNOVATION AND THE LAW 52, 61–62 (Marilyn Pittard et al. eds., 2013) ("[S]cientists do appear to be influenced by patent status, and to avoid projects that require licensing."); Bhaven Sampat & Heidi L. Williams, How Do Patents Affect Follow-on Innovation? Evidence from the Human Genome 25 (Feb. 12, 2015) (unpublished manuscript), *available at* http://economics.mit.edu/files/9778 (finding no significant value to patents in driving ex-post commercialization, even in biotechnology); SECRETARY'S ADVISORY COMM. ON GENETICS, HEALTH & SOC'Y, DEP'T OF HEALTH & HUMAN SERVS., GENE PATENTS AND LICENSING PRACTICES AND THEIR IMPACT ON PATIENT ACCESS TO GENETIC TESTS, 89–90 (2010), *available at* http://oba.od.nih.gov/oba/sachgs/reports/SACHGS_patents_report_2010.pdf (finding that gene patents have the potential to give one party a stranglehold on treatment technology); Heidi L. Williams, *Intellectual Property Rights and Innovation: Evidence from the Human Genome*, 121 J. POL. ECON. 1, 22, 24 (2013) (finding that products based on genetic data in public databases were more likely to be commercialized than products based on proprietary databases); *cf.* Michael J. Burstein, *Exchanging Information Without Intellectual Property*, 91 TEX. L. REV. 227, 282 (2012) (arguing that IP is not necessary for commercialization in many circumstances).

169 *See, e.g.*, Paul J. Heald, *How Copyright Keeps Works Disappeared*, 11 J. EMPIRICAL L. STUD. 829, 829 (2014) (finding in an empirical study that "[t]ogether with publishing business models, copyright law seems to deter distribution and diminish access"); Paul J. Heald, *Property Rights and the Efficient Exploitation of Copyrighted Works: An Empirical Analysis of Public Domain and Copyrighted Fiction Bestsellers*, 92 MINN. L. REV. 1031, 1034 (2008) (presenting empirical data that suggests copyright extension imposes deadweight losses without offsetting gains).

170 Jonathan Barnett, for example, argues that while the Internet reduces costs of creation, reproduction, and distribution, it increases the costs of finding and evaluating that content. Barnett, *supra* note 167, at 391–92, 414, 416; *see also id.* at 425–26 (arguing that copyright owners are necessary to pick future superstars for us). Patent theory has similarly focused on the role of patents as signaling devices. Clarisa Long, *Patent Signals*, 69 U. CHI. L. REV. 625 (2002); *see also* Mark A. Lemley, *Reconceiving Patents in the Age of Venture Capital*, 4 J. SM. & EMERGING BUS. L. 137, 144 (2000) (noting that patents can be indicators of a company's market model, product differentiation or branding, and progress in research and development).

the content they want. Indeed, in some modern content markets it is crowds that perform the intermediation function, with the content industries publishing works only after they have been pre-selected by the audience. For example, Joel Waldfogel and Imke Reimers show that an astonishing 10% of best-selling books were first self-published, and that in some popular genres that percentage is over 30%; those books got mainstream publishers only after they proved their value in the marketplace.[171] Similarly, many superstars in music and even television, such as Justin Bieber,[172] were relative unknowns disdained by the major studios but discovered by fans.[173] And even if crowds can't be relied upon to pick books, music, and movies, software is getting better and better at doing it for us as artificial intelligence improves and as Big Data gives it more detailed information about our likes and dislikes.[174]

There is still a role for IP on the Internet. There are some works that are so costly to create even in the digital world that they are unlikely to be made without effective IP protection. Big-budget movies and video games cost hundreds of millions of dollars to make. No amount of creative fire will drive someone who doesn't have hundreds of millions of dollars to make Peter Jackson's Lord of the Rings trilogy.[175] They need corporate backing, and the corporate backers need a revenue stream. But in the Internet era those works are increasingly the exception, not the rule. The law therefore needs to figure out ways to protect those exceptional works without blocking the creativity that is happening despite, not because of, IP.

B. Lessons from the Internet Experience

The Internet offers valuable lessons for the coming economy of plenty. In a world where goods, services, and biologics share the economic characteristics of content distributed over the Internet, what

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171 Waldfogel & Reimers, *supra* note 109, at 22; *see also* Alexandra Alter, *Publishers Turn to the Crowd to Find the Next Best Seller*, N.Y. TIMES, Aug. 12, 2014, at B1 (describing efforts to crowdsource the selection of a work for publication).

172 OK, bad example.

173 *See* Joel Waldfogel, And the Bands Played On: Digital Disintermediation and the Quality of New Recorded Music 25, 31 (June 25, 2012) (unpublished manuscript), *available at* http://ssrn.com/abstract=2117372 (finding that independently produced albums that would not have made it to market under a pre-Internet regime account for a growing share of commercially successful albums).

174 *See* RIFKIN, *supra* note 5, at 130 (describing companies picking potential hits in music and movies by using Big Data).

175 The Lord of the Rings trilogy reportedly cost a total of $281 million to create and The Hobbit even more. Nick Perry, *APNewsBreak: 'Hobbit' Trilogy Costs $561M So Far*, THE BIG STORY (Oct. 4, 2013, 9:54 AM), http://bigstory.ap.org/article/apnewsbreak-hobbit-trilogy-cost-561m-so-far.

can we learn about IP and innovation in those spaces? Here are several lessons.

1. IP Owners Will Fight the Death of Scarcity

Content owners fought tooth and nail to prevent the development of digital content. They sought to shut down the technology, to sue the people who used it, and to sue anyone associated with those people.[176] Ironically, at least one reason that copyright infringement is so prevalent on the Internet is that, for many years, consumers who wanted access to digital content on demand had no legal alternative. The music industry spent years trying to shut down digital music before actually offering a realistic, legal, digital music service, and when they finally did agree to license a legal alternative—iTunes—they priced their songs to protect their offline music market rather than to make digital music attractive. Book publishers conspired to raise the price of eBooks so they wouldn't cut into the sales of hardback books; it took a successful government antitrust case to force competition in eBook pricing.[177] And even today, the labyrinth of rules around lawful access to television shows is so great that it is impossible to know what episodes of a show will be available when, from what source, and for how long.[178]

Some of that resistance is irrational, a fear that the sky is falling whenever things change. But some of it is rational even if it is not socially optimal. While I suggest *society* would benefit from the explosion of content on the Internet,[179] and I think that on balance *creators* would too, it does not follow that existing copyright *industries* will benefit. The history of technological disruption of copyright law is almost always one of more people creating more content and making more money,[180] but the people making money from content in the new regime are not always the same ones who made money in the old one. The phonograph was a godsend to both musicians and consumers, but those in the business of printing sheet music probably didn't see it that way. Similarly, while record companies, movie stu-

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176 *See supra* notes 110–14 and accompanying text.

177 United States v. Apple Inc., 952 F. Supp. 2d 638 (S.D.N.Y. 2013).

178 This problem has even been mocked in a cartoon. *I Tried to Watch Game of Thrones and This Is What Happened*, THE OATMEAL, http://theoatmeal.com/comics/game_of_thrones (last visited Nov. 21, 2014) (detailing the adventures of someone who tries and fails to watch Game of Thrones legally on the Internet). Warning: As with most of the Oatmeal cartoons, this one is NSFW.

179 *See supra* Part II.A.

