

USERS AS INNOVATORS: IMPLICATIONS FOR PATENT DOCTRINE

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User innovators range from commercial firms, which invent new production methods in expectation of competitive advantage, to individual hobbyists motivated entirely by their enjoyment of the inventive process. In this Article, I consider the implications for patent doctrine of the fact that many user innovators derive sufficient benefit simply from developing and using their inventions to motivate them to invest the effort necessary to invent them. Moreover, user innovators often benefit from "freely revealing" their innovations to others. Trade secrecy and patenting are not central to motivating this inventive activity.

This picture of user innovation contrasts sharply with the seller innovator picture which dominates patent policy. In that picture, incentives for inventing, disclosing, and disseminating new technologies arise from the potential for recouping innovative investments through commercial sales. Because user innovators have different incentives, we should consider modifying patent doctrine so as to avoid the social costs of unnecessarily broad protection in contexts in which user innovation predominates.

This Article lays out a framework for thinking about patent doctrine in the context of user innovation. It then explores one context in which user innovation plays a significant role—the development of inventions that can be used as research tools. Considering the specific incentives to invent, disclose, and disseminate research tools of different classes of research tool inventors leads to a proposal for a blanket exemption from infringement liability for research use. The Article also proposes an alternative, more modest, "double-edged sword" exemption, which would excuse non-commercial research use of all patented inventions and all research use of inventions made by non-profit inventors.

INTRODUCTION

A sailplane aficionado develops a rocket-assisted emergency ejection system.¹ Steel manufacturers develop improvements on the Bessemer steel process that lead to an eight-fold increase in production in a ten-year period.² Users of printed circuit computer-aided design software modify and develop the software to accommodate increasingly densely-packed circuit boards.³ Surgeons improve and modify medical equipment for their own use.⁴ Builders develop means for routing wiring through commercially available "stressed-skin panels" used to form the outer walls of houses.⁵ Cyclists interested in off-road cycling invent the original mountain bikes.⁶ Manufacturers develop improved designs for their factories. An operator of an online store develops a method of

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1. Nikolaus Franke & Sonali Shah, *How Communities Support Innovative Activities: An Exploration of Assistance and Sharing Among End-Users*, 32 RES. POL'Y 157, 163 (2003).

2. Peter B. Meyer, *Episodes of Collective Invention* (U.S. Dept. of Labor, Bureau of Labor Statistics, Working Paper No. 368, 2003), available at http://papers.ssrn.com/sol3/papers.cfm?abstract_id=466880.

3. Glen L. Urban & Eric von Hippel, *Lead User Analyses for the Development of New Industrial Products*, 34 MGMT. SCI. 569, 571-72 (1988).

4. Christian L  thje, *Customers as Co-Inventors: An Empirical Analysis of the Antecedents of Customer-Driven Innovations in the Field of Medical Equipment*, in PROCEEDINGS OF THE 32ND EMAC CONFERENCE, Glasgow (2003) (on file with author).

5. Sarah Slaughter, *Innovation and Learning During Implementation: A Comparison of User and Manufacturer Innovations*, 22 RES. POL'Y 81, 83-85 (1993).

6. See CHRISTIAN PENNING, *BIKE HISTORY* (1998); Guido Buenstorf, *Designing Clunkers: Demand-Side Innovation and the Early History of Mountain Bikes*, in CHANGE, TRANSFORMATION AND DEVELOPMENT 61 (John Stan Metcalfe & Uwe Cantner eds., 2002).

streamlining the payment process for frequent customers.⁷ A research scientist develops a new instrument for measuring the chemical composition of a surface.⁸

The above are all examples of user innovation. User innovators develop technology for their own use, rather than to sell it. Of course, the list of user innovations could go on and on because the phenomenon is ubiquitous among users ranging from hobbyists to commercial firms. Despite the importance of user innovation as a source of technological progress, its existence—and the differing incentives for innovation faced by users and sellers—has been virtually unrecognized in the patent law context. This Article explores the implications of user innovation for patent law.

In 2005, Eric von Hippel published the book *Democratizing Innovation*.⁹ In this and a body of earlier work, he and others demonstrated that “users of products and services—both firms and individual consumers”—have invented many of the products and services they use and “are increasingly able to innovate for themselves” in many fields of technology.¹⁰ User innovators derive benefits from developing and using their inventions, which motivate them to invest the effort necessary for invention. User innovators range from commercial firms, which invent new production methods in expectation of competitive advantage, to individual hobbyists motivated entirely by their enjoyment of the inventive process.¹¹ Under current law, user innovators may, and sometimes do, choose to protect their inventions by trade secrecy or patenting, but in many cases these legal protections are not central to motivating their inventive activity.¹² User innovators often

7. See, e.g., Saul Hansell, *Injunction Against BarnesandNoble.com is Overturned*, N.Y. TIMES, Feb. 15, 2001, at C3 (discussing patent dispute between Amazon.com and Barnes & Noble over “One-Click” ordering method).

8. William Riggs & Eric von Hippel, *Incentives to Innovate and the Sources of Innovation: The Case of Scientific Instruments*, 23 RES. POL’Y 459, 460–64 (1994).

9. ERIC VON HIPPEL, *DEMOCRATIZING INNOVATION* (2005) [hereinafter *DEMOCRATIZING INNOVATION*].

10. *Id.* at 1.

11. See *infra* notes 36–48 and accompanying text.

12. The precise definition of “user innovator” is somewhat tricky. Certainly there are inventors with mixed motivations—intending both to use and to sell their inventions—and inventors whose motivations are partly competitive, and who are thus motivated not simply by the prospect of use but by the prospect of the *exclusive* use made possible by patenting or trade secrecy. In this Article, I have begun by considering a narrow definition of “ideal user innovator” encompassing only those for whom use alone, without the legal protection of

"freely reveal" their innovations to others because of private benefits they are able to obtain as a result.¹³

This picture of user innovation is in sharp contrast to the picture of innovation that dominates discussions of patent policy in the legal literature. While new capacities for creative expression provided by the Internet have inspired considerable discussion of the impact of non-sales mechanisms for producing creative works—such as amateur and peer production—on copyright law and policy,¹⁴ discussions of patent law and policy have for the most part remained rooted in the paradigm of commercial sale as motivation for invention, disclosure, and dissemination of technical advances.¹⁵

patenting or trade secrecy, is sufficient motivation for invention. In a particular context one may then inquire to what extent user innovation predominates and whether deviations from the ideal user innovation picture are significant.

13. See *infra* note 51.

14. See, e.g., LAWRENCE LESSIG, *FREE CULTURE* (2004); Yochai Benkler, *Coase's Penguin, or, Linux and The Nature of the Firm*, 112 YALE L.J. 369, 381–99 (2002); Yochai Benkler, *Through the Looking Glass: Alice and the Constitutional Foundations of the Public Domain*, 66 LAW & CONTEMP. PROBS. 173 (2003); Julie E. Cohen, *Creativity and Culture in Copyright Theory*, 40 U.C. DAVIS L. REV. (forthcoming 2008); Dan Hunter & F. Gregory Lastowka, *Amateur-to-Amateur*, 46 WM. & MARY L. REV. 951 (2004); Roberta R. Kwall, *Inspiration and Innovation: The Intrinsic Dimension of the Artistic Soul*, 81 NOTRE DAME L. REV. 1945 (2006).

15. Probably the two major exceptions to this rule are discussions of university research and open source software. For discussions of the relationship between open source software and intellectual property law, see generally ERIC S. RAYMOND, *THE CATHEDRAL AND THE BAZAAR: MUSINGS ON LINUX AND OPEN SOURCE BY AN ACCIDENTAL REVOLUTIONARY* (2001); STEVEN WEBER, *THE SUCCESS OF OPEN SOURCE* (2004); Benkler, *Coase's Penguin*, *supra* note 14; Ronald J. Mann, *Commercializing Open Source Software: Do Property Rights Still Matter?*, 20 HARV. J.L. & TECH. 1 (2006); David McGowan, *Legal Implications of Open Source Software*, 2001 U. ILL. L. REV. 241 (2001); Robert P. Merges, *A New Dynamism in the Public Domain*, 71 U. CHI. L. REV. 183 (2004); Maurice Schellekens, *Free and Open Source Software: An Answer to Commodification?*, in *THE FUTURE OF THE PUBLIC DOMAIN: IDENTIFYING THE COMMONS IN INFORMATION LAW* 303 (Lucie Guibault & P. Bernt Hugenholtz eds., 2006); Stephen M. Maurer & Suzanne Scotchmer, *Open Source Software: The New Intellectual Property Paradigm* (Nat'l Bureau of Econ. Research, Working Paper No. W12148, 2006), available at <http://www.nber.org/papers/w12148>; Robert P. Merges, *From Medieval Guilds to Open Source Software: Informal Norms, Appropriability Institutions, and Innovation* (Nov. 13, 2004), available at http://papers.ssrn.com/sol3/papers.cfm?abstract_id=661543, for discussions of the relationship between open source software and intellectual property law. For discussions of the interactions between university research and intellectual property law, see generally *ADVANCES IN THE STUDY OF ENTREPRENEURSHIP, INNOVATION, AND ECONOMIC GROWTH* (Gary D. Libecap ed., 2005) and references therein; DAVID C. MOWERY ET AL., *IVORY TOWER AND INDUSTRIAL INNOVATION: UNIVERSITY-INDUSTRY TECHNOLOGY TRANSFER BEFORE AND AFTER THE BAYH-*

In the standard analysis, incentives for inventing, disclosing, and disseminating new technologies arise from the potential for recouping innovative investments through commercial sales.¹⁶ When an invention is revealed during the sales process, the argument goes, patents are needed to maintain socially optimal levels of innovation.¹⁷ User innovation (and other non-sales-motivated production of technological advance) challenges this picture because user innovators do not need the prospect of sales to motivate them to invent. It is worth considering, therefore, whether patent doctrine should be modified in these cases. If we can identify

DOLE ACT (2004) and references therein; Paul A. David, *Can 'Open Science' Be Protected from the Evolving Regime of IPR Protections?*, 160 J. INSTITUTIONAL & THEORETICAL ECON. 9 (2004) [hereinafter *Open Science*]; Paul David, *The Economic Logic of 'Open Science' and the Balance between Private Property Rights and the Public Domain in Scientific Data and Information*, in THE ROLE OF SCIENTIFIC AND TECHNICAL DATA AND INFORMATION IN THE PUBLIC DOMAIN: PROCEEDINGS OF A SYMPOSIUM (Julie M. Esanu & Paul F. Uhler eds., 2003); Rebecca S. Eisenberg, *Proprietary Rights and the Norms of Science in Biotechnology Research*, 97 YALE L.J. 177 (1987); F. Scott Kieff, *Facilitating Scientific Research: Intellectual Property Rights and the Norms of Science—A Response to Rai and Eisenberg*, 95 NW. U. L. REV. 691 (2001); Richard R. Nelson, *The Market Economy, and the Scientific Commons*, 33 RES. POL'Y 455 (2004); Arti Kaur Rai, *Evolving Scientific Norms and Intellectual Property Rights: A Reply to Kieff*, 95 NW. U. L. REV. 707 (2001); Arti K. Rai, *Regulating Scientific Research: Intellectual Property Rights and the Norms of Science*, 94 NW. U. L. REV. 77, 115–20 (1999) [hereinafter *Regulating Scientific Research*]; Lawrence M. Sung, *Collegiality and Collaboration in the Age of Exclusivity*, 3 DEPAUL J. HEALTH CARE L. 411 (2000); Jerry G. Thursby & Marie C. Thursby, *University Licensing and the Bayh-Dole Act*, 31 SCI. 1052 (Aug. 2003); Fiona Murray, *The Oncomouse that Roared: Resistance and Accommodation to Patenting in Academic Science* (Sloan School of Management, Working Paper, Mar. 2006), available at http://web.mit.edu/fmurray/www/papers/THE%20ONCOMOUSE%20THAT%20ROARED_FINAL.pdf; Andrew J. Nelson, *Institutional Convergence And The Diffusion Of University versus Firm-Origin Technologies* (May 11, 2007) (unpublished Ph.D. dissertation, Stanford University) (on file with author). However, those discussions have focused primarily on characterizing these alternative systems for creating technology and understanding the possible effects of intellectual property on these non-IP-based innovation models, rather than on the potential implications of these models for patent doctrine itself. As detailed later in this Article, even proposals to expand the patent infringement exemption for research have generally remained rooted in the sales paradigm.

16. For discussions of the traditional incentive theories of patenting, see, e.g., Roger D. Blair & Thomas F. Cotter, *Rethinking Patent Damages*, 10 TEX. INTELL. PROP. L.J. 1, 78–80 (2001); Rebecca S. Eisenberg, *Patents and the Progress of Science: Exclusive Rights and Experimental Use*, 56 U. CHI. L. REV. 1017, 1024–28 (1989); Katherine J. Strandburg, *What Does the Public Get? Experimental Use and the Patent Bargain*, 2004 WIS. L. REV. 81 (2004).

17. See, e.g., Eisenberg, *supra* note 16, at 1024–30 (discussing the free rider problem).

contexts in which user innovations would be produced, disclosed, and disseminated despite limitations on patent protection, we may be able to modify patent doctrine so as to avoid the social costs of unnecessarily broad patent protection.

In Part I of this Article, I discuss the growing importance of user innovation and describe several issues in patent doctrine for which it might have significant implications. Part II lays out a theoretical framework for thinking about patent doctrine in the context of user innovation.

In Part III, I introduce a specific context in which user innovation plays a significant role—the development of inventions that can be used as research tools. Many inventions can be used as research tools, from genetically modified mice to scientific instruments such as microscopes, gene sequencers, and SQUID magnetometers. Laboratory processes and protocols can also serve as tools for research. Patents on inventions that can be used in research pose special difficulties for innovation policy. Inventors can use patent exclusivity not only to recoup development expenses but also to restrict research that employs the patented invention.¹⁸ For this reason, various proposals have been made to exempt at least some research use of patented inventions from infringement liability.¹⁹ These proposals have generally run up against a

18. All patents unavoidably place burdens on follow-on inventors, of course. Heightened concern about these burdens in the case of research use stems from the fact that many research tools have a wide variety of potential uses, meaning that the burdens on follow-on invention are likely to have a particularly broad and indeterminate scope.

19. See, e.g., Lorelei Ritchie de Larena, *What Copyright Teaches Patent Law about "Fair Use" and Why Universities are Ignoring the Lesson*, 84 OR. L. REV. 779 (2005); Natalie M. Derzko, *In Search of a Compromised Solution to the Problem Arising from Patenting Biomedical Research Tools*, 20 SANTA CLARA COMPUTER & HIGH TECH. L.J. 347 (2004); Rochelle Dreyfuss, *Protecting the Public Domain of Science: Has the Time for an Experimental Use Defense Arrived?*, 46 ARIZ. L. REV. 457 (2004); Eisenberg, *supra* note 16; Ronald D. Hantman, *Experimental Use as an Exception to Patent Infringement*, 67 J. PAT. & TRADEMARK OFF. SOC'Y 617 (1986); David C. Hoffman, *A Modest Proposal: Toward Improved Access to Biotechnology Research Tools by Implementing a Broad Experimental Use Exception*, 89 CORNELL L. REV. 993, 1008 (2004); Kevin Iles, *A Comparative Analysis of the Impact of Experimental Use Exemptions in Patent Law on Incentives to Innovate*, 4 NW. J. TECH. & INTELL. PROP. 61 (2005); Joseph Mohr, *Unshackle Academia and Allow it to Exemplify the Purpose of Patent Law: "To Promote the Progress of Science and the Useful Arts,"* 88 MARQ. L. REV. 671 (2004); Janice M. Mueller, *The Evanescent Experimental Use Exemption from United States Patent Infringement Liability: Implications for University and Non-profit Research and Development*, 56 BAYLOR L. REV. 917 (2004); Janice M. Mueller, *No "Dilettante Affair": Rethinking the Experimental Use Exception to Patent*

presumed need to compensate inventors financially to preserve their incentives for inventing research tools,²⁰ yet empirical studies show that a large fraction of research tool inventions are made by researchers for their own use.²¹ In light of the prevalence of user innovation of research tool inventions, I therefore consider in Part IV the potential incentive effects of a broad exemption from patent infringement liability for all research *use* (but not *sales*) of patented inventions. This proposal combines the analysis of this Article with my earlier work arguing for an exemption for “experimenting on” a patented invention to understand, improve upon, or design around it.²² Here I argue that we should consider the specific incentives to invent, disclose, and disseminate research tools of

Infringement for Biomedical Research Tools, 76 WASH. L. REV. 1 (2001); Maureen A. O'Rourke, *Toward a Doctrine of Fair Use in Patent Law*, 100 COLUM. L. REV. 1177 (2000); Jennifer L. Owens, “Not Quite Dead Yet”: *The Near Fatal Wounding of the Experimental Use Exception and its Impact on Public Universities*, 3 J. TELECOMM. & HIGH TECH. L. 453 (2005); Gary Pulsinelli, *Share and Share Alike: Increasing Access to Government-Funded Inventions under the Bayh-Dole Act*, 7 MINN. J. L. SCI. & TECH. 393 (2006); David G. Sewell, *Rescuing Science from the Courts: An Appeal for Amending the Patent Code to Protect Academic Research in the Wake of Madey v. Duke University*, 93 GEO. L.J. 759 (2005); Strandburg, *supra* note 16; TED HAGELIN, *THE EXPERIMENTAL USE EXCEPTIONS TO PATENT INFRINGEMENT* (Sept. 2005) (NYSTAR Research Report), available at <http://www.nystar.state.ny.us/nl/nlassets/pdf/stlc1.pdf>. But see Michelle Cai, *Madey v. Duke University: Shattering the Myth of Universities' Experimental Use Defense*, 19 BERKELEY TECH. L.J. 175 (2004); Heather Hamme Ramirez, *Defending the Privatization of Research Tools: An Examination of the “Tragedy of the Anticommons” in Biotechnology Research and Development*, 53 EMORY L.J. 359 (2004); Elizabeth A. Rowe, *The Experimental Use Exception to Patent Infringement: Do Universities Deserve Special Treatment?*, 57 HASTINGS L.J. 921 (2006); Cristina Weschler, *The Informal Experimental Use Exception: University Research after Madey v. Duke University*, 79 N.Y.U. L. REV. 1536 (2004); Richard J. Bauer, Comment, *Why Not Try the Experiment and Stop Pointing the Finger? Modern University Research Unaffected by a Narrow Experimental Use Exception*, 24 TEMP. J. SCI. TECH. & ENVTL. L. 121 (2005), arguing that a research exemption is either unnecessary or undesirable.

20. For proposals for exemptions involving limitations to non-commercial research and/or some form of financial compensation to the patentee, see, e.g., Derzko, *supra* note 19, at 389; Dreyfuss, *supra* note 19, at 464; Eisenberg, *supra* note 16, at 1035–36; Iles, *supra* note 19, at 63; de Larena, *supra* note 19, at 812; Mueller, “*Dilettante Affair*,” *supra* note 19, at 40; O'Rourke, *supra* note 19, at 1203–10; Owens, *supra* note 19, at 465–66; Pulsinelli, *supra* note 19, at 442–43; Sewell, *supra* note 19, at 778; Strandburg, *supra* note 16, at 90 (proposing exemptions involving limitations to non-commercial research and/or some form of financial compensation to the patentee).

21. William Riggs & Eric von Hippel, *The Impact of Scientific and Commercial Values on the Sources of Scientific Instrument Innovation*, 23 RES. POL'Y 459 (1994).

22. Strandburg, *supra* note 16, at 119–21.

both researcher innovators and firms that invent research tools in order to sell them. Such consideration alleviates concerns that a blanket research use exemption would cut significantly into incentives for the development of technologies that can be used as research tools. Researchers would very often continue to invent tools and methods for performing their own research even if they could not prevent others from later using those inventions.

Part IV concludes by presenting an alternative, more modest, proposal of a “double-edged sword” exemption, which would excuse *non-commercial users’* research use of *all* patented inventions and *all users’* research use of inventions made by non-commercial inventors.²³ The double-edged sword proposal alleviates concern that the blanket exemption might depress the incentives of commercial researchers to invent, disclose, and disseminate research tools. It also builds on prior proposals for exemptions for non-profit research. On the other hand, the blanket exemption has the advantages of a bright line rule. Part V summarizes the previous Parts and concludes that patent doctrine should be reconsidered in light of the important role of non-sales motivations—including the intention to use an innovation—in producing technological progress.

I. WHY USER INNOVATION MATTERS FOR PATENT LAW

A. *Incorporating Non-Sale Motivations into Patent Theory*

Up until now patent discourse has been relatively unanimous in assuming that inventors of new technology need to recoup their inventive investments through commercial sales of embodiments of the invention or by licensing the technology to others.²⁴ To do this, inventors must have means of garnering returns on those sales in excess of the returns

23. This proposal bears some similarity to, but is broader than, the exemption proposed in Pulsinelli, *supra* note 19, at 442, which would permit those performing publicly funded research to use patented inventions developed with public funding without facing liability for infringement.

24. For example, this assumption has been implicit in earlier discussions of the possibility of a research exemption from patent infringement, which have assumed that research tool inventors would lose their incentives to invent if they did not receive royalties. See, e.g., Pulsinelli, *supra* note 19 and accompanying text.

garnered by their competitors, who can otherwise free ride on their inventive activity. While there is debate as to the relative desirability and efficacy of various means of appropriating such returns—such as patents, trade secrets, and first-mover advantages—and their optimal legal treatment,²⁵ there has been little debate as to the presumed need for a means of recouping investments through sales. This view is incomplete. Recent legal and technological developments have combined to heighten the salience of non-sale motivations for invention to the extent that we should consider them explicitly in devising socially beneficial patent doctrine.

Several recent developments exemplify the importance of user motivations for invention, thus highlighting the flaws in focusing exclusively on commercial sale as the motivation for technical development. Probably the most noted such development has been the robust success of open source software—complex technology, requiring substantial expertise and team development, often produced with no intention of selling it and no expectation of financial compensation for the effort invested in developing and improving it.²⁶ The

25. For discussions of various ways in which inventors recoup their inventive investments, see generally Wesley M. Cohen et al., *Protecting Their Intellectual Assets: Appropriability Conditions and Why U.S. Manufacturing Firms Patent (or Not)* (Nat'l Bureau of Econ. Research, Working Paper No. W7552, 2000), available at <http://www.nber.org/papers/w7552>; Richard Levin et al., *Appropriating the Returns from Industrial Research and Development*, in 3 BROOKINGS PAPERS ON ECONOMIC ACTIVITY 783 (Martin Neil Bailly & Clifford Winston eds., 1987); Anthony Arundel, *The Relative Effectiveness of Patents and Secrecy for Appropriation*, 30 RES. POL'Y 611 (2001); Najib Harabi, *Appropriability of Technical Innovations—An Empirical Analysis*, 24 RES. POL'Y 981 (1995); Henrik Sattler, *Appropriability of Product Innovations: An Empirical Analysis for Germany*, 26 INT'L J. TECH. MGMT. 502 (2003).

26. For some discussions and description of the open source software innovative system, see, generally, DEMOCRATIZING INNOVATION, *supra* note 9, at 97–103; RAYMOND, *supra* note 15; WEBER, *supra* note 15; Josh Lerner & Jean Tirole, *Some Simple Economics of Open Source*, 52 J. IND. ECON. 197 (2002); James Bessen, *Open Source Software: Free Provision of Complex Public Goods* (Working Paper, 2005), available at <http://ssrn.com/abstract=588763>; Joachim Henkel, *The Jukebox Mode of Innovation—a Model of Commercial Open Source Development* (CEPR Discussion Paper, Working Paper No. 4507, 2004), available at http://papers.ssrn.com/sol3/papers.cfm?abstract_id=578142; Eric von Hippel, *Horizontal Innovation Networks—By And For Users* (MIT Sloan School of Management, Working Paper No. 4366-02, 2002), available at http://papers.ssrn.com/sol3/papers.cfm?abstract_id=328900; Karim R. Lakhani & Robert G. Wolf, *Why Hackers Do What They Do: Understanding Motivation Effort in Free/Open Source Software Projects*, (MIT Sloan School of Management, Working Paper No. 4425-03, 2003), available at

expanding patentability of the tools and products of agriculture, such as genetically modified seeds, also highlights the fact that not all inventors seek to sell their inventions, bringing agricultural firms, which innovate in order to sell, into conflict with farmers who have a long tradition of innovation for their own use.²⁷ The extension of patentable subject matter to encompass "business methods" has also been met with skepticism as to whether patents are necessary to produce innovations of this type.²⁸ Underlying this skepticism may be an implicit recognition that intent to use rather than sell has

http://papers.ssrn.com/sol3/papers.cfm?abstract_id=443040; Maurer & Scotchmer, *supra* note 15, at 15–20, for some discussions and description of the open source software innovative system.

27. See, e.g., Keith Aoki, *Weeds, Seeds, & Deeds: Recent Skirmishes in the Seed Wars*, 11 CARDOZO J. INT'L & COMP. L. 247 (2003); David R. Downes, *The Convention on Biological Diversity: Seeds of Green Trade?*, 8 TUL. ENVTL. L.J. 163, 168 (1994); Cynthia M. Ho, *Biopiracy and Beyond: A Consideration of Socio-Cultural Conflicts with Global Patent Policies*, 39 U. MICH. J.L. REFORM 433 (2006); Sabrina Safrin, *Chain Reaction: How Property Begets Property in an Interconnected World*, 82 NOTRE DAME L. REV. 1917 (2007); Haley Stein, *Intellectual Property and Genetically Modified Seeds: The United States, Trade, and the Developing World*, 3 NW. J. TECH. & INTELL. PROP. 160 (2005).

28. See, e.g., Jay Dratler, Jr., *Does Lord Darcy Yet Live? The Case Against Software and Business-Method Patents*, 43 SANTA CLARA L. REV. 823 (2003); Rochelle Cooper Dreyfuss, *Are Business Method Patents Bad for Business?*, 16 SANTA CLARA COMPUTER & HIGH TECH. L.J. 263 (2000); Alan L. Durham, "Useful Arts" in the Information Age, 1999 BYU L. REV. 1419, 1488–96 (1999) (similarly arguing that software-embodied business method patents should not be patentable subject matter); Julia Alpert Gladstone, *Why Patenting Information Technology and Business Methods Is Not Sound Policy: Lessons from History and Prophecies for the Future*, 25 HAMLINE L. REV. 217 (2002); Nari Lee, *Patent Eligible Subject Matter Reconfiguration and the Emergence of Proprietary Norms—The Patent Eligibility of Business Methods*, 45 IDEA 321 (2005); Keith E. Maskus & Eina Vivian Wong, *Searching for Economic Balance in Business Method Patents*, 8 WASH. U. J.L. & POL'Y 289 (2002); Robert P. Merges, *As Many as Six Impossible Patents Before Breakfast: Property Rights for Business Concepts and Patent System Reform*, 14 BERKELEY TECH. L.J. 577, 580–81 (1999); Michael J. Meurer, *Business Method Patents and Patent Floods*, 8 WASH. U. J.L. & POL'Y 309 (2002); Malla Pollack, *The Multiple Unconstitutionality of Business Method Patents: Common Sense, Congressional Consideration, and Constitutional History*, 28 RUTGERS COMPUTER & TECH. L.J. 61 (2002); John R. Thomas, *The Patenting of the Liberal Professions*, 40 B.C. L. REV. 1139, 1143–63 (1999). See also *Lab. Corp. of Am. Holdings v. Metabolite Labs., Inc.*, 548 U.S. 124 (2006) (Breyer, J. dissenting from dismissal of certiorari as improvidently granted); *eBay Inc. v. MercExchange, L.L.C.*, 547 U.S. 388 (2006) (Kennedy, J. concurring) (raising questions about business methods patents and the Federal Circuit's standard for patentable subject matter). But see, e.g., John R. Allison & Emerson H. Tiller, *The Business Method Patent Myth*, 18 BERKELEY TECH. L.J. 987 (2003) (arguing that business method patents are indistinguishable from other patents on processes).

traditionally motivated the invention of business methods.²⁹ The commercial sale motivations assumed by traditional patent doctrine are also in conflict with the traditional “open science” motivations of scientific researchers who invent in the course of their research.³⁰ Nonetheless, universities are increasingly patenting discoveries resulting from such research, which are more likely to be patentable in light of expansive interpretations of patentable subject matter.³¹

As these examples illustrate, patenting is increasingly relevant to inventive activities to which the traditional assumption—that invention costs must be recouped by sales of the invention—may not apply. Almost undoubtedly, the most significant non-sale motivation for innovation is an inventor’s intention to use the invention. Open source software, for example, is to a great degree an example of successful user innovation. Studies of participants in open source software projects find that many participants work on software programs they intend to use (including commercial entities that find participation in open source projects to be an effective means to obtain software they need). Besides providing products with mass appeal, such as Linux, the open source process is a means to pool inventive resources to obtain customized software products to suit the needs of a dispersed and relatively small group.³²

While user innovation has no doubt always been widespread,³³ its significance—and particularly the importance

29. For a more extensive discussion of this case, see Katherine J. Strandburg, *What If There Were a Business Method User Exemption to Patent Infringement?*, 2008 MICH. ST. L. REV. (forthcoming 2008) (on file with author).

30. See, e.g., Brett M. Frischmann, *Commercializing University Research Systems in Economic Perspective: A View from the Demand Side*, in 15 ADVANCES IN THE STUDY OF ENTREPRENEURSHIP, INNOVATION, AND ECONOMIC GROWTH 155 (Gary D. Libecap ed., 2004); Rai, *Regulating Scientific Research*, *supra* note 15, at 109–15; Katherine J. Strandburg, *Curiosity-Driven Research and University Technology Transfer*, in 15 ADVANCES IN THE STUDY OF ENTREPRENEURSHIP, INNOVATION, AND ECONOMIC GROWTH 93 (Gary D. Libecap, ed., 2004); David, *Can ‘Open Science’ be Protected*, *supra* note 15, at 22–26; Eisenberg, *supra* note 15, at 206–07; Rebecca S. Eisenberg, *Public Research and Private Development: Patents and Technology Transfer in Government-Sponsored Research*, 82 VA. L. REV. 1663, 1726 (1996) (positing that the patenting of upstream research tools calls into question the appropriateness of public funding to support that research).

31. See, e.g., David, *Can ‘Open Science’ Be Protected*, *supra* note 15, at 9; Rai, *Evolving Scientific Norms*, *supra* note 15, at 103–05.

32. See *supra* note 26.

33. Of course, the patenting of user innovations is hardly new. Historically, patent law has implicitly covered many user innovations, perhaps most notably

of user innovation by individuals and smaller business enterprises—is growing because of some of the same technological changes that have injected the “amateur” back into copyright.³⁴ Software can often be developed using an inexpensive personal computer. Its rising importance, as both a tool of innovation and a component of products, means that more and more design and experimentation is feasible with relatively limited capital expenditure. Computerization of manufacturing and design also decreases the cost of creating custom-designed products.³⁵ The Internet also enhances the potential for user innovation by providing mechanisms by which medium-sized groups of users with similar needs for customization can pool their inventive resources, dividing the costs of user innovation among themselves and thereby widening the range of cost-effective user innovations.

B. Characteristics of User Innovation

User innovation is innovation motivated by an intention to use, rather than sell, an innovative technology. In the ideal sense used in this Article, this means that the user innovator receives sufficient “return on investment” from developing and using the invention to compensate for expenditures on developing it. This “return on investment” can take any form: monetary compensation for use, reputational enhancement from using or developing the invention, or simple enjoyment of using the invention or of the inventive process. User innovators include commercial firms developing equipment or processes for use in their own factories, as well as hobbyists—such as the sports enthusiasts mentioned above, users of many computer software products such as video games, and early microcomputer enthusiasts such as the members of the

through the patenting of processes. Manufacturing processes, for example, are a traditional example of user innovations. Despite the long history of patenting of user innovations, the distinctive incentives faced by user innovators and the potential implications of these distinctive incentives for patent doctrine have not been explored. Patent doctrine and theory have focused on the seller innovator. This Article argues that it is time to focus on user innovation to develop a sounder basis for patent policy.

34. See YOCHAI BENKLER, *THE WEALTH OF NETWORKS* 68–90, 212–33, 277–78 (2006); Hunter & Lastowka, *supra* note 14.

35. Stefan Thomke & Eric von Hippel, *Customers as Innovators: A New Way to Create Value*, HARV. BUS. REV., Apr. 2002, at 74, 74–81.

Homebrew Computing Club³⁶—adapting commercial products for their individual needs.³⁷

As explained by von Hippel in *Democratizing Innovation*:

Users . . . are firms or individual consumers that expect to benefit from *using* a product or a service. In contrast, manufacturers expect to benefit from *selling* a product or a service. A firm or an individual can have different relationships to different products or innovations. For example, Boeing is a manufacturer of airplanes, but it is also a user of machine tools. If we were examining innovations developed by Boeing for the airplanes it sells, we would consider Boeing a manufacturer-innovator in those cases. But if we were considering innovations in metal-forming machinery developed by Boeing for in-house use in building airplanes, we would categorize those as user-developed innovations and would categorize Boeing as a user-innovator in those cases.