180 *See* Lemley, *supra* note 32, at 125–32 (offering several examples from the nineteenth century to the present where technological disruption created a new boom in content consumption even though content industries predicted disaster).

dios, and book publishers will all likely survive the digital transition, it is doubtful they will be able to hold on to a business model in which they take the lion's share of the revenue, leaving only a small percentage for the artists. It may well be rational for record companies and movie studios to fight the digital transition, even if it is rational for everyone else concerned to hope they lose that fight.[181]

The same dynamic is likely to play out in each of the new technologies I discussed in Part I. Professional industrial design firms will resist having their works "Napsterized"[182] because they fear losing control over who can use their design and not getting paid when people do.[183] Indeed, some have already called for strengthening IP laws to try to block the distribution of designs for patented products to 3D printers.[184] Large biotechnology companies will resist the move to a modular, open-source synthetic biology. And while the economics are less clear, robotics companies may well resist giving control over what their robots do to a host of amateurs who can change and upgrade those robots, preferring instead to keep control in the factory (and keep demand for new versions strong).[185] IP law offers tools to each of those companies: design and utility patents in the case of 3D printing,[186] utility patents for synthetic biology, and patents and copy-

[181] *See* RIFKIN, *supra* note 5, at 6 ("Powerful industry leaders often strive to restrict entry of new enterprises and innovations."); Mark P. McKenna, *Fixing Copyright in Three Impossible Steps*, 39 J.C. & U.L. 715, 724 (2013) ("It is, of course, inevitable that economic interests will harden around existing rules and technologies. But that is all the more reason to be skeptical of claims by rights owners that new technologies threaten creativity—what they really mean is that those new technologies threaten certain entrenched interests.").

[182] *See supra* note 62 and accompanying text (discussing the impact of 3D printing on patent industries and comparing it to the technological disruption in the copyright industries).

[183] *See id.* at 1705 ("The temptation to lobby for legal limits on 3D printing technology will be strong."); Finocchiaro, *supra* note 38, at 507–08 (noting the risk that incumbents will seek to regulate 3D printing to protect their own interests).

[184] *See, e.g.*, Nicole A. Syzdek, *Five Stages of Patent Grief to Achieve 3D Printing Acceptance*, 49 U.S.F. L. REV. (forthcoming 2015) (manuscript at 10–11) (on file with the New York University Law Review) ("Currently, it may be easy for enraged patent holders to persuade policy makers and judges to impose limits on the growth of 3D printing technology . . . . Patent holders may [also] try to teach the public about the illegality of infringement through litigation."). Notably, Syzdek does not support these efforts to stifle the technology. *Id.* (manuscript at 25).

Futurist Cory Doctorow's 2007 short story *Printcrime* is premised on the idea that governments banned 3D printers because of their potential for illegal use. CORY DOCTOROW, *Printcrime*, *in* OVERCLOCKED: STORIES OF THE FUTURE PRESENT 1, 2–4 (2007).

[185] Manufacturers of robots and 3D printers may worry for other reasons as well, such as the risk of liability if their devices are misused. *See* Engstrom, *supra* note 39, at 38 (discussing the difficulties in assessing liability in a world of 3D printing).

[186] Patent law has traditionally not applied to the movement or sale of information or blueprints for creating devices rather than the devices themselves. *See, e.g.*, Microsoft

rights for robotics. We should expect to hear the same sorts of warnings about these new technologies that we heard about the Internet, and we should expect to see the same effort to use IP rights and the courts to bring those technologies under control.

2. *IP Owners Will (Probably) Lose That Fight*

IP owners lost the fight to keep content off the Internet, or alternatively to lock down the Internet itself, for two reasons. First, there was simply too much value to the Internet as a whole and the digital distribution of content. Courts were willing to shut down sites like Napster, Grokster, and others that they viewed as designed entirely to profit from copyright infringement,[187] but they have so far balked at IP owner requests to ban sites like Amazon, Google, or YouTube that clearly had large social value despite also facilitating some infringement.[188] The second reason has to do with the democratizing nature of the Internet. There is no central infringer on the Internet. When centralized nodes for specialized services did appear, like Napster, courts promptly shut them down. But because there was so much demand for content online, even when sites were shut down, others promptly took their place. And those sites became more and more decentralized, and correspondingly harder and harder to shut down.[189] IP owners were reduced to playing Whac-a-Mole with infringing sites.

Corp. v. AT&T Corp., 550 U.S. 437, 451–52 (2007) (asserting that Congress purposely excluded "information" and "instructions" from 35 U.S.C. § 271(f)); Bayer AG v. Housey Pharm. Inc., 340 F.3d 1367, 1377 (Fed. Cir. 2003) (holding that "the production of information is not covered" by 35 U.S.C. § 271(g)). But the International Trade Commission recently ignored that precedent in issuing an order barring the "importation" of digital files describing braces for teeth. Certain Digital Models, Digital Data, and Treatment Plans for Use in Making Incremental Dental Positioning Adjustment Appliances, the Appliances Made Therefrom, and Methods of Making Same, Inv. No. 337-TA-833, USITC Pub. 531073, at 22 (Apr. 3, 2014) (final) (affirming an ALJ's determination that the "electronic transmission of digital data sets constitute[s] 'importation of . . . articles'" and therefore meets the threshold for a patent claim).

[187] *See, e.g.*, Metro-Goldwyn-Mayer Studios Inc. v. Grokster, Ltd., 545 U.S. 913, 941 (2005) (finding important Grokster's "purpose to cause and profit from third-party acts of copyright infringement"); A&M Records, Inc. v. Napster, Inc., 239 F.3d 1004, 1015 (9th Cir. 2001) (highlighting Napster's "commercial use" of copyrighted material).

[188] *See, e.g.*, Viacom Int'l, Inc. v. YouTube, Inc., 676 F.3d 19, 26 (2d Cir. 2012) (holding that YouTube could legally replicate, transmit, and display copyrighted videos as long as it did not have "actual knowledge . . . of specific infringing activity"); Perfect 10, Inc. v. Amazon.com, Inc., 508 F.3d 1146, 1176 (9th Cir. 2007) (holding that Amazon may legally direct a user's computer to a third party computer displaying copyrighted images); Field v. Google Inc., 412 F. Supp. 2d 1106, 1109 (D. Nev. 2006) (holding that Google did not violate IP rights by "allowing Internet users to access copies of . . . copyrighted works").

[189] For instance, Napster was a single, centralized search function for peer-to-peer sharing of mp3 sites. *Napster*, 239 F.3d at 1011. When it was shut down, it was replaced by Grokster and Morpheus, which did not use a central server but relied on "supernodes" run by individual users of the software to distribute content across the peer-to-peer network.

The same dynamic is likely to unfold with each of the three technologies I discuss in this paper. We have already seen calls to ban content on 3D printers—not because of IP infringement, but because people have distributed blueprints for 3D printing plastic guns that can bypass traditional airport security.[190] But precisely because the blueprint for the 3D-printed gun is nothing more than information, it turns out to be extremely hard to suppress it. IP owners are likely to run into the same sorts of obstacles in suppressing patented designs, code for robots, and genetic sequences distributed on the Internet.

IP owners in each of those industries may well turn, as the content industries did, to an effort to shut down or regulate the new technology altogether.[191] Lawmakers frustrated by 3D-printed guns have already begun to talk about regulating the sale of 3D printers themselves,[192] just as copyright owners have sought to regulate Internet connections and search engines. It is easy to imagine legislators similarly seeking to regulate gene printers in an effort to stop smallpox or to regulate unauthorized modifications to robots that might invade privacy or carry weapons.