Innovation user and innovation manufacturer are the two general “functional” relationships between innovator and innovation. Users are unique in that they alone benefit *directly* from innovations. All others (here lumped under the term “manufacturers”) must sell innovation-related products or services to users, indirectly or directly, in order to profit from innovations. Thus, in order to profit, inventors must sell or license knowledge related to innovations, and manufacturers must sell products or services incorporating innovations. Similarly, suppliers of innovation-related materials or services—unless they have direct use for the innovations—must sell the materials or services in order to profit from the innovations.³⁸

Building on a theoretical and empirical foundation, von Hippel demonstrates that user innovation tends to have features that distinguish it from manufacturer innovation. Many user innovators are “lead users” who develop their innovations by customizing or modifying commercial products.³⁹ These users often have heterogeneous needs that

36. Meyer, *supra* note 2, at 12–14.

37. See, e.g., DEMOCRATIZING INNOVATION, *supra* note 9, at 3; Sonali K. Shah, *Open Beyond Software*, in OPEN SOURCES 2.0: THE CONTINUING EVOLUTION 338 (Chris DiBona et al. eds., 2006).

38. DEMOCRATIZING INNOVATION, *supra* note 9, at 3.

39. *Id.* at 22–31.

mass-market products do not satisfy.⁴⁰ They are different from the prototypical “consumer” of a product in that they are expert enough and sufficiently devoted to optimizing their use of the product to devise modifications for their own use.⁴¹ They may anticipate features for which general consumer demand has not yet developed.⁴² These users possess “sticky information”—information that is costly to transfer from one individual to another because of differences in background knowledge, experience, and so forth—about user needs.⁴³ Transferring this information to manufacturers can be expensive, making user innovation more efficient, in many cases, than attempting to teach manufacturers what lead users want. User innovations will thus tend to be those that leverage the user’s information advantages, including experiential knowledge of issues that arise during use, rather than those that leverage manufacturers’ information advantages regarding manufacturing techniques and “typical user” experiences.⁴⁴ A study of innovations in mountain biking equipment, for example, found that user innovations often depended on information that the inventors had obtained through their own cycling experience, reflecting their own unique circumstances and interests, such as a desire to bike in extreme weather conditions or to perform acrobatic stunts.⁴⁵ Unlike many manufacturer innovations, some user innovations require relatively low investments in capital equipment and little technical expertise beyond that which is a byproduct of

40. *Id.* at 34–43.

41. *Id.*

42. *Id.* at 20–30.

43. *Id.* at 8; see Sonali K. Shah, *From Innovation to Firm Formation in the Windsurfing, Skateboarding, and Snowboarding Industries* (Univ. of Ill., Working Paper No. 05-0107, 2006), available at http://research.kauffman.org/cwp/ShowProperty/webCacheRepository/Documents/2006_SonaliShah.pdf.

44. DEMOCRATIZING INNOVATION, *supra* note 9, at 45–61; Shah, *supra* note 37, at 341–43; Shah, *supra* note 43, at 32–33.

45. DEMOCRATIZING INNOVATION, *supra* note 9, at 73.

use,⁴⁶ though this is certainly not always the case because large firms are also user innovators.⁴⁷

User innovators may derive other non-pecuniary returns from innovation, such as enjoyment of the process of improving products for their own use or reputational status within a user community.⁴⁸ Even commercial user firms might reap indirect benefits from the process of inventing things for their own use if it provides an opportunity for their employees to obtain skills or insights that augment the innovative capacity of the firm. In situations in which user innovators are rewarded by their enjoyment of or ability to learn from the process of invention, user innovators may be willing to make investments of time and effort over and above the private value of using the resulting invention; user innovation thus has the potential to produce more costly inventions than would otherwise be expected.

User innovation is not ubiquitous, of course. It is of greatest importance where users have both sticky information about their needs and the technical capacity to make inventions that fulfill those needs. The comparative advantage of user innovation for a particular technology depends on factors such as the heterogeneity of uses, the presence of "lead users," the technical difficulty of invention in a particular field, and the costs of development. As a result, user innovation may play a major role in development of some inventions, such as certain kinds of software, and a much more limited role in developing others, such as pharmaceuticals, development of which requires significant scientific knowledge and expertise which users (those who take the medications) do not ordinarily possess. Though it is not ubiquitous, user innovation is important in many fields, and yet it has been neglected in discussions of patent doctrine.

46. *Id.* at 19–31; Shah, *supra* note 37, at 340–43; Shah, *supra* note 43, at 13–14. The innovations related to use of stressed-skin panels for building, for example, took on average one half day and \$153 for the builders, whereas an estimate of the likely costs of seeking a manufacturer solution put the average delay at forty-four days and the average cost at least 100 times higher. Slaughter, *supra* note 5, at 85–91.

47. DEMOCRATIZING INNOVATION, *supra* note 9, at 3; Shah, *supra* note 37, at 338, 351; Shah, *supra* note 43, at 24.

48. DEMOCRATIZING INNOVATION, *supra* note 9, at 85–88; Shah, *supra* note 37, at 343–45; Shah, *supra* note 43, at 27. They may also be more likely than seller innovators to be using their inventions to pursue non-economic goals, a point to which I return, *see infra* Part II.B.4.

II. IMPLICATIONS OF USER INNOVATION FOR PATENT DOCTRINE

User innovation matters for patent doctrine because user innovators are subject to different incentives than is the canonical seller innovator. The goal of patent policy is to encourage inventors to invent, disclose, and disseminate their inventions to the public.⁴⁹ Patents serve these three goals to a greater or lesser extent and in different combinations in different inventive contexts. Identifying inventive contexts in which patent protection may be eliminated or limited without substantially reducing invention, disclosure, and dissemination of inventions is important because patenting is not free. It imposes unavoidable costs on consumers of the patented good and on next-generation innovators, who must pay higher prices, negotiate licenses, and obtain authorization from the patent holder before using the invention. It is also possible, as has been suggested with respect to patenting of upstream scientific advances, that introducing patent exclusivity into situations in which there would otherwise be cooperation and free exchange of ideas might decrease or delay the disclosure of inventions and discourage cooperation. User inventors may seek to put patent boundaries around their inventions so as to extract rents above and beyond what they need to recoup their research and development investments.⁵⁰ If we can identify contexts in which inventions would be produced, disclosed, and disseminated despite limits on patent protection, we may be

49. For discussions of incentive theories of patent law, see, for example, *Bonito Boats, Inc. v. Thunder Craft Boats, Inc.*, 489 U.S. 141, 150–51 (1989); *Kewanee Oil Co. v. Bicron Corp.*, 416 U.S. 470, 484 (1974); *Seymour v. Osborne*, 78 U.S. (11 Wall.) 516, 533–34 (1870); Mark A. Lemley, *The Economics of Improvement in Intellectual Property Law*, 75 TEX. L. REV. 989, 993–95 (1997); Robert P. Merges, *Commercial Success and Patent Standards: Economic Perspectives on Innovation*, 76 CAL. L. REV. 805, 806–10 (1988); Robert P. Merges & Richard R. Nelson, *On the Complex Economics of Patent Scope*, 90 COLUM. L. REV. 839, 844–45 (1990); Suzanne Scotchmer & Jerry Green, *Novelty and Disclosure in Patent Law*, 21 RAND J. ECON. 131, 132 (1990). For discussions of patents as facilitators of commercialization and licensing, see, for example, Paul J. Heald, *A Transaction Costs Theory of Patent Law*, 66 OHIO ST. L.J. 473 (2005); F. Scott Kieff, *Property Rights and Property Rules for Commercializing Inventions*, 85 MINN. L. REV. 697 (2001). For other theories of the function of patents, see, for example, Clarisa Long, *Patent Signals*, 69 U. CHI. L. REV. 625, 628–35 (2002); Gideon Parchomovsky & R. Polk Wagner, *Patent Portfolios*, 154 U. PA. L. REV. 1 (2005).

50. See, e.g., Rai, *Regulating Scientific Research*, *supra* note 15, at 109–112; Strandburg, *supra* note 16, at 113–14; Sung, *supra* note 15, at 438–39.

able to improve public welfare by modifying patent doctrine congruently. In Section A of this Part, I lay out a theoretical framework for considering the implications of user innovation for patent doctrine. I then briefly describe in Section B several areas of patent doctrine for which user innovation may have significant implications.

The framework developed in Section A is summarized in Table 1. The patent system is intended to supply incentives for inventors to invent, disclose, and disseminate their inventions. Inventors seek to maximize their private benefits by choosing between patenting, maintaining trade secrecy, and freely revealing their inventions. In earlier work, I focused on the ways in which the incentives provided by the patent system differ depending on whether an invention must be disclosed to be exploited by its inventor ("self-disclosing" inventions) or may be exploited as a trade secret ("non-self-disclosing" inventions). Recognizing that seller and user innovators begin with differing incentives to invent, disclose, and disseminate their inventions adds to the analysis another dimension which may affect the assessment of whether current patent doctrine serves the public interest in a particular inventive context.

In Section A, I explore the general implications of these two distinctions—between user and seller innovators and between self-disclosing and non-self-disclosing inventions—for incentives to invent, disclose, and disseminate inventions. Part IV applies this general framework to the specific context of research tool invention.

A. Theoretical Framework for Considering Implications of User Innovation for Patent Doctrine

A careful analysis of user innovator incentives to invent, disclose, and disseminate inventions elucidates under what circumstances the benefits of patent protection for user innovations outweigh its costs. The analysis reveals that, in general, the case for patenting is much weaker for user inventions than it is for seller inventions. In particular, user innovations that are self-disclosing-in-use⁵¹ will frequently be

51. Inventions that are self-disclosing-in-use include, for example, modifications to sports equipment that can be observed by companions; business methods that are not hidden in the back office, such as new methods of arranging payment, delivering services, or promoting processes. User innovations that are

invented, disclosed, and disseminated despite limitations on patent protection, as will some non-self-disclosing-in-use inventions whose inventors choose to reveal them rather than keep them as trade secrets. This framework is useful for evaluating specific proposals for modifying patent protection in light of user innovation.

For purposes of the present analysis, I have defined an ideal “user innovator” as any inventor or inventive entity for which the intrinsic value of using the invention exceeds the cost (in time, money, and so forth) of developing the invention. By intrinsic value, I mean the value an invention has to a user even if it is not kept as a trade secret or patented. Where an invention is used competitively, the intrinsic value of a user invention may include a “first mover advantage,” which is the advantage that may accrue to a user inventor due to the time it takes competitors to adopt the invention even if it is not kept secret or patented. User innovators receive substantial intrinsic rewards from using their inventions, changing the balance of social costs and benefits in the patent regime.

Under the seller innovator paradigm, patents encourage invention primarily by excluding competitors (and thus driving up profits for patent-holding manufacturers) or by facilitating a market for licenses and assignments so that inventors can sell their ideas to others. As I have noted in earlier work, the patent “incentive to invent” is important only for “self-disclosing” inventions, which can be copied by competitors when they are sold.⁵² A patent incentive to invent is not needed when an invention is “non-self-disclosing” and can be exploited by the inventor as a trade secret, either because it is used in secret (like a manufacturing process), or because it is embodied in a product that is difficult to reverse-engineer.

not self-disclosing-in-use include many manufacturing processes, back office business methods, and craft-type techniques that are performed alone. It is clear from this description that the extent to which an innovation is self-disclosing-in-use depends on the social milieu in which it is used. A cooking technique, for example, might be non-self-disclosing-in-use if the chef restricts access to her kitchen, but could not remain secret in a social network of chefs whose reputations depend on demonstrating their innovations to one another. I discuss the connection between user innovation and disclosure at greater length in Katherine J. Strandburg, *Sharing Research Tools and Materials: Homo Scientificus and User Innovator Community Norms*, in *WORKING WITHIN THE BOUNDARIES OF INTELLECTUAL PROPERTY* (Rochelle Dreyfuss et al. eds., forthcoming 2008).

52. Strandburg, *supra* note 16, at 107–11.

Unlike seller innovators, ideal user innovators do not need the protection of patents to motivate them to produce their inventions, *even if their inventions are self-disclosing*. The intrinsic value of using the invention is enough to offset its development costs even if it is copied by others.

With no need for patent protection to motivate invention of user innovations, the focus shifts to disclosure and dissemination. Though disclosure and dissemination are often linked, they are distinct. Disclosure makes the patented *idea* available to the public, while dissemination makes *embodiments* of the patented invention available. Selling a product on the open market is probably the most common way of disseminating an invention to the public. While seller innovators need no special incentives to sell their products, patenting can facilitate dissemination of seller inventions in situations where the inventor does not have manufacturing capability through the reduction of the transaction costs of licensing⁵³ and through the provision of a mechanism for transferring exclusive rights in inventions to those who will invest in dissemination.⁵⁴

Patents are much less likely to be needed to enhance the dissemination of user innovations as long as those inventions are *disclosed* to other potential users. Upon disclosure to other potential users, a user innovation is likely to be picked up and disseminated even if it is not patented. Lead users, who are willing and able to “do-it-themselves,” are particularly likely to be able to adopt and disseminate the types of inventions other users make, since those inventions likely depend on sticky user information and user technical expertise.

Once disclosed to and vetted by lead users, user innovations are likely to be relatively cheap for manufacturers to commercialize and bring to a wider market because they are, by definition, already developed enough to be used. There should be little need, therefore, for exclusive rights as an incentive to invest in bringing an invention to market. The underlying assumption of a competitive market system is that previously developed products and services will be supplied to the market if there is demand for them. Exclusive intellectual

53. See generally Heald, *supra* note 49; Long, *supra* note 49.

54. This prospect is the basis of the “incentive to commercialize” theory used, for example, to justify patenting university inventions. See, e.g., Kieff, *supra* note 49, at n.209.

property rights are the exception and are intended to allow inventors to recoup inventive investments their competitors would not have to make. Commercial suppliers of user innovations often have little additional investment to recoup. The relatively small investments needed to commercialize a user invention can often be recouped through first mover advantage. If costly improvements are needed to prepare a user invention for commercial marketing, those improvements themselves are often patentable. The patent system implicitly assumes that, on average, the requirements of utility, novelty, and non-obviousness delimit those technological improvements that society needs to encourage with the incentive of exclusive patent rights. There is no apparent reason to make a different assumption about any investments needed to commercialize user innovations. Thus, patent protection is likely to play a comparatively modest role in ensuring that user innovations are disseminated to the public once they have been disclosed.

In fact, patent exclusivity restricts the dissemination of some user innovations. Unlike seller innovators, who seek to disseminate their own *embodiments* of the invention while restricting competitors' ability to make use of the inventive *idea* in competing products, user innovators sometimes seek to restrict dissemination of embodiments of the invention to other users. If a widget manufacturer invents an improved kind of widget, the manufacturer will seek to sell as many widgets as possible. The widget manufacturer is a seller innovator, disseminating widgets broadly to the public while seeking to restrict competing manufacturers from free riding on the inventive idea by selling improved widgets themselves. The same widget manufacturer is a user innovator with regard to a new process for manufacturing widgets. As a competitive user innovator, the manufacturer has no interest in disseminating the invention by licensing use of the new process, but instead seeks exclusive use so as to gain a competitive advantage in the widget market. Widgets are disseminated to the public, but the patented manufacturing process is not.

In another example, a bicycle manufacturer might invent an improved pedaling mechanism for the bicycles it sells. Its sales disseminate the invention even if patent protection forestalls competitive sales. If, on the other hand, a competitive bicyclist invents the pedaling mechanism so as to compete at faster speeds, she may use patenting to restrict its

dissemination. Because a competitive user inventor will choose to patent only if patent exclusivity affords a competitive advantage exceeding that afforded by trade secrecy, patent exclusivity decreases dissemination of the invention.

In sum, patents are unlikely on balance to increase dissemination of user innovations significantly once they have been invented and disclosed. Patent exclusivity is usually not needed to encourage other users, and eventually manufacturers, to adopt these innovations, and it can be exploited by competitive user innovators to restrict dissemination to competing users. Thus, user innovations will in most cases be invented and disseminated regardless of patent incentives.