I believe—and hope—that those efforts will fail, for the simple reason that the potential social value in these new technologies, like the Internet, is enormous. But that outcome is not certain. It depends on how established the technologies are when IP owners and others try to ban them, how clear the benefits of those technologies have become, and the farsightedness of courts and legislators asked to restrain innovation in order to protect incumbent businesses.

It also depends on the particular characteristics of the IP regimes affected. Fairly early on in the growth of the Internet, copyright law

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Grokster, 545 U.S. at 921. When Grokster was shut down it was replaced by BitTorrent, which has no centralized nodes at all and relies on individual user computers to pass along small bits of individual files, so that no user is transmitting all or most of a particular work. *See* Carmen Carmack, *How BitTorrent Works*, HowStuffWorks (Mar. 26, 2005), http://computer.howstuffworks.com/bittorrent.htm.

190 *See, e.g.*, Engstrom, *supra* note 39, at 36 n.7 (noting that it is currently illegal to possess or manufacture a firearm not detectible by a metal detector or an airport x-ray machine); Nick Bilton, *The Rise of 3-D Printed Guns*, N.Y. Times, Aug. 14, 2014, at E2 (describing the proliferation and ease of access to 3D-printed guns).

191 For the content industries' response, see *supra* notes 110–14 and accompanying text.

192 *See, e.g.*, Caitlyn R. McCutcheon, *Deeper than a Paper Cut: Is It Possible to Regulate Three-Dimensionally Printed Weapons or Will Federal Gun Laws Be Obsolete Before the Ink Has Dried?*, 2014 J. Tech. L. & Pol'y 101, 127–30 (proposing to apply federal firearms regulations to 3D-printed guns); Ryan W. Neal, *3D Printer Regulation Proposed: Democrats Fear Criminals Printing Guns*, Int'l Bus. Times (May 13, 2013, 11:26 AM), http://www.ibtimes.com/3d-printer-regulation-proposed-democrats-fear-criminals-printing-guns-1254537 (reporting a legislative proposal by California State Senator Leland Yee, which he later disavowed, for registration and background checks for 3D printers capable of printing guns).

built in a limited immunity for intermediaries that allowed the development of distribution technologies like YouTube.[193] But the IP laws that will apply to 3D printers, synthetic biology, and robotics are not just copyright but also utility patent and design patent law, which have characteristics that are much less hospitable to intermediaries.

Utility patent and design patent law do not require copying; independent creation of the same technology is an act of infringement.[194] And while they were written with manufacturing entities in mind, anyone who makes or uses the invention is an infringer, creating a risk that end-users will be sued for patent infringement when they use 3D printers.[195] There is as yet no immunity for intermediaries from utility patent or design patent infringement. And design patents at least have a draconian damages regime that imposes a disproportionate cost on those found to infringe.[196] On the other hand, copyright law is more easily adapted to information; depending on the way the claims are written, owners of utility or design patents might have to sue the actual maker of a thing rather than just the intermediary who provides a blueprint.[197]

The Internet has survived repeated efforts by private parties to lock it down, and it seems unlikely after the dramatic defeat of SOPA[198] that anything so draconian will pass, at least in the United States. But that was never a guaranteed outcome.[199] One possible

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193 17 U.S.C. § 512 (2012) (giving immunity to service providers for material transmitted through an "automated technical process"); *see also* Anupam Chander, *How Law Made Silicon Valley*, 63 EMORY L.J. 639, 660–61 (2014) (noting the importance of this immunity for websites dealing with third-party content).

194 *See, e.g.*, Allen Eng'g Corp. v. Bartell Indus., Inc., 299 F.3d 1336, 1351 (Fed. Cir. 2002) (explaining that copying is irrelevant to "whether the claims of an issued patent are infringed"); Mark A. Lemley, Correspondence, *Should Patent Infringement Require Proof of Copying?*, 105 MICH. L. REV. 1525, 1525 (2007) (explaining that patent infringement is a strict liability offense and does not require knowledge of the patent's existence).

195 Skyler R. Peacock, Note, *Why Manufacturing Matters: 3D Printing, Computer-Aided Designs, and the Rise of End-User Patent Infringement*, 55 WM. & MARY L. REV. 1933, 1934–35 (2014).

196 *See* 35 U.S.C. § 289 (2012) (awarding a design patent plaintiff the defendant's entire profit from the sale of the article, regardless of how much the patented design contributed to that profit). For criticism of this rule, see Mark A. Lemley, *A Rational System of Design Patent Remedies*, 17 STAN. TECH. L. REV. 219, 224–31 (2013).

197 Brean, *supra* note 38, at 807–13 makes this argument.

198 The Stop Online Piracy Act was proposed legislation that would have given courts the power to prevent interconnection on the Internet to websites deemed to traffic in piracy. It was stopped by an unprecedented coalition of Internet companies and individuals. *See* HACKING POLITICS: HOW GEEKS, PROGRESSIVES, THE TEA PARTY, GAMERS, ANARCHISTS, AND SUITS TEAMED UP TO DEFEAT SOPA AND SAVE THE INTERNET (David Moon et al. eds., 2013) (telling the story of SOPA).

199 Nor did the Internet emerge entirely unscathed from the lockdown efforts, as Mike Linksvayer points out. Mike Linksvayer, *Innovation Policy in a World with Less Scarcity*,

future for 3D printing, synthetic biology, and robotics is a dystopian one in which a few large companies get the right to decide what sorts of innovation are permissible, whether by combining existing law with ubiquitous surveillance technology or by passing new laws that restrict entry into the technology. That is a particularly worrisome outcome in complex technologies like synthetic biology and robotics, because it is unlikely that any one company is going to be the best at developing all the pieces of the technology someone might want to use.[200] iRobot might make a great vacuum cleaner (the Roomba), but there is no guarantee they will also make the best software for having a robot drive you to work or wash your dishes.

3. IP Owners' Loss Is (Mostly) Innovation's Success

If we can avoid the dystopian future of lockdown, the future of technology is likely to look quite a bit like the Internet. Lots of people will create lots of designs, code, and biobricks. Other people will use, repurpose, and improve on those things, often without paying. But people will continue to create, because some people will pay for their creations, because there will be other ways to make money from being creative, because they want to be known for something or want the feeling of accomplishment that comes with creating, and, ultimately, simply because they can. More and more of these creations will operate outside the IP system, either expressly (biobrick inventors who choose not to patent their inventions, for instance) or by the simple virtue of ignoring that system.[201]

This future is not a utopia. None of the technologies I have described is perfect, and each requires physical inputs that will in turn be subject to the laws of scarcity. Further, the lesson of the Internet is that while cheap, democratized production drives more creation, not less, it may also change the nature of that creation. Without IP rights we may see more creation by amateurs and academics and less by professional creators, just as in music we now see more new bands and fewer bands with multi-album staying power.[202] That is both a good and a bad thing; removing the requirement of a major label record contract has let lots of new talent into music, but the decline of professional artists may change the nature of music in ways that cause us to

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GONDWANALAND (Mar. 28, 2014), http:///gondwanaland.com/mlog/2014/03/28/ip-post-scarcity/.

[200] *See* Lemley, *supra* note 26, at 1048–52 (observing that the first person to invent something might not be the best person to change or improve it).

[201] *See* VON HIPPEL, *supra* note 155, at 89–91 (noting how the willingness of user innovators to give their ideas away calls into question the basic theory of IP).

[202] *See supra* notes 150–56 and accompanying text (noting this trend).

lose some music we'd like to have. Similarly, it is possible to imagine both a wealth of new product designs for 3D printers and a decline in the number of professional design firms. And in synthetic biology, where at least some products, like viruses and FDA-controlled chemicals, are likely to be heavily regulated, the cost and delay associated with that regulation may require some means to recoup investment.

At least in the medium term, however, those professional firms are likely to coexist with the amateurs, just as professional musicians and movie studios have found it possible to coexist—even thrive—alongside the new entrants. The dramatic reduction in cost that has spurred new entry also boosted the demand for content—people consume more music and video content than ever before, for example[203]—and people are willing to pay for things they like if they are delivered in convenient packages. And IP rights are unlikely to disappear even if they are increasingly flouted, so professional providers who choose to rely on IP rather than sharing their work for free can still make some money by doing so.[204]

In short, the technologies I highlight in this Article offer a world in which people create more things at less cost, largely despite rather than because of the IP laws. The IP laws will continue to exist, and they will provide a necessary incentive for some forms of creativity. But creation that relies on IP is likely to play a less and less significant role in a post-scarcity world.

None of this is to say that these new technologies have no risks. A number of scholars have worried about the health and safety risks of distributed access to technologies that can 3D print guns or, worse, viruses.[205] Some might conclude that we should regulate these technologies, not in the hopes of encouraging innovation, but in order to prevent innovation that can cause harm to society.[206] But that is not what IP is supposed to be about. If we want to regulate technologies because of their harmful social effects, IP would seem an odd place to do it.

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[203] *See supra* notes 122–33 and accompanying text (noting a growth in demand for music, movies, and books).

[204] *See* Desai & Magliocca, *supra* note 62, at 1705 ("[F]irms would be better off embracing this change in production to cultivate new markets instead of trying to win Pyrrhic victories in Congress and the courts.").

[205] *See, e.g.*, Bilton, *supra* note 190 (discussing the dispute over 3D-printed guns); Jordan Paradise & Ethan Fitzpatrick, *Synthetic Biology: Does Re-Writing Nature Require Re-Writing Regulation?*, 117 PENN ST. L. REV. 53, 61 (2012) (discussing the threat of synthetically manufactured organisms).

[206] BENJAMIN WITTES & GABRIELLA BLUM, THE FUTURE OF VIOLENCE: ROBOTS AND GERMS, HACKERS AND DRONES—CONFRONTING A NEW AGE OF THREAT 115–22 (2015) (arguing for a greater role for government in regulating access to dangerous distributed technologies).

III
BEYOND THE ECONOMICS OF SCARCITY

As we saw in Part II, IP law has significant implications for the development of a number of different technologies. But those technologies also have broader implications for IP law, and indeed for the economy more generally.

A. IP in a Post-Scarcity World

I suggested in Part II that on the Internet, we increasingly get creativity in spite of, rather than because of, IP law. If true, that fact has important implications for the role of IP. We are still a long way from a post-scarcity world. But as more and more pieces of the economy are based on information coupled with cheap, decentralized supplies of physical goods, our IP rules will take on increasing importance. The point of the IP laws is to encourage creation. If those laws are not promoting innovation and creation in that new world, we need to rethink them.

The IP laws were created in a world of scarcity. They sought to take ideas that were public goods—things that by their nature were not scarce—and artificially make them scarce by designating them as owned by someone.[207] The hope was that by bringing those ideas within the traditional framework of economics, we would create market incentives we could understand and accordingly encourage investment both in the creation of new things and the distribution of those things to the world. By most accounts, that approach has worked quite well for a long time.[208]

But that doesn't mean it always will. IP regimes have always coexisted with areas of innovation not protected by IP, governed instead by open competition or informal norms of sharing: food, fashion, comedy, and many others come to mind.[209] And as Jessica

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[207] *See supra* notes 24–27 and accompanying text.

[208] *See, e.g.*, MERGES, *supra* note 15, at 26–27 (arguing that IP "still makes sense" as a reward to creators).

[209] *See, e.g.*, KAL RAUSTIALA & CHRISTOPHER SPRIGMAN, THE KNOCKOFF ECONOMY: HOW IMITATION SPARKS INNOVATION 14 (2012) ("Fashion, food, football, and comedy are all industries in which creativity is vibrant and the patent and copyright laws are either absent or irrelevant."); Stefan Bechtold, *The Fashion of TV Show Formats*, 2013 MICH. ST. L. REV. 451 (arguing that television thrives in part by not giving broad protection to TV show ideas); David Fagundes, *Talk Derby to Me: Intellectual Property Norms Governing Roller Derby Pseudonyms*, 90 TEX. L. REV. 1093, 1093 (2012) (detailing the self-governance system that skaters have developed and implemented to "protect the uniqueness of their pseudonyms"); Emmanuelle Fauchart & Eric von Hippel, *Norms-Based Intellectual Property Systems: The Case of French Chefs*, 19 ORG. SCI. 187, 191–96 (2008) (describing an empirical study of appropriation norms among chefs); Amy L. Landers, *The Anti-Economy of Fashion; An Openwork Approach to Intellectual Property*

Litman has noted, we have seen robust innovation environments develop wherever there are limits or exceptions to copyright law.[210]

Even in domains in which IP offered protection, people have chosen to opt out of that protection or change its rules to suit their needs.[211] The Internet is one such domain; most of the work created for the Internet is nominally copyrighted but, in practice, subject to norms of nonenforcement under a wide range of conditions.[212] It may be that we simply do not need IP protection when both the cost of creation and the cost of distribution fall below a certain point. If I am right about the trajectory of the technologies I have discussed here, more and more pieces of the economy will fall below that threshold.

Protection, 24 FORDHAM INTELL. PROP. MEDIA & ENT. L.J. 427, 428 (2014) ("[N]arrow protection for fashion is . . . beneficial to the field because it facilitates spillovers . . . ."); Dotan Oliar & Christopher Sprigman, *There's No Free Laugh (Anymore): The Emergence of Intellectual Property Norms and the Transformation of Stand-Up Comedy*, 94 VA. L. REV. 1787, 1787–88 (2008) (discussing norms against copying among stand-up comedians); Aaron Perzanowski, *Tattoos & IP Norms*, 98 MINN. L. REV. 511, 513 (2013) ("Although tattoos fall squarely within the protections of the Copyright Act, copyright law plays virtually no part in the day-to-day operation of the tattoo industry."); Kal Raustiala & Christopher Sprigman, *The Piracy Paradox: Innovation and Intellectual Property in Fashion Design*, 92 VA. L. REV. 1687, 1695–717 (2006) (describing copying in the fashion industry); Elizabeth L. Rosenblatt, *A Theory of IP's Negative Space*, 34 COLUM. J.L. & ARTS 317, 319 (2011) (describing industries where innovation thrives without IP protection); Matthew Beasley, Note, *Who Owns Your Skin: Intellectual Property and Norms Among Tattoo Artists*, 85 S. CAL. L. REV. 1137, 1141 (2012) ("[T]attoo artists have developed some social norms which, in some respects, mirror formal intellectual property law."). *But see* C. Scott Hemphill & Jeannie Suk, *The Law, Culture, and Economics of Fashion*, 61 STAN. L. REV. 1147, 1170–80 (2009) (disputing Raustiala and Sprigman's claim that the lack of IP protection drives innovation in fashion). For criticism of the reliance on informal norms, see Jennifer E. Rothman, *The Questionable Use of Custom in Intellectual Property*, 93 VA. L. REV. 1899, 1946–60 (2007) (questioning the ability of industry-driven solutions to achieve optimal results). Amy Kapczynski has even explored the role of innovation without IP in high-cost areas like pharmaceuticals. Amy Kapczynski, Order Without Intellectual Property Law: A Case Study in Influenza 3 (unpublished manuscript) (on file with the New York University Law Review).