The balance of social costs and benefits of patenting is determined primarily by whether patenting increases disclosure of these inventions enough to compensate for the burdens exclusivity imposes. Disclosure of the invention is a requirement for obtaining patent protection, policed by the doctrines of enablement and written description, which require that a patent application "shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains . . . to make and use the same."⁵⁵

Patenting is an important incentive to disclose only in certain circumstances. For seller innovators, patenting provides no socially beneficial incentive to disclose "self-disclosing inventions," since those inventions can be reproduced by competitors soon after the inventor markets them without reference to any patent disclosure.⁵⁶ Similarly, disclosure will not be an issue for those user innovations that are apparent to others when in use. Because patents do not substantially enhance invention, disclosure, or dissemination of these self-disclosing-in-use user innovations, the overall social benefits of patent exclusivity are generally minimal for such inventions and unlikely to outweigh the social costs.

55. 35 U.S.C. § 112 (2000).

56. Strandburg, *supra* note 16, at 111. Seller innovators are often protected by first mover advantages and may not need patent exclusivity to recoup their inventive investments before free riding can begin. For this reason, an invention is deemed "self-disclosing" only if any first mover advantage is insufficient to recoup the inventive costs.

Patents do provide an important incentive to disclose when trade secrecy is a possibility, however. User innovators who use their inventions away from the public eye may maintain those inventions as trade secrets. Furthermore, even public use will not reveal some user innovations because the inventive aspects are not apparent during use. Because these inventions are “non-self-disclosing-in-use” and could be kept as trade secrets, patenting them would lead to earlier disclosure. An inventor will choose to patent a non-self-disclosing invention if patenting is privately beneficial. This will be the case if the patent term is long enough compared to the expected duration of trade secrecy. The social benefits of such earlier disclosure must be weighed against the costs of restricted dissemination due to a longer period of exclusivity.

The potential benefits of the disclosure incentive may not be as great as one might think at first. Empirical studies suggest that a rather surprising amount of “free revealing” of user innovations takes place.⁵⁷ This can only mean that user innovators often perceive the private benefits of free revealing to outweigh those of trade secrecy and patenting.⁵⁸ Presumably, this is because free revealing sometimes has significant reputational, reciprocal, and other benefits. For example, user innovators sometimes form innovative communities in which they informally exchange ideas to the mutual advantage of group members. These informal exchange mechanisms may have lower transaction costs than licensing.⁵⁹ Such exchanges occur even among competitors, who sometimes find it efficient to reveal certain kinds of information freely while maintaining other competitive advantages. In principle, an entire industry might prefer reciprocal revealing to duplicative research if a particular line of research and development is relatively straightforward—so that virtually all industry players are fairly certain to complete it successfully. Splitting the cost of such research, either informally through reciprocal revealing or formally through collaboration, may be mutually preferable to duplicating the research. Where user

57. See DEMOCRATIZING INNOVATION, *supra* note 9, at 77–80; Henkel, *supra* note 26, at 21; Joachim Henkel, *Selective Revealing in Open Innovation Processes: The Case of Embedded Linux*, 35 RES. POL'Y 953, 954–55, 959–67 (2006); Shah, *supra* note 43, at 16–17; Shah, *supra* note 37, at 344–45; von Hippel, *supra* note 25, at 12–21.

58. DEMOCRATIZING INNOVATION, *supra* note 9, at 86–87.

59. *Id.* at 94–106.

benefits do not depend primarily on obtaining a competitive advantage, free revealing may also enable others (including, potentially, manufacturers) to improve on a user innovation, thus making that innovation more valuable to the user.⁶⁰

The possibility of free revealing also affects the analysis of disclosure. Whenever inventors prefer free revealing to trade secrecy, patenting is unnecessary to induce disclosure. However, inventors may nonetheless seek to boost their inventive returns by patenting even when they would choose free revealing over trade secrecy. Thus, it is extremely likely that the availability of patent protection depresses the amount of free revealing that occurs. If patent protection were unavailable, inventors of non-self-disclosing inventions would choose between trade secrecy and free revealing. While trade secrecy may or may not be socially preferable to patenting in a particular context, free revealing is socially preferable in general. Because free revealing also tends to be more profitable for user innovators than for seller innovators, patenting is less likely to serve a useful disclosure function and more likely to be socially detrimental for user inventions.⁶¹

Table 1 summarizes the discussion of incentives. For ideal user innovations, patenting is unnecessary as an incentive to invent. It is also unimportant in promoting dissemination of most user innovations once they have been disclosed. Patenting is also unnecessary to induce disclosure either of user innovations that are self-disclosing-in-use or of non-self-disclosing inventions for which the benefits of free revealing outweigh the benefits of trade secrecy. The social balance sheet for patenting user innovations thus weighs the benefits of patent-motivated disclosure of non-self-disclosing-in-use inventions that an inventor would not freely reveal against the social costs of patent exclusivity. This balance must be made in context, but in general, patent protection is less necessary and more costly for user innovations than for seller innovations.

To apply this framework in a particular context, one must first identify groups of user and seller innovators and consider

60. *Id.* at 10, 87.

61. There is a further possibility, which I do not explore in detail here, that the availability of patenting produces Prisoners' Dilemma type situations in which free revealing by everyone would be preferable to each, but patenting provides a way to defect and thus everyone chooses to patent, leading to a situation in which everyone is worse off. For a detailed discussion of this issue, see Strandburg, *supra* note 51.

how closely the user innovators approximate the “ideal” user innovator who is able to recoup his or her investment from use alone. Then, one must evaluate the extent to which relevant inventions are self-disclosing or non-self-disclosing. In light of this categorization one can then analyze each group’s incentives to invent, disclose, and disseminate each type of invention with and without patent protection. In any specific context, other factors affecting incentives may also have to be considered.

Of course, even if patent protection is socially undesirable for a particular type of user innovation, it would not generally be feasible for the law to offer patent protection only to seller innovators. Moreover, many user innovators may have mixed motives and hence do not fit the idealized user innovator paradigm emphasized here. Depending on the prevalence and character of user innovation in a particular area of innovation, optimal doctrinal adaptations may vary from a complete ban on patenting certain types of inventions to more subtle adaptations, such as the limited infringement exemption for research use proposed in later Parts of this Article.

B. Areas of Patent Doctrine for Which User Innovation May Have Significant Implications

In the subsequent Parts of this Article, I apply the user innovation framework to analyze the desirability of exempting research use of patented inventions from infringement liability. Here I briefly describe some other issues in patent doctrine for which user innovation may be important.

1. Business Methods and User Innovation

The patenting of business methods has been controversial since the *State Street Bank* case established the “useful, concrete, and tangible result” standard for patentable subject matter.⁶² In that case, the Federal Circuit held that a particular “Hub and Spoke” structure for a mutual fund was patentable subject matter because, although it was a business method, it produced a “useful, concrete, and tangible result.”⁶³

62. *State St. Bank & Trust Co. v. Signature Fin. Group, Inc.*, 149 F.3d 1368, 1373 (Fed. Cir. 1998).

63. *Id.*

As the court described it, “the transformation of data, representing discrete dollar amounts, by a machine through a series of mathematical calculations into a final share price, constitutes a practical application of a mathematical algorithm, formula, or calculation, because it produces ‘a useful, concrete and tangible result.’”⁶⁴ Most recently, Justice Breyer questioned this standard (in a dissent from the dismissal of certiorari as improvidently granted) in the case of *Laboratory Corporation of America Holdings v. Metabolite Laboratories, Inc.*⁶⁵ Although discomfort with business method patenting (and the related patenting of sports moves, tax shelters, methods of entertaining cats and so forth) is widespread,⁶⁶ it has been difficult to come up with a convincing rationale to distinguish business methods from other patentable processes.

One possible explanation for the discomfort with business method patenting is that it reflects an underlying intuition that business method development is most often a species of user innovation, undertaken for its intrinsic and competitive benefit to the user innovator and not requiring a patent incentive to invent. The user innovator perspective may help us to analyze the extent to which patents are necessary for invention, disclosure and dissemination of these methods, the mechanisms and motives for free revealing which might function in the business methods context, and the role which seller innovators (business consulting firms and business software developers, for example) play in promoting progress in business methodology.

At a minimum, the user innovator paradigm suggests that it is not surprising that the patenting of business methods arose in the context of financial software, at a time when the importance of business consultants and providers of software for business operations seems to be increasing. If seller innovators become more prevalent in the field of business methods, the traditional patenting paradigm will obtain force. Yet a side effect of making patent protection available to vendors of business methods has almost certainly been a surge

64. *Id.*

65. 126 S. Ct. 2921 (2006) (Breyer, J., dissenting from dismissal of certiorari as improvidently granted).

66. See *supra* note 15. For a more extensive discussion of business method patenting and user innovation, see Katherine J. Strandburg, *What If There Were a Business Method Use Exemption to Patent Infringement?*, MICH. ST. L. REV. (forthcoming 2008).

of unnecessary patenting of user innovations. An analysis cognizant of the user innovation paradigm may offer some insight into whether it is possible and desirable to accommodate both paradigms in a more socially beneficial way.

2. User Innovation and the Patentability of Scientific Principles and Abstract Ideas

The user innovation paradigm may also shed some light on the canonical exceptions to patentable subject matter—"laws of nature, natural phenomena, and abstract ideas." As Justice Breyer has recently explained:

The justification for the principle does not lie in any claim that "laws of nature" are obvious, or that their discovery is easy, or that they are not useful. To the contrary, research into such matters may be costly and time-consuming; monetary incentives may matter; and the fruits of those incentives and that research may prove of great benefit to the human race. Rather, the reason for the exclusion is that sometimes too much patent protection can impede rather than "promote the Progress of Science and useful Arts," the constitutional objective of patent and copyright protection [The] rule reflects "both . . . the enormous potential for rent seeking that would be created if property rights could be obtained in [those basic principles] and . . . the enormous transaction costs that would be imposed on would-be users." [The rule] reflects a basic judgment that protection in such cases, despite its potentially positive incentive effects, would too often severely interfere with, or discourage, development and the further spread of useful knowledge itself.⁶⁷

Certainly there would be large transaction costs associated with patenting ideas that are of such widespread and diverse use. Yet the emphasis on the transaction costs associated with patenting these types of inventions and discoveries does not address the question of where the incentives to invent and discover these fundamental "laws of nature, natural

67. *Lab. Corp. of Am. Holdings*, 126 S. Ct. at 2926 (Breyer, J., dissenting from dismissal of cert. as improvidently granted) (quoting U.S. CONST. art I, § 8, cl. 8; WILLIAM M. LANDES & RICHARD A. POSNER, *THE ECONOMIC STRUCTURE OF INTELLECTUAL PROPERTY LAW* 305, 305–06 (2003)).

phenomena, and abstract ideas” are to be found.⁶⁸ Ideally, at least from the point of view of “promoting the progress of the useful arts,”⁶⁹ the line between patentable and unpatentable subject matter would be drawn based at least in part on the likelihood that a particular invention or discovery would be made without the need for a patent incentive. The novelty and non-obviousness requirements police this boundary in a quantitative sense—they preclude patents on inventions that are not “large enough” to require a patent incentive. However, those requirements do not make any qualitative distinctions. Considering user innovation—and, more broadly, non-sales incentives in general—raises the question whether there are categories of subject matter for which patents are not needed because other incentives are sufficient. Focusing on the presence of other incentives (rather than merely the costs imposed by patenting) may be useful in understanding and refining the doctrine of patentable subject matter.

Laws of nature, natural phenomena, and abstract ideas have at least two characteristics which make them likely subjects of the ideal sort of user innovation in which the benefits of developing and using them are sufficient compensation for the investment in discovering them. These types of discoveries and inventions are often user innovations in the sense that they are intermediate discoveries and inventions which are necessary along the path to some more directly commercially viable result. In this sense, they are rather like the research tools discussed at length in the next Part of this Article. Incentives to make these fundamental discoveries come from the contribution they make to later discoveries which may be patentable (or provide other commercial rewards) in their own right. Rewarding the later discoveries may be sufficient incentive to discover the necessary “principles of nature.” In addition, these categories encompass subject matter for which the intrinsic rewards of both the process of discovery and the ideas themselves are quite large for many individuals. Just as hobbyists are motivated to improve the tools and equipment associated with their hobbies “for the fun of it,” scientists, explorers, philosophers, and scholars of other sorts have been willing to

68. *Diamond v. Chakrabarty*, 447 U.S. 303, 309 (1980).

69. U.S. CONST. art. I, § 8, cl. 8.

“pay”—either literally or by foregoing more lucrative options—for the privilege of discovering “laws of nature, natural phenomena, and abstract ideas.”⁷⁰ This situation continues today as, for example, university research is funded partly out of public monies and partly out of the willingness of scientists to accept lower salaries than they might otherwise command in the market.⁷¹ A theory of patentable subject matter should take these types of incentives into account. Because there are strong incentives to discover and develop this subject matter so as to use and enjoy it, the patent incentive may not be necessary. Moreover, the societal burden imposed by patenting such foundational subject matter may be particularly large. Of course in some cases, developing basic scientific knowledge or abstract ideas may be so very expensive that the rewards of use alone may not be sufficient to motivate a single inventive entity to do the work. In these cases, some mechanism for aggregating the payoffs from a variety of downstream uses is necessary. While patenting is one such mechanism, its costs for this type of invention are likely to be rather high due to the transaction costs discussed by Justice Breyer. Other aggregative mechanisms (including public funding and other collaborative endeavors) are likely to be more effective and efficient, especially since they can piggyback on the user incentives just discussed.

3. User Innovation and Repair, Reconstruction, and Reaping What You Sow

Recognizing the importance of user innovation might also inform our approach to another group of related issues. The patent law doctrines of “repair and reconstruction,”⁷² the related issue of the conflict between sales of genetically modified seeds and the traditional seed-saving and horticultural practices of farmers,⁷³ and questions about the extent to which limitations on patent protection may permissibly be overcome through license terms that impose

70. For a recent empirical study of this phenomenon, see Scott Stern, *Do Scientists Pay to be Scientists?*, 50 MGMT. SCI. 835 (2004).

71. *Id.*

72. 5 DONALD S. CHISUM, CHISUM ON PATENTS § 16.03[3] (2005).

73. See *supra* note 27.

what are essentially “super-patent” rights⁷⁴ all relate to ways in which expansive approaches to patent protection can serve to stifle user innovation.⁷⁵ In the past, the first sale doctrine and a rather expansive reading of the right to repair a patented device protected and encouraged user innovation. The first sale doctrine holds that a patentee’s rights are “exhausted” when a patented product is sold, leaving the purchaser free to do with it as he or she wishes.⁷⁶ The related repair and reconstruction doctrine holds that a purchaser of a patented item may repair it without the permission of the patentee as long as the repairs do not amount to a complete reconstruction of the patented item (essentially making a new item).⁷⁷ These doctrines give users considerable freedom in what they do with patented items that they own. However, recent controversies dealing with reproduction of living organisms (rather than repair or reconstruction of mechanical devices)⁷⁸ and recent trends in using licensing terms to control post-sale use of patented inventions⁷⁹ raise important questions of the extent of a purchaser’s right to use a patented invention in ways not anticipated by the original patentee. In addressing these questions, one should not neglect the importance of leaving space for user innovation.

74. See, e.g., Michael J. Madison, *Legal-Ware: Contract and Copyright in the Digital Age*, 67 FORDHAM L. REV. 1025 (1998) (discussing similar issues in the context of copyright protection).

75. See, e.g., Viktor Braun & Cornelius Herstatt, *Barriers to User-Innovation: The Paradigm of “Permission to Innovate,”* in 2006 IEEE INTERNATIONAL CONFERENCE ON MANAGEMENT OF INNOVATION AND TECHNOLOGY 176 (2006) (discussing the evolution of a “permission culture”).

76. See *Motion Picture Patents Co. v. Universal Film Mfg. Co.*, 243 U.S. 502 (1917), *United States v. Univis Lens Co.*, 316 U.S. 241 (1942).

77. See *Aro Mfg. Co. v. Convertible Top Replacement*, 365 U.S. 336 (1961).

78. See, e.g., *Monsanto Co. v. McFarling*, 488 F.3d 973 (Fed. Cir. 2007), *cert. denied*, 76 U.S.L.W. 3344 (U.S. Jan. 8, 2008) (No. 07-241) (dealing with patented, genetically modified seeds). The Petition for Certiorari asks, “Do the doctrines of patent exhaustion and patent misuse permit the purchaser of a patented good to use that good and dispose of its products as it sees fit, absent a valid contract?” See Kevin E. Noonan, *Supreme Court Fails to Grant Certiorari in Monsanto Co. v. McFarling*, http://www.patentdocs.net/patent_docs/2008/01/supreme-court-f.html (last visited Jan. 7, 2008).

79. See *Quanta Computer, Inc. v. LG Elecs., Inc.*, 168 L. Ed. 2d 805, *cert. granted*, 76 U.S.L.W. 3153 (U.S. Sept. 25, 2007) (No. 06-937). In that case, the question presented is “[w]hether the Federal Circuit erred by holding, in conflict with decisions of this Court and other courts of appeals, that respondent’s patent rights were not exhausted by its license agreement with Intel Corporation, and Intel’s subsequent sale of product under the license to petitioners.” *Id.*

4. User Innovation and the Benefits of the Public Domain

User innovation may raise issues related to personal creative investment that have, in the past, had little traction in the patent law arena. The analysis in this Article has so far assumed that as long as incentives to invent are preserved, society is better off if inventions are placed into the public domain as quickly as possible. Patent law doctrine generally reflects the same assumption, requiring disclosure, providing incentives for early patent filing, refusing to treat trade secrets as prior art, and so forth.⁸⁰ Economic arguments regarding the tradeoff between the efficiencies of development coordinated by a single owner and the efficacy of competitive development of inventions using information available to all in the public domain have been well vetted and are not rehearsed here.⁸¹ Other potential challenges to the assumption that free access to inventions is categorically preferable have not been so well explored. Along with, and perhaps as a consequence of, increasingly strong intellectual property rights has come rising deployment of intellectual property rights by inventors in pursuit of non-economic objectives.⁸²

Again, the example of open source software is instructive. Though the open source approach is by now understood to be a viable economic engine for developing software—and is one path taken by major industrial players such as IBM—it arose out of a social or political agenda opposed to at least some approaches to the commercialization of software.⁸³ Open source software developers in this mold use a “viral” license for

80. See 35 U.S.C. § 112 (2000) (disclosure requirements); 35 U.S.C. § 102(b) (2000) (statutory bar to patenting more than one year after public use or sale); *W.L. Gore & Assocs., Inc. v. Garlock, Inc.*, 721 F.2d 1540, 1550 (Fed. Cir. 1983) (“Early public disclosure is a linchpin of the patent system. As between a prior inventor who benefits from a process by selling its product but suppresses, conceals, or otherwise keeps the process from the public, and a later inventor who promptly files a patent application . . . the law favors the latter.”).

81. See, e.g., Kenneth Arrow, *Economic Welfare and the Allocation of Resources for Invention*, in *THE RATE AND DIRECTION OF INVENTIVE ACTIVITY* 609, 619–22 (R. Nelson ed., 1962); Edmund P. Kitch, *The Nature and Function of the Patent System*, 20 J.L. & ECON. 265 (1977); Robert P. Merges & Richard R. Nelson, *On the Complex Economics of Patent Scope*, 90 COLUM. L. REV. 839 (1990).

82. See, e.g., Safrin, *supra* note 27, at 1968.

83. See, e.g., Free Software Foundation, www.fsf.org (last visited Nov. 15, 2007) (“Free software is a matter of liberty, not price.”).

intellectual property embodied in their software,⁸⁴ willingly sharing the fruits of their creative labor only on condition that users agree to share the results of their own modifications to the software on similar terms. Similarly, the BIOS project promotes the use of an “open source” approach in biological innovation. According to BIOS,

both products and improvements can still be patented, and products and services can be developed for profit or for public good—but licensees and those who have used the technology under MTAs may not assert rights to exclude from use of improvements, even patented improvements, against the licensor and other licensees within the protected commons.⁸⁵

As university technology transfer offices come to the realization that, with rare but well-publicized exceptions, patent licensing is not a significant moneymaking enterprise,⁸⁶ they have begun to explore strategies for using intellectual property rights in pursuit of their public service missions.⁸⁷ The Public Intellectual Property Rights for Agriculture project (“PIPRA”) is a consortium of universities with the objective of “helping to improve agriculture in emerging economies by decreasing intellectual property barriers and increasing technology transfer.”⁸⁸ PIPRA, along with the Centre for Management of Intellectual Property in Health Research and Development, maintains an IP Handbook of Best Practices,

84. See WEBER, *supra* note 15, at 48–49.

85. See Bios: Open Source Open Science Open Society, <http://www.bios.net/daisy/bios/licenses/398/2532.html> (last visited Jan. 22, 2008).

86. See Ashley J. Stevens, Do Most Academic Institutions Lose Money on Technology Transfer?, Presentation before the 2005 Annual Meeting of the Technology Transfer Society (2005), *available at* http://www.kauffman.org/pdf/tt/Stevens_Ashley.pdf. Only under the most generous of assumptions did even 60% of university technology transfer offices break even. *Id.* Under other sets of assumptions, only 30% broke even. The gross income from technology licensing had a highly skewed distribution, with the median generally only around \$300,000. *Id.*

87. See Patrick L. Jones & Katherine J. Strandburg, *Technology Transfer and An Information View of Universities: A Conceptual Framework For Academic Freedom, Intellectual Property, Technology Transfer and the University Mission* 7–13 (2006) (Working Paper), *available at* http://works.bepress.com/katherine_strandburg/10/ (discussing how universities are rethinking their approaches to technology transfer).

88. See PIPRA: The Public Intellectual Property Resource for Agriculture, <http://www.pipra.org/en/about.en.html> (last visited Jan. 22, 2008).

which provides advice and information about, among other things, “[c]reative licensing practices that ensure global access and affordability.”⁸⁹ Among the practices described is a “reservation of rights for humanitarian uses.”⁹⁰ PIPRA’s draft language for such a reservation of rights provides that “University hereby reserves an irrevocable, nonexclusive right in the Invention/Germplasm for Humanitarian Purposes,” along with a proposed definition of “Humanitarian Purposes.”⁹¹ Along similar lines, some advocates of indigenous communities’ rights propose using intellectual property rights or *sui generis* rights in traditional knowledge modeled on intellectual property rights as means both to generate economic returns and to pursue non-economic goals of cultural protection.⁹²

This desire to direct the use of one’s inventions toward particular non-economic goals is in tension with the view that, as much as possible consistent with incentives to invent, inventions should be placed into the public domain for others to use as they will.⁹³ The blanket research use exemption I propose below, for example, would be in tension with viral licensing terms requiring non-commercial use. This tension between an inventor’s desire to have some say in the way his or her invention is used and the social benefits of placing inventions into the public domain is similar to the tension between “moral rights” and “the public domain” which has been explored at length in the copyright context.⁹⁴

Patent discourse has been mostly oblivious to these problems except in the traditional knowledge context.⁹⁵

89. See *The Role of IP Management in Health and Agricultural Innovation*, in IP HANDBOOK OF BEST PRACTICES, <http://www.iphandbook.org/handbook/ch01/p01/eo/index.html> (last visited Jan. 22, 2008).

90. Alan B. Bennett, *Reservation of Humanitarian Uses*, in IP HANDBOOK OF BEST PRACTICES, <http://www.iphandbook.org/handbook/ch02/p01/> (last visited Jan. 29, 2008).

91. *Id.*

92. See, e.g., Safrin, *supra* note 27, at 1935–46.

93. See R. Polk Wagner, *Information Wants To Be Free: Intellectual Property and the Mythologies of Control*, 103 COLUM. L. REV. 995, 1031–33 (2003) (making a similar point about open source software).

94. See, e.g., Jon M. Garon, *Normative Copyright: A Conceptual Framework for Copyright Philosophy and Ethics*, 88 CORNELL L. REV. 1278 (2003) (discussing this tension).

95. See, e.g., Anupam Chander & Madhavi Sunder, *The Romance of the Public Domain*, 92 CAL. L. REV. 1331 (2004); Shubha Ghosh, *Reflections on the Traditional Knowledge Debate*, 11 CARDOZO J. INT’L & COMP. L. 497 (2003).

However, there are reasons to anticipate that non-economic factors will often be of greater concern to user innovators than to seller innovators. Most obviously, the potential for economic return is generally the primary motivator of seller innovators. Historically, they have been limited by practicality and the first sale doctrine in their ability to exact payment for the uses to which purchasers put their inventions.⁹⁶ User innovators may be more likely to be personally invested in their inventions and more likely to believe that there are “acceptable” and “unacceptable” uses for them. They may be part of innovative communities governed by social norms grounded in non-economic goals and principles. As user innovators become more important, there may be a rising debate about “moral rights” in the patent law context.

III. USER INNOVATION AND RESEARCH USE OF PATENTED INVENTIONS

To put some flesh on the bones of the framework developed in Part II, I consider in some detail in the remaining Parts of this Article the potential consequences of an infringement liability exemption for research use of a patented invention.⁹⁷ This Part provides background on the research tool issue. The next Part applies the analytic framework to the research tool issue.

A. *What is a Research Tool?*

When a technology is employed in researching the properties of something else, it is functioning as a research tool or method (often collectively denominated “research tools” in the literature). A technology may also, of course, be the subject of research into its properties. I have argued elsewhere that such “experimenting on” a patented invention should always be exempt from infringement liability.⁹⁸ For that reason, the discussion here focuses on the potential incentive effects of “experimenting with” a patented invention—using it as a research tool or method. Because research tools and methods

96. See, e.g., *United States v. Univis Lens Co.*, 316 U.S. 241 (1942). But see, e.g., *Braun & Herstatt*, *supra* note 75.

97. See *supra* note 19.

98. Strandburg, *supra* note 16, at 119–21.

are often developed by those engaged in doing research, they frequently are user innovations.

The “research tool” category is somewhat ill-defined, since a technology may often be employed both as a tool for research and in some other way. A microscope, for example, can be used in research, but can also be used to read the results of a diagnostic test. Similarly, the common laboratory chemical acetone can be used in research or to remove nail polish. Thus, rather than speaking of a “patented research tool,” it is more proper to speak of “research tool use of a patented invention.”⁹⁹ Because of this possibility of multiple uses, any legal distinctions should be based not on whether an invention “is” a research tool, but on whether there is a research use. Nonetheless, a list of “research tools” provided by in an NIH report is illustrative, at least in the biotechnology arena: “[T]he term may [] include cell lines, monoclonal antibodies, reagents, animal models, growth factors, combinatorial chemistry libraries, drugs and drug targets, clones and cloning tools (such as PCR), methods, laboratory equipment and machines, databases and computer software.”¹⁰⁰ The research exemptions proposed in this Article apply only when a patented invention is used in research and have no impact on patent rights to those inventions when used in other contexts.

B. The Research Tool Issue in Patent Law

Research is a primary path for technological and scientific progress. Because patents can restrict follow-on research, there is a tension between incentives for initial invention and the progress that comes from building upon the available store of knowledge.¹⁰¹ Under a research exemption, some unauthorized “experimental uses” of patented inventions are exempted from infringement liability. Because no license is required for exempted research, refusals to license that are intended to constrain follow-on innovation can be evaded by

99. The definition of “research use” is clear in most circumstances, but there may be controversy at the margins. This issue is discussed in greater detail, *infra* Part IV.G.1.

100. REP. OF NAT’L INST. OF HEALTH WORKING GROUP ON RESEARCH TOOLS (1998), available at <http://www.nih.gov/news/researchtools/> (last visited Nov. 15, 2007).

101. See Strandburg, *supra* note 16, at 122 (discussing the history of the research exemption).

such an exemption. Under current United States law, however, the exemption from infringement liability for research use of patented inventions is limited almost entirely to FDA-regulated inventions (primarily pharmaceuticals).¹⁰² In principle, there is also a more general judge-made exemption for noncommercial research use.¹⁰³ However, under recent case law the general research exemption has shrunk nearly to extinction.¹⁰⁴

Scholars have made a number of proposals to broaden the research exemption.¹⁰⁵ In earlier work, I advocated a broad exemption for “experimenting on” a patented invention to understand, improve, or design around it. Such an exemption would effectuate patent disclosure of the inventive idea, which is the most important contribution most inventions make to follow-on invention.¹⁰⁶

102. See 35 U.S.C. § 271(e) (2000) (stating “[i]t shall not be an act of infringement to make, use, offer to sell, or sell within the United States . . . a patented invention . . . solely for uses reasonably related to the development and submission of information under a Federal law which regulates the manufacture, use, or sale of drugs or veterinary biological products”); see also *Merck KGaA v. Integra Lifesciences I, Ltd.*, 125 S. Ct. 2372 (2005); *Eli Lilly & Co. v. Medtronic, Inc.*, 496 U.S. 661 (1990) (construing the statutory exemption broadly). For a general review of the statutory exemption, see Katherine J. Strandburg, *The Research Exemption to Patent Infringement: The Delicate Balance Between Current and Future Technical Progress*, in *INTELLECTUAL PROPERTY AND INFORMATION WEALTH* 107, 112–15 (Peter Yu ed., 2006).

103. See *Whittemore v. Cutter*, 29 F. Cas. 1120, 1121 (C.C.D. Mass. 1813) (No. 17,600); *Sawin v. Guild*, 21 F. Cas. 554, 555 (C.C.D. Mass. 1813) (No. 12,391); 5 DONALD S. CHISUM, *CHISUM ON PATENTS*, § 16.03 (2005); 3 WILLIAM C. ROBINSON, *THE LAW OF PATENTS FOR USEFUL INVENTIONS* § 898 (1890). See also Strandburg, *supra* note 16, at 109–12.

104. *Madey v. Duke Univ.*, 307 F.3d 1351, 1362–63 (Fed. Cir. 2002) (university research ineligible for the research exemption because it “unmistakably further[s] the institution’s legitimate business objectives, including educating and enlightening students and faculty participating in these projects”); *Embrex, Inc. v. Serv. Eng’g Corp.*, 216 F.3d 1343, 1349 (Fed. Cir. 2000) (“While SEC tries to cloak these tests in the guise of scientific inquiry, that alone cannot immunize its acts.”); *Roche Prods. v. Bolar Pharm. Co.*, 733 F.2d 858, 863 (Fed. Cir. 1984) (holding that courts should not “construe the experimental use rule so broadly as to allow a violation of the patent laws in the guise of ‘scientific inquiry,’ when that inquiry has definite, cognizable, and not insubstantial commercial purposes”); see also *Integra Lifesciences I, Ltd. v. Merck KGaA*, 331 F.3d 860, 872–78 (Fed. Cir. 2003) (Newman, J., concurring in part and dissenting in part) (disputing recent Federal Circuit interpretations of the common-law experimental-use exemption).

105. See *supra* note 19.

106. Strandburg, *supra* note 16, at 119.

At least one Federal Circuit judge advocates interpreting current law to include an “experimenting on” exemption.¹⁰⁷ It has been substantially more difficult to come up with a well-designed infringement exemption for use of a patented invention as a research *tool*, however. When research *tools* are patented, “Progress [in the] . . . useful Arts”¹⁰⁸ depends upon using an *embodiment* of the invention. Societal interests in permitting inventors to recoup investment in developing the patented tool through sales and in freeing up the potential for follow-on innovation are thus entangled.¹⁰⁹ A research tool exemption intended to free up the follow-on innovation market has the potential to cut directly into the product market—and hence into the traditional sales-oriented incentives to invent—for the research tool.

While no court decision concerning either the general judge-made research exemption or the statutory FDA exemption has yet turned on the research tool issue, the question has become increasingly salient. A large number of amicus briefs¹¹⁰ addressing the issue were filed in the recent

107. *Integra*, 331 F.3d at 872–78.

108. U.S. CONST. art. I, § 8, cl. 8.

109. This “product” market and “innovation” market distinction is discussed by Graeme B. Dinwoodie and Rochelle Cooper Dreyfuss, *WTO Dispute Resolution and the Preservation of the Public Domain of Science under International Law*, in *INTERNATIONAL PUBLIC GOODS AND TRANSFER OF TECHNOLOGY UNDER A GLOBALIZED INTELLECTUAL PROPERTY REGIME* 861 (K.E. Maskus & J. H. Reichman eds., 2005).