210 Jessica Litman, *Revising Copyright Law for the Information Age*, 75 OR. L. REV. 19, 27–30 (1996).

211 *See, e.g.*, BENKLER, *supra* note 135, at 63–67 (discussing open source as an example of opting out of IP protection); Jonathan M. Barnett, *Property as Process: How Innovation Markets Select Innovation Regimes*, 119 YALE L.J. 384, 390 (2009) (arguing that we can judge the proper strength of an IP regime by whether private parties opt out of it); Mark A. Lemley, *Intellectual Property Rights and Standard-Setting Organizations*, 90 CALIF. L. REV. 1889, 1952–54 (2002) (discussing standard-setting organization IP rules as a means of opting out of too-strong IP protection); Mark A. Lemley, *Contracting Around Liability Rules*, 100 CALIF. L. REV. 463, 470–83 (2012) (showing that parties can bargain around inefficient liability rules); Robert P. Merges, *Contracting into Liability Rules: Intellectual Property Rights and Collective Rights Organizations*, 84 CALIF. L. REV. 1293, 1295–96 (1996) (showing that parties can bargain around inefficient property rules); Perzanowski, *supra* note 209, at 564–66 (discussing social norms that ignore IP entitlements).

212 *See* Tim Wu, *Tolerated Use*, 31 COLUM. J.L. & ARTS 617, 622 (2008) (discussing this phenomenon).

That doesn't mean IP can or will disappear, and certainly not overnight. It simply means that how much (if any) IP we need in a given industry is a function of the characteristics of that industry. As those characteristics change, so must IP. There are some industries, like pharmaceuticals, that will need strong IP protection for the foreseeable future to encourage innovation despite the cost of government regulatory barriers. Even in industries that lack those barriers, there may be technologies or creative works (like big-budget movies and video games) that cost so much to develop that no one will invest in them without IP protection.[213] Further, the technologies I have described won't eliminate all scarcity, and certainly not right away. Rather, market disruption will come in fits and starts as technologies develop and are deployed at differing rates. But in a post-scarcity world, high-cost products will increasingly become the exception, not the norm. They will be islands of IP-driven content in a sea of content created without the need for IP.

IP is essentially a form of government regulation. The government restricts entry into the market, or alternatively controls the price at which that entry can occur, in order to serve valuable social ends.[214] But regulation is not a moral entitlement or something that we must take for granted. In the past, the government regulated all sorts of industries—railroads, trucking, electric power, gas, telephones—because it could not see, given the economics of those industries, how a free market could produce socially optimal results.[215] But in a surprising number of cases, when we deregulated those industries we found that the market could indeed find a way to supply goods we thought would be provided only with government rulemaking.[216] IP is

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[213] Or perhaps some other form of government subsidy. States in the United States spent $1.4 billion subsidizing films in 2010. Reihan Salam & Patrick Ruffini, *The Internet and Its Enemies*, *in* COPYRIGHT UNBALANCED: FROM INCENTIVE TO EXCESS 23, 25 (Jerry Brito ed., 2012).

[214] *See* sources cited *supra* note 16; *see also* Shubha Ghosh, *Decoding and Recoding Natural Monopoly in Intellectual Property*, 2008 U. ILL. L. REV. 1125, 1152 (2008) [hereinafter Ghosh, *Decoding*] (noting the regulatory character of IP law); Shubha Ghosh, *Patents and the Regulatory State: Rethinking the Bargain Metaphor After* Eldred, 19 BERKELEY TECH. L.J. 1315, 1352 (2004) (same); Lunney, *supra* note 109 at 1 (same). Some suggest that property rights are not regulatory. *E.g.*, Thomas B. Nachbar, *The Antitrust Constitution*, 99 IOWA L. REV. 57, 70 (2013). But that presupposes a definition of property at some scale smaller than a market. A "property right" to prevent competition is in essence regulatory. Yochai Benkler, *Some Economics of Wireless Communications*, 16 HARV. J.L. & TECH. 25, 25–27 (2002).

[215] *See* Ghosh, *Decoding*, *supra* note 214, at 1154 ("Utilities such as electricity and telephone companies are traditionally restricted in their ability to set prices for their services.").

[216] While people's views of success may differ, for me, clear examples of successful deregulation include the trucking industry, the railroads, the telephone network, wireless

no different in this respect than any other form of regulation. Regulation as a whole shouldn't disappear, but regulation of particular industries often turns out to be a reflexive response to a failure of imagination, something we do because we have done it for so long that we cannot imagine how a market in that industry could function without it.

We must similarly be willing to question IP in a post-scarcity economy. Changing economic characteristics may undermine the theoretical basis for IP.[217] The Internet certainly undermines the logic of IP as an incentive to commercialize works once they are created,[218] but it may also undermine the classic theory of IP as an incentive to create. Once creation is cheap enough, people may do it without the need for any IP incentive. This suggests that we should pay more attention to alternative means of encouraging production, rather than assuming the superiority of IP.[219] IP will continue to exist in a post-scarcity economy, but it is likely to recede in importance as a driver of creation.

It is hard to translate this skepticism into immediate policy prescriptions, both because the whole point is that the need for IP must be sensitive to individual industry characteristics and because the technologies I am discussing are still in their infancy. Nonetheless, the Internet experience offers some guidance in making laws for this new world. First, we should resist the tendency to expand IP reflexively to meet every new technological challenge. Incumbent industries are always threatened by new technologies and they often turn to regulation to create barriers to those technologies in order to protect the old

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telephony, electric power generation, and the airline industry. *See, e.g.*, John Howard Brown, *Jimmy Carter, Alfred Kahn, and Airline Deregulation: Anatomy of a Policy Success*, 19 INDEP. REV. 85, 85 (2014) ("[T]he deregulation movement that was largely initiated during [President Jimmy Carter's] term in office was and remains a very successful policy."); Ghosh, *supra* note 214, at 1176 (asserting that "the move from a regime of regulation was justified and correct" in the airline, telecommunications, and electricity industries).

217 *See* Newman, *supra* note 35, at 1407 ("In the face of the 'magic' of zero prices, the neoclassical economic model that underpins modern U.S. copyright law largely collapses. Consequently, the shift toward a freeconomic model carries with it sweeping implications for copyright law and discourse.").

218 *See supra* notes 167–69 and accompanying text.

219 *See* Michael Abramowicz, *Perfecting Patent Prizes*, 56 VAND. L. REV. 115, 122 (2003) (arguing that prizes can sometimes be preferable to patents); Hemel & Ouellette, *supra* note 160, at 303 (arguing that non-IP tools are sometimes better for encouraging innovation); Kapczynski, *supra* note 15, at 978 (arguing that IP overemphasizes price). For a more skeptical note, see Saul Levmore, *The Impending iPrize Revolution in Intellectual Property Law*, 93 B.U. L. REV. 139, 161 (2013) (predicting that a move from property rights to prizes will "involve significantly more interest-group activity" and "camouflage[ ] spending and taxing decisions").

way of doing things. IP owners will do the same thing. Trademark owners used to a world in which only commercial counterfeiters reproduce their brands will struggle with how to adapt trademark law to private home generation of logoed products.[220] But it is not clear that they should have a right to prevent the mere making of a thing that looks like a trademark when it is not sold in commerce.[221] Copyright owners will struggle with how to protect files that are effectively only blueprints for the making of a useful article.[222] While some changes in the economics of production and distribution may call for IP rights as a response, others may suggest that IP rights are unnecessary.[223] The post-scarcity technologies heighten the disjunction between what the law covers and what the public thinks is fair because IP law will increasingly purport to govern what individuals do for non-commercial purposes in their own home.[224]

Second, IP owners should not be allowed to reach beyond suing infringers to shut down or modify the technology itself. The temptation for them to do so is powerful, and will only grow as new technologies democratize the acts of reproduction and distribution. But blocking technological development in order to protect IP rights is likely to do far more damage than good to the economy. We have (so far) avoided that route with the Internet,[225] but the expansive interpretation given to doctrines of secondary liability in copyright makes it a continued risk.[226] Patent law may pose an even greater risk,

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220 *See* Desai & Magliocca, *supra* note 62, at 1712 (predicting 3D printing of trademarked logos).