110. 125 S. Ct. 2372 (2005). 15 of 21 amicus briefs filed in the case discuss the research tool issue. Brief for Wis. Alumni Research Found. et al. as Amici Curiae Supporting Respondents, *Merck KGaA v. Integra Lifesciences I, Ltd.*, 125 S. Ct. 2372 (2005) (No. 03-1237); Brief for Applera Corp. and Isis Pharm. as Amici Curiae Supporting Respondents, *Merck*, 125 S. Ct. 2372 (No. 03-1237); Brief for Vaccinex, Inc. as Amicus Curiae Supporting Respondents, *Merck*, 125 S. Ct. 2372 (No. 03-1237); Brief for Benitec Austl. Ltd. as Amicus Curiae Supporting Respondents, *Merck*, 125 S. Ct. 2372 (No. 03-1237); Brief for Invitrogen Corp. et al. as Amici Curiae Supporting Respondents, *Merck*, 125 S. Ct. 2372 (No. 03-1237); Brief for the United States as Amicus Curiae Supporting Petitioner, *Merck*, 125 S. Ct. 2372 (No. 03-1237); Brief for Eli Lilly & Co. et al. as Amici Curiae Supporting Petitioner, *Merck*, 125 S. Ct. 2372 (No. 03-1237); Brief for the Am. Intellectual Prop. Law Ass’n. as Amicus Curiae Supporting Neither Party, *Merck*, 125 S. Ct. 2372 (No. 03-1237); Brief for Bar Ass’n of D.C. as Amicus Curiae Supporting Neither Party, *Merck*, 125 S. Ct. 2372 (No. 03-1237); Brief for Intellectual Prop. Professors as Amici Curiae Supporting Neither Party, *Merck*, 125 S. Ct. 2372 (No. 03-1237); Brief for Genentech, Inc. and Biogen Idec, Inc. as Amici Curiae Supporting Petitioner, *Merck*, 125 S. Ct. 2372 (No. 03-1237); Brief for Consumer Project on Tech. et al. as Amici Curiae Supporting Petitioner, *Merck*, 125 S. Ct. 2372 (No. 03-1237); Brief for the San Diego Intellectual Prop. Law Ass’n as Amici Curiae Supporting Neither Party, *Merck*, 125 S. Ct. 2372 (No.

Supreme Court case of *Merck v. Integra*—even though the Court did not consider the research tool question. Judge Newman’s dissent from the initial opinion in *Integra* at the Federal Circuit level also focused on the distinction between research tools and “experimenting on” a patented invention.¹¹¹ Judge Rader picked up the issue again in questioning at oral argument following the Supreme Court’s remand of the case, despite the fact that the parties had agreed that the research tool issue was not presented on remand.¹¹²

There is no “research tool issue” if a patentee commercializes a research tool and sells or licenses it on the open market at a reasonable price.¹¹³ Concern arises directly from the fact that profit from commercial sales of the tool is not the prime motivator for many research tool inventors. Many are competitive user innovators, who wish to use a tool in research (or perhaps license it exclusively for research) in order to win the research race. In this situation, exclusive control of a research tool during a patent term may give the tool inventor the ability to block technological progress by controlling the research that may be performed using the tool. It is in society’s interest to have research performed by the quickest and most effective researchers. Where a tool has wide application or is relevant to a particularly difficult problem, it may also be important to have a diversity of perspectives applied to research using the tool.¹¹⁴ A genetic marker for a certain cancer or other serious disease is an example of this type of invention. Research using the marker as a tool may be crucial

03-1237); Brief for Eon Labs, Inc. as Amicus Curiae Supporting Petitioner, *Merck*, 125 S. Ct. 2372 (No. 03-1237).

111. 331 F.3d at 872–78.

112. See *Federal Circuit Hears Oral Arguments in Integra v. Merck, After Remand from Supreme Court*, ORANGE BOOK BLOG (June 7, 2006), http://www.orangebookblog.com/2006/06/federal_circuit.html.

113. See Mueller, *No “Dilettante Affair,” supra* note 19, at 15. This is an oversimplification, of course, because a patented research tool presumably will still be more expensive than it would be if not patented. But this kind of price increase is an unavoidable and necessary result of patenting any type of invention. The important characteristic of widespread commercial availability is that it decouples control over research using the tool from recovering the toolmaker’s investment.

114. Strandburg, *supra* note 16, at 124. For a similar discussion of the conditions under which problems with access to research tools can arise, see John P. Walsh et al., *Effects of Research Tool Patents and Licensing on Biomedical Innovation*, in *PATENTS IN THE KNOWLEDGE-BASED ECONOMY* 285, 332–33 (Wesley M. Cohen & Stephen A. Merrill eds., 2003).

to developing treatments for the disease.¹¹⁵ It is in society's interest to encourage inventors of such tools to make them broadly available to interested researchers. Such cases, unfortunately, are precisely the ones in which a competitive user inventor might refuse to make the tool widely available because of the private benefits available from control of an important research stream.

Where tool inventors seek to control a research stream by restricting research tool availability, a research use exemption might be socially beneficial. However, research exemption proposals must take into account the potential for impact on incentives to invent, disclose, and disseminate inventions with significant research tool uses. Previous proposals have generally been of three types: 1) exemptions applying only to non-profit research;¹¹⁶ 2) exemptions inspired by copyright "fair use," involving balancing a number of factors;¹¹⁷ and 3) compulsory licensing.¹¹⁸ Non-profit and fair use exemptions seek to maintain commercial sale incentives by confining the exemption to particular sectors of the market where the effects of patenting on control of the research stream seem most severe and the effects on tool sales are minimal. I have reviewed some of these proposals in more detail elsewhere (and supplied a proposal of my own).¹¹⁹ While each has its

115. See, e.g., TREVOR COOK, *THE INTELLECTUAL PROP. INST., A EUROPEAN PERSPECTIVE AS TO THE EXTENT TO WHICH EXPERIMENTAL USE, AND CERTAIN OTHER, DEFENCES TO PATENT INFRINGEMENT, APPLY TO DIFFERING TYPES OF RESEARCH* (2006); Dreyfuss, *supra* note 19, at 459–60; Pulsinelli, *supra* note 19, at 471–72.

116. See, e.g., Dreyfuss, *supra* note 19, at 462–63.

117. See O'Rourke, *supra* note 19, at 1205–09 (proposing the following factors: "(i) the nature of the advance represented by the infringement; (ii) the purpose of the infringing use; (iii) the nature and strength of the market failure that prevents a license from being concluded; (iv) the impact of the use on the patentee's incentives and overall social welfare; and (v) the nature of the patented work"); Mueller, *The Evanescent Experimental*, *supra* note 19, at 972–79 (proposing the following factors: "(1) the availability of consensual licenses; (2) whether the challenged use amounts to experimenting on a claimed invention or experimenting with it; (3) the degree to which the alleged experimental activity is necessarily incident to subsequent commercial exploitation; and (4) the balance of harms invoked in the granting or denial of an experimental use defense under the particular facts at hand").

118. See Strandburg, *supra* note 16, at 138–46; see generally sources cited *supra* note 19.

119. See Strandburg, *supra* note 16, at 135–46; Strandburg, *supra* note 102 (reviewing proposals).

advantages, all suffer from varying degrees of administrative complications and questionable effectiveness.

Most importantly, despite their differences, prior proposals for a research tool infringement exemption run up against the presumed need to compensate tool patentees for unauthorized use because of a concern that failure to do so will depress incentives to invent research tools. This presumed need for compensation is a primary reason for the administrative complications associated with these proposals. In focusing primarily on the commercial or non-commercial character of the *users* of research tools, most approaches to the research tool problem have failed to look deeply into whether patent incentives are necessary to promote the invention, disclosure, and widespread dissemination of research tools by specific types of *inventors*.¹²⁰ The next Part addresses that question.

IV. ANALYSIS OF RESEARCH USE EXEMPTION IN LIGHT OF USER INNOVATION FRAMEWORK

This Part applies the framework developed in Part II to analyze the likely incentive effects of a blanket exemption for research use of a patented invention. Anyone who “without authority makes, uses, offers to sell, or sells” or “imports” a patented invention infringes the patent.¹²¹ A blanket research use exemption would exempt those who make and use patented

120. This is not to say that none of the analyses to date have taken any account of the fact that many research tools are invented by researchers. Professor Rochelle Dreyfuss’s proposed exemption would run in favor of noncommercial research organizations, universities, and their employees if (1) the patented materials they wish to utilize were not made available on reasonable terms; (2) the researchers agreed to publish the results of their work; and (3) the researchers agreed either to refrain from patenting the results or to patent the results and then license them on a nonexclusive basis and on reasonable terms. Dreyfuss, *supra* note 19, at 471. Dreyfuss’s waiver proposal implicitly treats non-profit tool inventors differently if the tool inventions result from research that employs other research tools on the basis of the non-profit waiver. *Id.* My own earlier work assumes that research tool inventors may choose to perform the research “in-house” using trade secrecy and thus implicitly assumes that some tool inventors are also tool users. Strandburg, *supra* note 16, at 132. Pulsinelli, *supra* note 19, has proposed an exemption which takes into account the non-commercial status of the inventor. But the effects of different types of incentives and rewards for different types of tool inventors have not been systematically considered.

121. 35 U.S.C. § 271 (2006).

inventions in research from liability for infringement, while leaving other prohibitions intact.

Applying the framework of Part II to a particular inventive context requires 1) identifying groups of user and seller innovators; 2) evaluating the extent to which relevant inventions are self-disclosing; and 3) analyzing each group's incentives to invent, disclose, and disseminate each type of invention with and without patent protection. In any specific context, other factors affecting incentives may also have to be considered. For example, there may be, as there are in the research tool context, subgroups of user and seller innovators with somewhat different incentives. Moreover, the paradigm of the ideal user innovator, who needs neither trade secrecy nor patenting to incentivize invention, will be more or less accurate in particular real world contexts. In reality, the "elasticity" of user innovators' incentives to patent and trade secrecy protection will vary. To apply the user innovation framework to specific inventive contexts one must take these variations from the ideal into account.

Research tools are produced both by researchers (user innovators) and by firms which intend to sell or license them (seller innovators). This Article categorizes research tool inventors into four main groups: non-profit researcher innovators, commercial researcher innovators, commercial research tool suppliers, and commercial research tool licensing firms whose business plans revolve around inventing high-tech research tools and then licensing the resulting patents either to tool manufacturers or to tool users. As common sense would predict and case studies confirm, researcher innovators are the inventors of a large proportion of scientific instruments.¹²² (See Table 2.) Studies have also found that researchers and manufacturers tend to make different types of inventions, consistent with their respective competencies.¹²³ (See Table 3.) Researchers tend to make "cutting edge" functional improvements, while manufacturers tend to make improvements in safety, consistency, and convenience.

Researcher innovators have different incentives to invent, to disclose, and to disseminate research tools than commercial

122. DEMOCRATIZING INNOVATION, *supra* note 9, at 19–31; Riggs & von Hippel, *supra* note 8, at 459; *see also* Table 1.

123. DEMOCRATIZING INNOVATION, *supra* note 9; Riggs & von Hippel, *supra* note 8.

tool manufacturers or tool licensing firms have. Researchers are generally “lead users” since the success of their research often depends entirely on their ability to devise “cutting edge” research methods. They have heterogeneous needs for tools optimized for their particular experiments. They have “sticky information” about their research tool needs that is not only difficult to transfer to a tool manufacturer, but evolves with their research. Researchers have significant expertise for inventing research tools and, unlike many other user innovators, often have access to sophisticated equipment with which to develop them. In essence, while researchers are usually not professional sellers of research tools, they are effectively professional inventors of research tools and methods for their own use and fit naturally into the user innovator paradigm.

Though researcher innovators are competitive user innovators, they also often gain significant intrinsic benefits from their use of research tools and receive reputational and other rewards for freely revealing their inventions. Moreover, for the large fraction of researcher innovators working in non-profit venues, non-commercial incentives and social norms are primary motivators.¹²⁴ Though intrinsic and free revealing benefits are most significant for non-profit researcher innovators, they are present to some extent for commercial researchers as well.

To determine the impact a research use exemption from infringement liability might have on the invention, disclosure, and dissemination of research tools, this Part considers the incentive effects of patent protection on each type of research tool inventor. The analysis assumes that inventors will choose the courses of action—patenting, free revealing, or protecting trade secrets—that maximize their private returns from invention. In cases in which free revealing or trade secrecy is preferred, it matters little whether patent protection is available or whether there is a research use exemption—inventors will not patent in any event. To determine whether a research use exemption will suppress incentives, one must focus on cases where the returns from patent protection are greater than those from either trade secrecy or free revealing.

124. See, e.g., David, *Open Science*, *supra* note 15; Eisenberg, *supra* note 15; Rai, *Regulating Scientific Research*, *supra* note 15; Strandburg, *supra* note 16; Sung, *supra* note 15.

Given the objections expressed by various groups to the prospect of a research exemption encompassing research tools,¹²⁵ it seems safe to assume that patenting research tool inventions is privately preferred in many cases. The relevant question is then whether, in those cases, limiting the scope of patent protection through a research use exemption would, on balance, significantly reduce the invention, disclosure, and dissemination of such inventions.

To answer this question, the following sections use the user innovation framework to assess how a research use exemption would affect the incentives of the various groups of research tool inventors.

A. The Incentives of Non-profit Researcher Innovators

1. Incentives to Invent Research Tools

Many research tools are invented by non-profit researcher innovators, such as university faculty, postdoctoral researchers, and graduate students.¹²⁶ Asking why they invent research tools and methods would probably strike most of these researchers as somewhat inane—developing research methods is a major part of what they do. These researchers are not primarily motivated to invent research tools by the prospect of commercial sales or licensing of the tools—they intend to use them in their own research. Thus, like user innovators more generally, they benefit directly from their own innovative activity. Their primary focus is on obtaining and publishing research results, which provides them with the benefits of enhanced reputation, intellectual satisfaction, the ability to obtain their own funding, and the ability to participate in an ongoing social discourse.¹²⁷ Research tools

125. See *supra* briefs cited in note 110.

126. See Riggs & von Hippel, *supra* note 8, (a study of the importance of innovation by researchers in the field of scientific instruments). The importance of research tools invented by non-profit researchers in particular is widely recognized. See, e.g., Strandburg, *supra* note 51 (discussing and citing some of the empirical studies of patenting of research tools, especially in the life sciences).

127. See, e.g., Strandburg, *supra* note 16, at 104–05. In the non-profit context, and especially in the university context, it makes sense to consider the motivations of the researchers themselves, even though they usually assign patents on their inventions to their employing organizations. The reason for this is that researchers in the non-profit context operate relatively independently of institutional directives. University professors often have tenure, usually acquire

and methods facilitate obtaining research results and the corresponding benefits.

Researchers tend to devise "leading edge" tools in their own laboratories.¹²⁸ They usually do not "outsource" the invention of these research tools to commercial manufacturers because researchers have both the expertise and the resources available to develop their own tools. Even if lead user researchers attempted to outsource tool development to manufacturers, the likelihood that manufacturers would accept the challenge is low. On the leading edge, the potential market for a research tool is often small and uncertain; the tool is specialized to a particular researcher's attack on a problem. There is no guarantee *ex ante* of a broad enough market for the tool to warrant commercial interest. The unpredictability of research and the hands-on nature of science also favor tool innovation by researchers themselves. Researchers have "sticky information" about their particular experimental needs that may be difficult and costly to transfer to a tool manufacturer.¹²⁹ Commercial manufacturers may be too removed from the cutting edge of research to perceive exactly what tools researchers might want in time to make those tools available on the market when researchers need them. Even when a researcher sends out "specs" to a custom manufacturer for a piece of equipment, the inventive activity will usually have been primarily that of the researcher. The pace of research also militates against relying on a commercial R&D process to provide leading edge tools. Researchers often prefer the flexibility of tinkering with a tool as the research progresses to obtain a better understanding of how the tool is working and to make needed changes "on the fly."

Furthermore, research is an area in which the "first mover advantages" that accrue to an inventor even if the invention is disclosed to competitors may be particularly important.¹³⁰

their own research funding (which they can take with them if they leave), and often receive a portion of any royalties to be used in their research projects. Universities, at least, have very little ability to control the research choices of their faculty once they have been hired and especially after they have tenure.

128. Riggs & von Hippel, *supra* note 8, at 468; see also DEMOCRATIZING INNOVATION, *supra* note 9, at 19–31, 70–71.

129. DEMOCRATIZING INNOVATION, *supra* note 9, at 66–70; Riggs & von Hippel, *supra* note 8, at 468.

130. "First mover advantage" differs from trade secrecy, which confers benefits based on non-disclosure of the invention.

Seller innovators derive first mover advantages from a brief period of exclusivity in the market while competitors “gear up” to make the new invention, and by establishing a recognizable brand and consumer connection of the first mover seller to the product.¹³¹ Except in cases in which a first mover advantage translates into “network effects”¹³² or in which the first mover has a particularly strong brand name, the “first mover advantage” for seller innovators may be limited.¹³³ Competitors can often get into the act relatively quickly, causing prices to return to the competitive level.

First mover advantage to a researcher who develops a research tool may be much more significant. Non-profit researchers are rewarded primarily for publishing their results.¹³⁴ Publication is a “winner-take-all” game. Unlike the competing seller, who can enter a market three months after a first moving inventor and appropriate most of the benefit of the invention through competing sales, a competing researcher who begins using a tool three months after a first moving researcher inventor may well end up with no publication (and hence no benefit) at all! Of course, this is an over-simplified view. It is unlikely that an inventor of an important tool or method will be able to “scoop” all research using it once it is available to other researchers. Other researchers will attack different problems or have complementary expertise that the original inventor does not have, for example. Nonetheless, the “winner-take-all” nature of research heightens the importance of the first mover advantage, giving researchers relatively large intrinsic motivations to invent research tools.

131. DEMOCRATIZING INNOVATION, *supra* note 9, at 10, 86.

132. Network effects arise when the benefits of using a particular product depend on the number of other users of that product. In such cases, first mover advantages may be extraordinarily important because an entire market can “tip” toward using one version of a technology. Computer operating systems and video recording technology are often-cited examples of technologies dominated by network effects. For a discussion of network effects, see Mark A. Lemley & David McGowan, *Legal Implications of Network Economic Effects*, 86 CAL. L. REV. 479 (1998).

133. Nonetheless, first mover advantage is an important appropriability mechanism even for traditional seller innovators. See Cohen et al., *supra* note 25, at 9–11.

134. See Rai, *Regulating Scientific Research*, *supra* note 15, at 88–94; Strandburg, *supra* note 30, at 102–07 and citations therein (discussing the norms and preferences of scientific researchers).

Of course, there are limits to the intrinsic tool invention incentives of researcher innovators. They are less likely than tool sellers to invest in improvements aimed at standardizing a tool for more general use, in aspects such as safety and stability, and in minor improvements that do not have significant effects on research functionality.¹³⁵ They may also be less likely than commercial manufacturers to invent general-purpose tools that require large investments of time or money. Their incentives to invent tools are limited by the returns (whether financial or not) they expect to receive from the results of their research and from collaborations and other reputational benefits that grow out of inventing the tool.

This does not mean, however, that researcher innovators never produce costly general-purpose tools in the absence of patenting. On the contrary, non-profit researchers often cooperate on projects which are advantageous to the group as a whole—for example, by obtaining collaborative funding for large facilities which are made available to all (though perhaps preferentially to those most involved in the project). High-energy particle accelerators, supercomputing facilities, and the Human Genome Project are some examples of this type of researcher innovation. Part of the reason that non-profit researchers collaborate on large-scale projects is that the rewards they get from research are reputational, intellectual, and social. Though they seek competitive advantage, theirs is not a strictly competitive game; each benefits when the whole field advances.¹³⁶ General-purpose research tools can increase the intrinsic benefits of research for all.

To summarize, non-profit researcher innovators are competitive user innovators who receive especially significant first mover advantages from developing research tools and methods. Moreover, they generally receive substantial intrinsic benefits from tool invention and use in addition to the benefits they receive from being “first.” The possibility of recouping their inventive investments by selling or licensing their research tool inventions plays a minor role, if any, in motivating their efforts to invent research tools. They are close to ideal user innovators, for whom patenting contributes little to the incentive to invent.

135. See Table 2; see also DEMOCRATIZING INNOVATION, *supra* note 9, at 70–71; Riggs & von Hippel, *supra* note 8, at 465.

136. See Strandburg, *supra* note 30, at 105–06.

2. Incentives to Disseminate Research Tools

Non-profit researchers may not go out and market their research tool inventions themselves, even if they patent them. Nonetheless, the factors that make dissemination of user innovations likely apply generally to research tools, as long as they are disclosed. The potential users of new research tools and methods are researchers themselves, who have the expertise and familiarity with the literature in their fields necessary to find and to employ research tools developed by others. To the extent that use of a particular research tool requires “know-how” not imparted by publication, the social structure of scientific research facilitates dissemination through collaboration and movement of research personnel (particularly graduate students and postdoctoral researchers) between non-profit laboratories, and between the non-profit sector and industrial laboratories.¹³⁷ Further, researcher innovators can benefit from widespread dissemination of their research tools and methods through attribution and collaboration, which will often motivate them to assist other researchers in adopting them.

In many cases, a market for a commercial version of a research tool invented by a researcher innovator will eventually develop. When this happens, there will often be no substantial barriers to dissemination by a commercial tool supplier. Like other user innovations, research tools and methods are developed sufficiently to be useful. That is not to say that there is never any inventive distance between the researcher’s laboratory and the supplier’s catalog—what satisfies a graduate student rushing to complete a thesis project may not be ready for commercial sale. Nonetheless, there is likely to be far less technical distance between laboratory and catalog for research tools than for other types of university inventions, which will often be “embryonic” research results. Research tool suppliers have substantial expertise and familiarity with research tools developed in the laboratories of non-profit researchers (who are their customers, after all). If

137. Cf. John P. Walsh et al., *Links and Impacts: The Influence of Public Research on Industrial R&D*, 48 MGMT. SCI. 1, 14–18 (2002) (describing study indicating that publication, conferences, hiring of graduates, and consulting are generally more important paths of knowledge flow from non-profit researchers to industry than patenting and licensing).

necessary, they may hire university faculty as consultants and university graduates as employees as a means to transfer “know-how.” There is little need for technology transfer outside of the scientific community in the research tool context. The upshot of these considerations is that, just as for user innovations in general, in most cases it is unlikely that a commercial tool manufacturer will have to make more substantial investments in commercializing a research tool than are generally required to commercialize any unpatented product.¹³⁸

Because research tools and methods are user innovations, the concerns that generally motivate university patenting and technology transfer efforts lose force.¹³⁹ University patenting is based on a fear that without a concerted effort to interest commercial firms in university inventions (and some incentives in the form of patent exclusivity), the inventions of non-profit researchers will simply languish and not be exploited to their full, socially beneficial, potential. Patenting of university inventions is justified by the argument that university inventions are “embryonic” and that large investments are needed to develop them into commercially marketable products.¹⁴⁰ There may also be a gap between the skills and knowledge base of university researchers and the absorptive capacity of commercial firms that might seek to adopt university inventions and bring them to market.¹⁴¹ University inventions need patent exclusivity, the argument goes, to

138. Cf. Pulsinelli, *supra* note 19, at 449–50.

139. See MOWERY ET AL., *supra* note 15, at 91; Kieff, *supra* note 49, at 746; Charles R. McManis & Sucheol Noh, *The Impact of the Bayh-Dole Act on Genetic Research and Development: Evaluating the Arguments and Empirical Evidence to Date*, 2–3 (Aug. 13, 2006) (Working Paper), available at <http://www.law.berkeley.edu/institutes/bclt/ipsc/papers2/mcmanis.doc>.

140. See, e.g., David C. Mowery, *The Bayh-Dole Act and High-Technology Entrepreneurship in U.S.*

Universities: Chicken, Egg, or Something Else?, in ADVANCES IN THE STUDY OF ENTREPRENEURSHIP, INNOVATION, AND ECONOMIC GROWTH 39, 61 (Gary D. Libecap ed., 2005).

141. See Wesley M. Cohen & Daniel A. Levinthal, *Absorptive Capacity: A New Perspective on Learning and Innovation*, 35 ADMIN. SCI. Q. 128 (1990); see also Thomas Hellmann, *The Role of Patents for Bridging the Science to Market Gap* (Nat'l Bureau of Econ. Research, Working Paper No. 11460, 2005), available at <http://www.nber.org/papers/w11460> (arguing that the primary role of patents in university technology transfer is to reduce search costs).

entice commercial firms to make the investments needed to seek out and commercialize them.¹⁴²

Whatever one thinks of these arguments generally,¹⁴³ the need for such special efforts to disseminate (beyond disclosing) researcher inventions must surely be at a low ebb where research tool inventions are concerned. For these reasons, while non-profit researchers may or may not promote the commercial dissemination of their research tools directly, it is likely that dissemination of research tool inventions will occur rather easily and naturally once a researcher discloses a tool. Patenting should play a minor role in disseminating research tool inventions made by non-profit researchers, just as it does for other user innovations.

3. Incentives to Disclose Research Tool Inventions

Because research tools can be used in a researcher's own laboratory, one might expect them to function as "non-self-disclosing-in-use"—and thus potentially be kept secret—even if they would be self-disclosing if marketed. Non-profit researchers compete with one another for reputational benefits and for research funding, so their interest in advancing their own research agendas might motivate them to keep their research tools secret.

There are nonetheless several reasons to expect that most research tools invented by non-profit researchers will be

142. See MOWERY ET AL., *supra* note 15, at 90; Kieff, *supra* note 49, at 746; McManis & Noh, *supra* note 139, at 2–3.

143. See Strandburg, *supra* note 16, at 114. While university research results may often be "embryonic" and need substantial investments to turn them into marketable products, improvement patents are designed for precisely this type of situation, in which improvements on prior advances are themselves significant innovations. Substantial investments in the development of "embryonic" inventions will likely result in patentable improvements. Additionally, some of the most lucrative university patents are licensed non-exclusively, which may be applauded for providing widespread access to the technology, but seems to belie the suggestion that exclusivity is needed to attract commercial interest. While technology transfer raises important issues about bridging academic and commercial systems of knowledge creation and exploitation, it is not clear that patents are always the optimal way to solve them. See Jones & Strandburg, *supra* note 87 (discussing the role that should be played by university technology transfer) (on file with author); see also Jerry G. Thursby & Marie C. Thursby, *Who is Selling the Ivory Tower? Sources of Growth in University Licensing*, 48 MGMT. SCI. 90 (2002) (noting the importance of inventor involvement in successful university-based startup firms).

disclosed within a relatively short time after invention. First, the potential for research tools to be non-self-disclosing-in-use is less than one might expect. Non-profit researchers receive their primary rewards for inventing research tools through publishing the results of the research. While these scientists may be able to delay publicizing their tool inventions long enough to obtain an initial set of research results, they will eventually have to reveal what they have done in order to back up their scientific publications or to apply for future research funding. Moreover, graduate students come and go, needing to publish, give presentations, and write detailed doctoral theses, and taking with them their knowledge of research methodology (of which they are often joint inventors). Scientific norms and competition between universities preclude saddling graduate students with the type of "non-compete" agreements common in industry. Finally, the likelihood of independent invention of a particular tool by a competitor limits the potential returns to secrecy.

While the potential for secrecy is thus limited for non-profit researchers, they are particularly able to benefit from freely revealing their research tool inventions. Publication of a new research method ensures that the authors of the publication receive credit for developing the new technique. They may gain opportunities for collaboration through their expertise in a new and useful research method. Exchange of information about research tools and methods is part of the social currency within the research community; membership in this community is important to reaching the intellectual, reputational, and social goals of most researchers. Finally, after a new tool is used for the first breakthrough research and when tinkering with the tool begins to provide diminishing returns, non-profit researcher innovators may seek to outsource tool development to a tool manufacturer in order to obtain a standardized tool and save researcher time. These factors conspire to make it highly unlikely that a non-profit researcher would keep a research tool secret for more than a couple of years (and probably significantly less time than that) even if patents were not available. Research tools and methods are effectively self-disclosing-in-use in the non-profit research context.

4. Potential Impact of a Research Use Exemption on Non-Profit Researcher Innovators

We can now summarize the likely impact of a research use exemption on the invention, disclosure, and dissemination of research tools by non-profit researcher innovators. Given their strong non-patent-based incentives to invent research tools for their own use, researcher inventors will generally be ideal user innovators who receive sufficient intrinsic benefits from inventing research tools to motivate them to invent them. Even though they might prefer patent exclusivity for competitive reasons, they are unlikely in most cases to be deterred from inventing research tools by a research use exemption permitting other researchers to use their patented tools. Not only will they retain substantial first mover advantages in the face of such an exemption, but the use of their research tool inventions by others can itself provide significant reputational benefits and opportunities for desirable collaboration and interaction. A research use exemption promotes dissemination to lead users who will have the capability to adopt new research tools and methods once they learn about them. A research use exemption also leaves intact the right to exclusive sales, preserving, to the extent necessary, financial incentives to license patented research tool inventions to commercial firms so that they can develop marketable standardized versions of the tools and sell them to other researchers.

A research tool use exemption is also unlikely to lead many non-profit researcher innovators to delay disclosure for very long by adopting trade secrecy in lieu of patenting. Research tools invented by non-profit researchers are effectively self-disclosing-in-use, given the open nature of university laboratories and the coming and going of graduate students and postdoctoral researchers. Indeed, there is some evidence in the university context that patenting delays disclosure rather than inducing it, due to time spent bringing the invention to a "patentable" stage and putting together the application.¹⁴⁴ Even though most applications are published

144. See Margo A. Bagley, *Academic Discourse and Proprietary Rights: Putting Patents in Their Proper Place*, 47 B.C. L. REV. 217, 246 (2006); David Blumenthal et al., *Withholding Research Results in Academic Life Science: Evidence from a National Survey of Faculty*, 277 J. AM. MED. ASS'N 1224 (1997); Jeremy M.

after eighteen months, the combination of the eighteen-month period of secrecy at the patent office with the one-year grace period before a patent application must be filed can result in a two-and-a-half year delay in disclosure when an invention is patented.¹⁴⁵ Especially in light of turnover of graduate and post-doctoral personnel and the need to justify grant renewal, a non-profit researcher is unlikely to maintain “trade secrecy” for that long.

Overall, then, a research use exemption is unlikely substantially to reduce the invention, disclosure, or dissemination of research tools and methods by non-profit researchers. This is consonant with the general unimportance of patent protection for incentivizing invention, disclosure, or dissemination of self-disclosing-in-use user innovations. At the margin, of course, the availability of patent protection against use by competing researchers might result in some additional research tool invention by non-profit researchers, either because of expected royalty income from licensing the patented tool to other researchers or because patenting extends the competitive research advantage afforded by the tool. On balance, though, potential restrictions on dissemination and delays of disclosure seem likely to outweigh the marginal increase in invention. Non-profit researcher innovators, unlike seller innovators, are also consumers of research tools. Where there is no research exemption, the restricted availability of others’ research tool inventions offsets benefits researcher innovators might obtain by enforcing their patents against other researchers’ use of their patented inventions. Research tool innovations can thus be subject to an “arms race” problem in which inventors obtain patents for their “trading” value.¹⁴⁶ This “trading” has significant transaction costs; free revealing seems likely to be a better strategy for the group as long as there is a way to deter defectors. A restriction on patent enforcement may be helpful to prevent defecting from a

Grushcow, *Measuring Secrecy: A Cost of the Patent System Revealed*, 33 J. LEGAL STUD. 59 (2004).

145. See 35 U.S.C. § 102(b) (2000) (one year “grace period” during which inventions may be used or sold publicly before filing a patent application); *id.* § 122(b) (publication of many applications eighteen months after filing).

146. See Mark A. Lemley, *Intellectual Property Rights and Standard-Setting Organizations*, 90 CAL. L. REV. 1889, 1949 (2002).

"research tool commons."¹⁴⁷ Finally, when researcher innovators develop research tool inventions that require substantial investment in standardization, safety improvements, and so forth before they can be put to their best use, the research use exemption does not preclude licensing those tools exclusively to commercial tool suppliers for development and sale to researchers.

B. The Incentives of Commercial Researcher Innovators

1. Incentives to Invent Research Tools

Like non-profit researcher innovators, commercial researchers are primarily rewarded based on the results of their research, which, in their case, are presumably new or improved products for the commercial market. Developing new research tools and methods is often part and parcel of producing those results. The potential winner-take-all advantages resulting from the leg up in the research race provided by either first mover advantages, trade secrecy, or patent exclusivity may be particularly significant for commercial researcher innovators, who may intend to patent their research *results* to significant commercial gain. For example, being first to develop a particular research method might allow a pharmaceutical company to be first to invent (and patent) a lucrative drug. The benefits of exclusive use of a research tool are likely to be a particularly important component of commercial researcher innovators' incentives to invent research tools. Moreover, while some commercial researchers publish their research in scientific journals and are motivated in part by the same non-pecuniary rewards as non-profit researchers, many are unable to benefit significantly from, for example, the reputational rewards associated with widespread adoption of their inventions. For this reason, commercial researchers are more likely than non-profit researchers to need patent or trade secret exclusivity to give them sufficient incentive to invent a research tool.