221 *See id.* at 1711–12 (explaining how the use-in-commerce requirement is necessary to limit trademark infringement since anyone can reproduce a trademark with a 3D printer); Stacey L. Dogan & Mark A. Lemley, *The Merchandising Right: Fragile Theory or Fait Accompli?*, 54 EMORY L.J. 461, 478–95 (2005) (arguing against such a right); Jeremy N. Sheff, *Veblen Brands*, 96 MINN. L. REV. 769, 831 (2012) (noting flaws in the post-sale confusion doctrine).

222 *See* Lucas S. Osborn, *Of PhDs, Pirates, and the Public: Three-Dimensional Printing Technology and the Arts*, 1 TEX. A&M L. REV. 811, 832–35 (2014) (analyzing this issue); Kyle Dolinsky, Note, *CAD's Cradle: Untangling Copyrightability, Derivative Works, and Fair Use in 3D Printing*, 71 WASH. & LEE L. REV. 591, 626–81 (2014) (same).

223 *See* Susson, *supra* note 39, at 45 (arguing that legislators should refrain from expanding IP protections in response to 3D printing until we see how the technology develops).

224 As Pam Samuelson put it in the context of the Internet, "[c]opyright has suddenly become significant not only to industry insiders who are steeped in this law's complexities, but also to the millions of people who access information on the Internet and who often share this information with others." Pamela Samuelson et al., *The Copyright Principles Project: Directions for Reform*, 25 BERKELEY TECH. L.J. 1175, 1177 (2010).

225 Indeed, Anupam Chander argues that the protection the law provided to Internet intermediaries is what allowed Silicon Valley to thrive. Chander, *supra* note 193, at 642.

226 *See, e.g.*, Metro-Goldwyn-Mayer Studios Inc. v. Grokster, Ltd., 545 U.S. 913, 933–34 (2005) (rejecting a narrow application of secondary liability).

because intermediaries and technology developers could be liable for direct rather than contributory infringement depending on the way the claims are drafted.[227]

IP laws should be reformed to give more breathing room to new technologies, even if those technologies can be misused for infringement. We may well need a form of legal immunity for the designers of the hardware for these technologies—3D printers, gene assemblers, and open robots[228]—just as we do for providers of general-purpose computers or Internet service providers.[229] We may also need immunity for those who host the information content that runs on that hardware.[230] Like those technologies, the makers of 3D printers, gene assemblers, and open robots are building a substrate divorced from

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227 For an argument that contributory rather than direct infringement liability is more likely, see Syzdek, *supra* note 184, at 15–18. For a discussion of claims to patent the design files themselves, and why we should be leery of such claims, see Timothy R. Holbrook & Lucas S. Osborn, *Digital Patent Infringement in an Era of 3D Printing*, 48 U.C. DAVIS L. REV. (forthcoming 2015) (manuscript at 42–52), *available at* http://ssrn.com/abstract=2483550.

228 *See* STEPHANIE JOYCE ET AL., POSITIONING SYNTHETIC BIOLOGY TO MEET THE CHALLENGES OF THE 21ST CENTURY 34–36 (2013) (proposing such a regime for synthetic biology); Calo, *supra* note 94 (proposing such a regime for open robotics); Calo, *supra* note 95, at 604–09 (same); Desai & Magliocca, *supra* note 62, at 1716–19 (proposing such a regime for 3D printing); Andrew W. Torrance & Linda J. Kahl, *Bringing Standards to Life: Synthetic Biology Standards and Intellectual Property*, 30 SANTA CLARA HIGH TECH. L.J. 199, 221–29 (2014) (discussing possible IP standards for synthetic biology).

James Grimmelman suggests that the legal issues posed by 3D printing are "as hard as some of the most notoriously difficult parts of copyright—but [] also no harder." Grimmelman, *supra* note 62, at 683–84. But 3D printing implicates not just copyright but also patent and design patent law, and the rules those laws have traditionally applied are different. *See supra* notes 194–97 and accompanying text (pointing out some of the differences between copyright and patent law implicated by 3D printing).

229 *See, e.g.*, 47 U.S.C. § 230(c)(2) (2012) (immunizing computer service providers from tort liability for publishing content they do not themselves originate).

230 Desai & Magliocca, *supra* note 62, at 1718–19. The Digital Millennium Copyright Act arguably protects those data host sites from copyright liability so long as they take down allegedly infringing material when copyright owners complain. 17 U.S.C. § 512 (2012). But there is no corresponding safe harbor for patent or design patent infringement. Mark A. Lemley, *Rationalizing Internet Safe Harbors*, 6 J. TELECOMM. & HIGH TECH. L. 101, 107 (2007). Whether a data host site is liable for patent infringement will therefore depend on whether making a copy of the blueprint or information can itself be "making" or "using" the invention. The answer will depend on how the claim is written. Software patent claims may well cover program code hosted on a computer even if that code is not operated on that computer. By contrast, at least one commentator has argued that copying a blueprint for a 3D printed object is not "making" the object itself. Brean, *supra* note 38, at 789–90 (arguing that distributing plans for an object does not "make" the object). If so, 3D printer design host sites will face little risk of patent infringement. The direct infringer would be the individual printing the design; intermediaries will be liable for inducement only if they know that the design is infringing. *See* Global-Tech Appliances, Inc. v. SEB S.A., 131 S.Ct. 2060, 2068 (2011) (discussing the knowledge requirement necessary to sustain intermediary liability).

the informational content of the design, and hence from the uses to which the device might be put.

Finally, IP law needs to make it easier for creators to opt out of the IP regime.[231] The Internet is littered with unnecessary copyrights automatically given to works that have no need for them.[232] While there are ways to release an idea to the public irrevocably, they are complex and seldom used.[233] It is easier not to obtain a patent or a design patent, but simply opting not to do so will not protect an inventor from being sued for sharing her own invention with the world.[234] As a result, even inventors with no interest in asserting IP rights often feel the need to obtain their own for defensive purposes.[235] IP law needs to protect inventors, not just by offering them exclusive rights, but by shielding them from exclusive rights claimed by others.[236]

B. What Will a Post-Scarcity Economy Look Like?

While the focus of this paper is on the role of IP in encouraging (or retarding) creation in the post-scarcity economy, it is worth ending

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[231] *See* VON HIPPEL, *supra* note 155, at 115–17 (discussing the advantages and complications of an intellectual property commons).

[232] While it is possible to disclaim copyright, it is harder than it appears. *See* Timothy K. Armstrong, *Shrinking the Commons: Termination of Copyright Licenses and Transfers for the Benefit of the Public*, 47 HARV. J. ON LEGIS. 359, 391 (2010) ("U.S. copyright law now supplies no clear statutory path for placing a work in the public domain during the author's lifetime.").

[233] *See, e.g.*, Lior Jacob Strahilevitz, *The Right to Abandon*, 158 U. PA. L. REV. 355, 390–405 (2010) (summarizing the law of property abandonment generally); Matthew W. Turetzky, *Applying Copyright Abandonment in the Digital Age*, 9 DUKE L. & TECH. REV. 019, ¶ 22 (2010) ("Proving that a copyright owner abandoned his copyright is a rather onerous process.").

[234] This is because patent and design patent law, unlike copyright law, do not require proof that the defendant copied the technology from the plaintiff. It is enough that the plaintiff has a patent whose claims cover what the defendant is doing. *See* sources cited *supra* note 194. Cotropia and Lemley find that in some industries as many as 97% of all patent suits are filed not against copyists, but against independent inventors. Christopher A. Cotropia & Mark A. Lemley, *Copying in Patent Law*, 87 N.C. L. REV. 1421, 1445–46 (2009).

[235] *See, e.g.*, Mark A. Lemley & A. Douglas Melamed, *Missing the Forest for the Trolls*, 113 COLUM. L. REV. 2117, 2129–30 (2013) (explaining how companies use their patent portfolio to cross-license with other patent owners).

[236] *See* Susson, *supra* note 39, at 48 (arguing against expanding IP protection for 3D printing); *cf.* Clark D. Asay, *A Case for the Public Domain*, 74 OHIO ST. L.J. 753, 801–05 (2013) (arguing for legislation that makes it easier to opt out of IP altogether). Sam Vermont has suggested that patent law should include an independent invention defense. Samson Vermont, *Independent Invention as a Defense to Patent Infringement*, 105 MICH. L. REV. 475 (2005). I have questioned whether that idea is appropriate as a general matter, Lemley, *supra* note 194, at 1527–32, but as more and more inventions occur in post-scarcity technologies, the case for an independent invention defense will grow stronger.

with some thoughts on the broader implications of that new economy. It is not just IP law that is based on scarcity; our whole economy is. What happens when most of the things people need and want are no longer scarce?

While getting things for free (or close to it) seems like a boon to the economy, a number of commentators worry that salaries of most people in the country are based on jobs performing tasks that may soon be obsolete.[237] If the Internet delivers our goods for us without trucks or stores, 3D printers manufacture our goods, gene assemblers take over a growing share of our health care and agribusiness, and robots provide many basic services, what is left for people to do?[238] They could create the things machines will produce and deliver, but as I have suggested in this Article, that creation may not be accompanied by a healthy paycheck. Our productivity will continue to increase, but it will be machines, not people, that generate that additional productivity.[239] If the returns to productivity accordingly accrue to capital, not labor, the result may be to deepen income inequality.[240] Some worry about massive unemployment, the decline of the middle class professional, and exacerbating the growing gap between rich and poor.[241] To the extent that our economy is based on an ever-expanding spiral of consumption, a long-term drop in the cost of most goods could trigger a fundamental economic contraction or social unrest. Work is central to human social identity, and in the past those displaced by technology have reacted violently against it.[242] One might also worry about vesting more and more power in the compa-

[237] The number of people talking about this has gone from essentially zero a few years ago to legion today. *E.g.*, ERIK BRYNJOLFSSON & ANDREW MCAFEE, RACE AGAINST THE MACHINE: HOW THE DIGITAL REVOLUTION IS ACCELERATING INNOVATION, DRIVING PRODUCTIVITY, AND IRREVERSIBLY TRANSFORMING EMPLOYMENT AND THE ECONOMY 1–9 (2011); David H. Autor & David Dorn, *How Technology Wrecks the Middle Class*, N.Y. TIMES, Aug. 25, 2013, at SR6; Rotman, *supra* note 101, at 29; *Coming to an Office near You*, *supra* note 93; Jon Evans, *VCs on Inequality, Unemployment, and Our Uncertain Future*, TECHCRUNCH (Feb. 15, 2014), http://techcrunch.com/2014/02/15/vcs-on-inequality-unemployment-and-our-uncertain-future/.

[238] The Gartner Group estimated in 2014 that one in three of today's jobs will be performed by machines in 2025. Patrick Thibodeau, *One in Three Jobs Will Be Taken by Software or Robots by 2025*, COMPUTERWORLD (Oct. 6, 2014), http://www.computerworld.com/article/2691607/one-in-three-jobs-will-be-taken-by-software-or-robots-by-2025.html.

[239] *See* JEREMY RIFKIN, THE END OF WORK 3, 13 (1995) (explaining how machines are replacing human productivity); Rotman, *supra* note 101, at 29 (noting recent growth in productivity).

[240] THOMAS PIKETTY, CAPITAL IN THE TWENTY-FIRST CENTURY 242–43 (Arthur Goldhammer trans., 2014).

[241] Autor & Dorn, *supra* note 237; Evans, *supra* note 237.

[242] *See, e.g.*, Thomas L. Friedman, *If I Had a Hammer*, N.Y. TIMES, Jan. 12, 2014, at SR11 (discussing modern analogs to the 1830s Luddite movement, in which the unemployed attacked factory machines that had displaced their jobs).

nies that control the networks over which information flows, companies that face little competition and seem increasingly less likely to be subject to common-carrier regulation.[243] And other aspects of our legal system, like torts, will have to change when the people who produce goods are no longer large companies who design them, but rather the very individuals who might be injured by them.[244]

While the risks these commentators have identified are substantial, I am somewhat more optimistic than many who have thought about this issue. This is not the first time technology or market forces have fundamentally disrupted our economy. I was alive in a time when the United States was considered a leader in manufacturing, and making products employed a substantial share of our workforce.[245] And I'm not *that* old. Today only 10% of our jobs come from manufacturing; the rest have been sent overseas or replaced by automation.[246] The loss of manufacturing jobs created substantial disruption, but it did not destroy our economy or lead to a long-term increase in unemployment. Rather, it created transition issues for individual workers, but the workforce as a whole transitioned into service and technology jobs.[247] Even industries still in transition, like the Internet, bring new opportunities along with disruption. A study by the McKinsey consulting group, for instance, found that the Internet has created nearly three times as many jobs as it has destroyed.[248]

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243 Kevin Werbach, *The Battle for Marginal-Cost Connectivity*, HUFFINGTON POST (Apr. 8, 2014), http://www.huffingtonpost.com/kevin-werbach/the-battle-for-marginalco_b_5110512.html.

244 Law responds to risk either by regulating entry or by regulating consequences. Tort law has generally regulated consequences, but that seems less and less feasible in a world in which production is noncommercial and democratized. *See* Deven R. Desai, *The New Steam: On Digitization, Decentralization, and Disruption*, 65 HASTINGS L.J. 1469, 1474 (2014) (discussing how centralized control and regulation will be rendered more difficult by the advent of technologies such as 3D printing); Engstrom, *supra* note 39, at 41 ("3-D printing *severs* the long-established identity between manufacturers and sellers, on the one hand, and enterprises, on the other. And this decoupling, in turn, . . . unsettles product liability law's traditional theoretical foundation."). Entry regulation seems likely to be both ineffective and a bad idea even if it could work. Desai, *supra*, at 1474. We may need to replace tort law with a social safety net as it becomes harder and harder to find those who make unsafe products and hold them liable.

245 Manufacturing represented 30% of all U.S. jobs in the 1950s and 1960s. Rotman, *supra* note 101, at 32.

246 *Id.*

247 *Id*. ("[N]o historical pattern shows these shifts leading to a net decrease in jobs over an extended period. . . . '[W]e have never run out of jobs. There is no long-term trend of eliminating work for people.'" (quoting Harvard economist Lawrence Katz)).

248 MATTHIEU PÉLISSIÉ DU RAUSAS ET AL., MCKINSEY GLOBAL INST., INTERNET MATTERS: THE NET'S SWEEPING IMPACT ON GROWTH, JOBS, AND PROSPERITY 3 (May 2011), *available at* http://www.mckinsey.com/insights/high_tech_telecoms_internet/internet_matters (follow "Full Report" hyperlink).

Going further back, there was a time when over 60% of the people in the United States were primarily employed producing food.[249] Even in 1900 the number was 41%.[250] Today that number is below 2%.[251] That transition was the first real move to a post-scarcity economy. And it was a dramatic one, more dramatic than anything we face today. What would people do when they no longer needed to grow food to survive? The answer is instructive: They would do a whole array of things no one in 1800 had ever imagined, simply because they could. They were freed from the need to work to feed themselves and turned loose to create new things and new means of passing their time. The result was the Industrial Revolution,[252] which brought dramatic change but also unprecedented improvement in the human condition.

Post-scarcity technologies promise the same sorts of improvements, reducing the cost of material things, health care, and services and greatly expanding their availability.[253] They may even provide those benefits while reducing the environmental footprint of consumption: The small bit of electricity it costs to download a song does far less harm to the world than manufacturing plastic discs, putting them in plastic cases, trucking them to retail stores, and having people drive to the stores to buy and sell them.[254] 3D printing and robotics may offer similar environmental benefits.

What will people do when they no longer have to work to produce the goods and services they need and want? I don't know. But I am doubtful the answer is "nothing." John Maynard Keynes predicted in 1932 that increases in productivity would mean that people would only work fifteen hours a week; there was simply no need to work more than that to pay for necessities.[255] It didn't happen—not because the productivity increases didn't materialize, but because there is

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249 RIFKIN, *supra* note 239, at 110 ("In 1850, 60 percent of the working population were employed in agriculture.").

250 Rotman, *supra* note 101, at 32.

251 *Id.* at 30.

252 *See, e.g.*, MARK OVERTON, AGRICULTURAL REVOLUTION IN ENGLAND: THE TRANSFORMATION OF THE AGRARIAN ECONOMY 1500–1850, at 206 (1996) (attributing the Industrial Revolution in part to labor freed up by improvements in farming).

253 *See* PETER H. DIAMANDIS & STEVEN KOTLER, ABUNDANCE: THE FUTURE IS BETTER THAN YOU THINK 9–11 (2012) ("[T]he advancement of new, transformational technologies . . . will soon enable the vast majority of humanity to experience what only the affluent have access to today."); Tyler Cowen, *Who Will Prosper in the New World*, N.Y. TIMES, Sept. 1, 2013, at SR5 (speculating how new technologies will positively impact certain goods and services).

254 *See* RIFKIN, *supra* note 5, at 92 (discussing how 3D printing can change our use of the transportation network).

255 John Maynard Keynes, *Economic Possibilities for Our Grandchildren*, *in* ESSAYS IN PERSUASION 358, 369 (1963).

something inherent in us that drives us to compete. We may make that competition artificial, as Barton Beebe has argued trademark law already does, recreating scarcity by declaring certain luxury goods to be off limits to most.[256] We may direct it in a more socially useful fashion, rewarding people in social "markets" for contributing to the world in positive ways.[257] Or, most likely, we will devote our time to doing, consuming, and making things that none of us can imagine today. As Lawrence Katz puts it, "[p]eople have always been able to create new jobs. People come up with new things to do."[258]

Notably, though, they will not necessarily do it within the framework of a scarcity-based economics driven by physical things sold for a price. While one possible future involves recreating scarcity, either by developing new goods that are scarce or by artificially duplicating it with brands, that is not the only possible path. The economy we have known for over a century may play a smaller and smaller role in defining how people actually live their lives. As Jeremy Rifkin puts it,

> As more and more of the goods and services that make up the economic life of society edge toward near zero marginal cost and become almost free, the capitalist market will continue to shrink into more narrow niches where profit-making enterprises survive only at the edges of the economy . . . .[259]
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> . . . .
>
> We have been so convinced of the economics of scarcity that we can hardly believe that an economy of abundance is possible. But it is.[260]

We may spend more of our time inventing and creating, not because we are paid to do so but simply because we have that time to spend. Post-scarcity technologies give more of us the means to be more creative. They give us an abundant source of raw materials to play with, mix, and remix.[261] They free us from constraints that

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256 *See* Barton Beebe, *Intellectual Property Law and the Sumptuary Code*, 123 HARV. L. REV. 809, 815 (2010) (arguing that trademark law creates scarcity in luxury goods in order to protect relative status, even though that scarcity is artificial; knock-off purses are often of equal quality to their brand-name counterparts).

257 *See* Katya Assaf, Trademarks and Social Competition 3–4 (Dec. 13, 2014) (unpublished manuscript) (on file with the New York University Law Review) (arguing for an economy of good deeds).

258 Rotman, *supra* note 101, at 32 (quoting Lawrence Katz, Harvard Economist); *see also* RIFKIN, *supra* note 5, at 266–67 (predicting new sources of employment in a post-scarcity economy).

259 RIFKIN, *supra* note 5, at 5.

260 *Id*. at 150.

261 *See generally* LAWRENCE LESSIG, REMIX: MAKING ART AND COMMERCE THRIVE IN THE HYBRID ECONOMY (2008) (discussing the creative value of remixing preexisting works).

demand our time and our attention.[262] And that, more than any legal regime designed to encourage creativity, makes me optimistic for the future.

CONCLUSION

The Internet is a harbinger of things to come—of a raft of new technologies that offer the promise of separating creativity from production and distribution, and reducing the cost of all three. Those technologies challenge the basis for our IP system, and indeed the basis for our economy as a whole. The lessons from the Internet experience are surprising and encouraging: People will create when given the opportunity to do so, even without effective IP protection. Those lessons will have relevance for patent and design patent as well as copyright as post-scarcity technologies remake more and more of our economy in the shape of the Internet.

The prospect of that reshaping has caused many to worry about the death of the middle class and the collapse of an economy based on a scarcity that will no longer exist. The disruptions we face are real, and I don't have a good answer to what people will spend their time doing over the next century or how (or even if) they will get paid. But I think history gives us reasons to be optimistic. Thinking about such questions has so far been mostly the province of science fiction authors,[263] but understanding what a post-scarcity economy will look like is the great task of economics for the next century.

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[262] *See* SENDHIL MULLAINATHAN & ELDAR SHAFIR, SCARCITY: WHY HAVING TOO LITTLE MEANS SO MUCH 6–7 (2013) (arguing that scarcity directs the mind towards the scarce thing at the expense of more productive lines of inquiry); STEFAN HECK & MATT ROGERS, RESOURCE REVOLUTION: HOW TO CAPTURE THE BIGGEST BUSINESS OPPORTUNITY IN A CENTURY 1–2 (2014) (arguing that as these technologies go mainstream they will create enormous new efficiencies).

[263] *See, e.g.*, CORY DOCTOROW, DOWN AND OUT IN THE MAGIC KINGDOM (2003) (envisioning a reputation-based system of payment for creativity); NEAL STEPHENSON, THE DIAMOND AGE (1995) (envisioning a world without scarcity due to advances in nanotechnology).