The lessened importance of non-pecuniary rewards for commercial researchers also suggests that they would be less

147. For a more detailed discussion of the evidence for and theory of a research tool commons, see Strandburg, *supra* note 51.

likely than non-profit researchers to pool their resources to create general-purpose tools, since collaborative tool development presumably reduces or destroys the potential for exclusive use of a tool. Nonetheless, there is mounting recognition of the importance of collaborative efforts in the commercial sector.¹⁴⁸ Such efforts are worthwhile from the perspective of those involved if they benefit members of the collaboration more than the expected benefit of competition in a particular instance. This may be the case if a particular innovation is important for responding to competition from outside the industry, or if collaboration is necessary to muster the necessary pecuniary resources or resources of talent or expertise. Where solving a particular problem requires a variety of skills, collaboration may be more effective than either hiring appropriate personnel or acquiring necessary expertise.¹⁴⁹ Standards-setting bodies, groups like the SNP Consortium, and industry participation in open source software projects provide examples of commercial participation in collaborative efforts.¹⁵⁰

148. See, e.g., Robert P. Merges, *A Transactional View of Property Rights*, 20 BERKELEY TECH. L.J. 1477 (2005); John Dubiansky, *The Role of Patents in Fostering Open Innovation* (Berkeley Electronic Press, Working Paper No. 1156, 2006), available at <http://law.bepress.com/expresso/eps/1156>; Henkel, *supra* note 26, at 1–2. There are, of course, antitrust issues and other concerns about anti-competitive behavior that can arise when firms collaborate. Indeed, such concerns have been prominent when firms try to deal with potential patent thickets through patent pools. See Richard J. Gilbert, *Antitrust for Patent Pools: A Century of Policy Evolution*, 2004 STAN. TECH. L. REV. 3 (2004), available at http://stlr.stanford.edu/STLR/Articles/04_STLR_3. Nonetheless, the law permits cooperative ventures in many circumstances. Since the development of common tools for research enhances competition in performing the research, whereas patenting gives exclusive control over a research stream to a single firm, such collaborative efforts do not appear to raise red flags related to competitiveness concerns.

149. See R. H. Coase, *The Nature of the Firm*, 4 ECONOMICA 386 (1937); Dan L. Burk & Brett H. McDonnell, *The Goldilocks Hypothesis: Balancing Intellectual Property Rights at the Boundary of the Firm* (University of Minnesota Law School, Legal Studies Research Paper Series, Research Paper No. 06-11, 2006), available at <http://ssrn.com/abstract=890944>.

150. The SNP Consortium Ltd. is composed of the following corporations: Wellcome Trust, Amersham Biosciences, AstraZeneca PLC, Aventis, Bayer AG, Bristol-Meyers Squibb Company, F. Hoffmann-LaRoche, GlaxoSmithKline, IBM, Motorola, Novartis, Pfizer Inc., and Searle. For studies of open source participation by commercial firms, see P. G. Capek et al., *A History of IBM's Open-Source Involvement and Strategy*, 44 IBM SYSTEMS J. 249 (2005); Joachim Henkel, *Champions of Revealing—The Role of Open Source Developers in Commercial Firms*, 1 (Munich Univ. for Tech., Working Paper 2008), available at http://opensource.mit.edu/papers/Henkel_Champions_of_revealing_2008-01.pdf;

In sum, while commercial researchers will sometimes be ideal user innovators, their limited ability to accrue non-pecuniary benefits when others use their research tools means that they are more likely than non-profit researchers to require the increased period of exclusive use stemming from patenting or trade secrecy to give them incentives to invent research tools.

2. Incentives to Disseminate Research Tools

As discussed in the next sub-section, commercial researcher innovators are far more likely than non-profit researchers to be able to keep their research tool inventions secret, though they may sometimes opt for free revealing. But once a research tool invention is disclosed, its dissemination to other researchers is likely if it is not patented, for many of the same reasons discussed in the context of non-profit researcher innovators. Indeed, patenting is even more likely to restrict dissemination of research tools invented by commercial researchers because they are far less likely than non-profit researchers to be subject to social norms encouraging sharing or to be able to benefit from disseminating their tools through collaboration. Just as non-profit researchers might license their tool inventions to a commercial company to supply the market for tools, the company for which a commercial researcher innovator works could choose to offer the tool for sale on the commercial market (or license another company to do so). If the tool is patented or can be kept secret, however, the employer of the commercial researcher innovator is more likely to choose to keep the tool exclusively for in-house research.

3. Incentives to Disclose Research Tool Inventions

In contrast to tools invented by non-profit researchers, which tend to be effectively self-disclosing because of the milieu in which they are used, tools invented by commercial researchers are likely to be “non-self-disclosing-in-use.” Trade secrecy is often a viable option for commercial researcher

innovators. Their laboratories are generally not open to the public, commercial corporations fund them, and grant proposals are usually not involved. Their rewards for successful research come primarily in the form of salary and other benefits awarded from within the firm. Of course, the efficacy of trade secrecy is limited even in the commercial context. Other researchers may independently invent the same or substitutable research tools. Importantly, non-profit researchers who invent similar tools are likely to reveal them freely within a short period after invention for all the reasons already discussed. There is also the danger of industrial espionage or theft of trade secrets by present or former employees. But overall, commercial researchers are much more likely than non-profit researchers to be able to keep their tool inventions secret.

Not only is trade secrecy more feasible for these researchers, but their ability to benefit from free revealing is less than that of their non-profit counterparts. They need not reveal their tools in order to facilitate peer review to obtain research funding and often do not aspire to publish their research results. They are also less able to benefit from a reputational boost from inventing a valuable research tool, since they rely less on peer review and collaboration to recoup rewards for their efforts and are less likely to reveal their tool inventions in the course of collaborations.

Of course, free revealing may still occur. Commercial researchers, like non-profit researchers, may sometimes participate in an informal exchange process among competitors in which they exchange information about some research tools and methods while seeking competitive advantage elsewhere.¹⁵¹ Nonetheless, research tool inventions will tend to be non-self-disclosing-in-use in the commercial context. Patenting might thus incentivize earlier disclosure of commercial researcher innovators' tool inventions. As is generally the case for such non-self-disclosing-in-use user innovations, however, patent disclosure will usually be accompanied by a longer period of exclusive use than would have been available through trade secrecy, and patenting may

151. See DEMOCRATIZING INNOVATION, *supra* note 9, at 86–88; Shah, *supra* note 37, at 356–57; Shah *supra* note 43, at 40, *supra* note 57 and accompanying text.

sometimes pre-empt free revealing which might otherwise have occurred.

4. Potential Impact of a Research Use Exemption on Commercial Researcher Innovators

We may now summarize the likely incentive effects of a research use exemption for invention by commercial researcher innovators. A research use exemption would eliminate the ability of commercial researcher innovators to use patenting directly as a means to control research using the patented tool or method.¹⁵² At the margin, there are three possible ways this lesser control might affect commercial researchers' invention, disclosure, and dissemination of research tools and methods: 1) a commercial researcher innovator might decide to pursue trade secrecy rather than patenting to maintain exclusive research use of the invention as long as possible; 2) a commercial researcher innovator might decide to patent the invention and sell a commercial version on the market or even to reveal it in an informal exchange rather than keeping the invention for exclusive in-house research using trade secrecy; or 3) in some marginal cases the inability to maintain exclusive control over the research stream beyond the trade secrecy period might lead the researcher to forego developing a particular tool invention. This last option is relatively unlikely, however. Trade secrecy will usually provide a sufficient incentive to invent a research tool for commercial researcher innovators. Only in those marginal cases in which patent exclusivity (in tandem with intrinsic benefits) provides sufficient incentive to invent, while trade secrecy does not, would a research exemption lead to a failure to invent.

The net social impact of a research use exemption is thus ambiguous as to commercial researcher innovators. If the researcher innovator chooses, in light of the exemption, either to patent and sell the tool invention or to freely reveal it, there is unambiguous social benefit because the result is a tool invention that is invented, disclosed, and disseminated more widely than it would otherwise have been. If, as is probable in the majority of cases, the researcher innovator responds by

152. Patenting would still make research more expensive if it restricted the availability of commercial versions of a research tool.

pursuing trade secrecy rather than patenting, the social balance is less clear: there will be some delay in disclosing the invention, but the invention will become available to other researchers at an earlier date under trade secrecy than it would under a full exclusive patent term. Finally, if, at the margin, the loss of exclusive control over use in research deters commercial researcher innovators from making some inventions, the net social cost depends on whether and when the tool is invented by some other researcher for whom the benefits of invention outweigh the costs even in light of the exemption. In some research areas, there is significant participation by non-profit researchers who will not be deterred by a research use exemption from inventing important tools. While there will be a delay if the commercial researcher would have "gotten there first," the delay may be minor compared to the social loss due to exclusive use of the invention in research for the entire twenty-year patent term.

The societal impact of a research use exemption is thus ambiguous in the commercial researcher innovator case; it depends on the tradeoff between the social benefits of earlier and wider spread research use of inventions that are patented or freely revealed and the social cost of increased trade secrecy and some decreased invention at the margins. This tradeoff may depend on whether non-profit researchers are active in a particular area of research, because the presence of non-profit researchers limits the effectiveness of trade secrecy, encourages free revealing, and provides a parallel source of inventive activity.

C. The Incentives of Commercial Research Tool Suppliers

1. Incentives to Invent Research Tools

Commercial research tool suppliers are paradigmatic seller innovators. They have incentives to invent new tools or improve existing tools if they can recoup their investments through commercial sales. Their incentives to invent are affected by how expensive it is to develop a particular tool, whether or not the tool is self-disclosing to competitors, what kind of market lead time they get by introducing a new or improved tool, and so forth. The inventive choices of research tool suppliers will also be affected by the fact that researchers

often invent certain types of tools themselves and may make "home-made" versions of some tools invented by tool suppliers if it is relatively easy and cheap to do so. Beyond questions of cost, researchers may reap other benefits from making a tool in the lab: making the tool might be educational for graduate students, for example, or "tweaking" a home-made tool might make it more suitable for a particular experimental use. Researcher propensity to make rather than buy a tool is a direct outcome of the balance between the financial cost of a commercial tool, any perceived advantages of making a tool in-house, and the expenditure of time, effort, and money required to make the tool in-house.

The commercial supplier's competitive advantage thus lies in the types of research tool inventions that are less likely to be invented and made in-house by researchers—inventions relating to standardizing tools for more general application, making them more convenient, safer to use, cheaper, easier to manufacture, and so forth.¹⁵³ Tool suppliers also have incentives to invent general-purpose research tools that require investments that are too large (relative to the benefits of the tool to an individual researcher) to be worthwhile for individual researcher innovators to invent. A common path of research tool development (probably the most common path, though empirical studies are limited) is for tools with new functionality to emerge from researcher innovators' laboratories, be gradually adopted and improved by researchers, and then be picked up by commercial manufacturers who standardize them and make the types of improvements in convenience, reliability, accuracy, safety, and manufacturing techniques that are relevant to a wide range of researchers.¹⁵⁴ Like other seller innovators, tool suppliers may well need patent protection to give them incentives to invent self-disclosing research tools.

2. Incentives to Disseminate Research Tools

Research tool suppliers have every incentive, of course, to disseminate their own tool inventions via commercial sales. But it is worth reiterating that research tool suppliers can also

153. See DEMOCRATIZING INNOVATION, *supra* note 9, at 70–72; Riggs & von Hippel, *supra* note 8, at 465; see also Table 2, *infra*.

154. See DEMOCRATIZING INNOVATION, *supra* note 9, at 19–31.

play a role in disseminating tools invented by researcher innovators. Even when they could make research tools in-house, researchers often prefer to purchase them for the same reasons that consumers purchase commercial versions of anything they could make themselves. Commercial suppliers develop supply chains, expertise in tool manufacture, economies of scale, and so forth which can make it more efficient and cost-effective for researchers to purchase commercial versions of tools than to make tools themselves.¹⁵⁵ This is the case for many pieces of relatively simple equipment (standard chemicals and so forth), but also for more complex and specialized equipment (such as scanning tunneling microscopes, SQUID magnetometers, and genetically engineered mice).¹⁵⁶ Regardless of whether a tool is patented, researchers are likely to “make” tools in their own laboratories only when there is an advantage to doing so—when commercially available tools are too expensive (a problem often mitigated by substantial non-profit discounts), when the amount of customization required makes it easier or necessary to do so, when making a tool is part of an educational process for graduate students, or when making the tool provides insights into the research itself. Tool suppliers can thus profitably disseminate both their own tool inventions and standardized versions of researcher inventions. Since they do not bear the costs of inventing researcher inventions, they often will not need patents to motivate them to disseminate researcher-invented tools. If significant investment in commercialization is necessary, however, an exclusive patent license may motivate them to disseminate a commercial version of a user-invented tool.

3. Incentives to Disclose Research Tool Inventions

Research tool suppliers may find it particularly difficult to maintain trade secrecy with respect to their inventions because, even if a technology is not inherently self-disclosing, a

155. See *id.* at 9, 51.

156. See *id.* at 51–52. See also Murray, *supra* note 15 (discussing history of patenting and supply of oncomouse); Quantum Design, <http://www.qdusa.com/products/index.html> (last visited Nov. 10, 2006) (commercial seller of SQUID magnetometers); Veecom, <http://www.veecom.com.cn/> (last visited Nov. 20, 2007) (commercial seller of scanning tunneling microscopes).

research tool supplier may have to disclose its inner workings in the course of marketing it. Research tool consumers are far more likely than ordinary consumers of products like television sets to demand a detailed understanding of the tool and how it works prior to purchase and to be able to reverse engineer it once it is in hand. Such knowledge may be crucial to the design and interpretation of experiments using the tool. Because research tool inventions are more likely than other products to be effectively self-disclosing when marketed, patents play a relatively lesser role in promoting research tool disclosure (and a correspondingly greater role in motivating research tool invention).

4. The Effects of a Research Use Exemption on Commercial Research Tool Suppliers

For research tool suppliers, patenting plays its canonical role of stemming free riding by market competitors and thus providing incentives to invent and sell new tools or tool improvements. A research use exemption preserves the important role of patents in protecting tool suppliers from free riding competing sales. In principle, a research use exemption invites "user appropriation" of suppliers' tool inventions. In practice, because researchers are often unaware of, or essentially indifferent to, patents,¹⁵⁷ because monitoring laboratory infringement is difficult, and because enforcing patents against researchers would involve suing the tool suppliers' customers, patenting is of limited efficacy in deterring "lab-made" versions of patented tools. For this reason, we can expect suppliers to tend to specialize in inventing the types of improvements in convenience, standardization, and so forth that researchers are less likely to make in-house. Moreover, patents may often be relatively unimportant in the "make or buy" decision. Researchers will buy many tools from suppliers whether or not the tools are patented, simply as a matter of efficiently allocating limited researcher time and resources. Because tool suppliers will already rationally focus on developing research tools and tool improvements that researchers will buy rather than make, a

157. See Walsh et al., *supra* note 114, at 334–35; JOHN P. WALSH ET AL., PATENTS, MATERIAL TRANSFERS AND ACCESS TO RESEARCH INPUTS IN BIOMEDICAL RESEARCH 15 (2005).

research use exemption may have little impact, simply bolstering that preference.

D. The Incentives of Tool Patent Licensing Firms

Just as there are two main types of researcher innovators, there are two types of seller innovators in the research tool arena. Besides tool suppliers, whose business model is to manufacture and supply research tools to researchers, there are firms whose revenues come primarily from licensing technology either to researchers themselves or to tool suppliers to manufacture tools with that technology. These firms develop research technology and either do not have the in-house capability to manufacture, market, and distribute research tools themselves or have developed research methods or techniques that are not amenable to a "tool supplier" commercial model because they may be used directly by researchers once they learn of them.¹⁵⁸

1. Incentives to Invent Research Tools

Tool patent licensing firms invent research tools in order to license their inventions either to manufacturers or directly to users. To have incentives for invention they must be able to recoup their research and development expenses and avoid free rider copying of their inventions by either manufacturers or users. Because these firms must disclose their proprietary research tools and methods in order to license them, trade secrecy is of limited value even if a tool is non-self-disclosing when used or sold. Though trade secret licensing is possible through confidentiality agreements, it is difficult to enforce, which often makes patents a better option for protecting against free riding and preserving incentives to invent for tool patent licensing firms. Patents thus provide an important incentive to invent for these firms, and probably a critical

158. I do not mean to include in this category tool licensing "spin-offs," such as many university "start-ups," that are spawned only after a researcher innovator has invented a tool. While patenting increases the potential for pecuniary benefits from research tool invention for those researcher innovators, the incentive to invent that patenting provides remains rather minimal in comparison with the direct benefits of using the tools in research. The tool licensing firms I discuss here are firms which invent tools "in house."

incentive for inventing methods to be licensed directly to researcher innovators.

2. Incentives to Disseminate Research Tools

Research tool licensing firms may or may not have incentives to disseminate tool technology widely. If they license their proprietary technology to manufacturers or non-exclusively to users, they have incentives to maximize their royalty revenues by encouraging widespread use. If, on the other hand, they believe that exclusive licensing to researchers maximizes their private benefit, they may, like some commercial researcher innovators, fail to license socially useful research in favor of private rent-seeking through control of the research stream.

3. Incentives to Disclose Research Tool Inventions

The incentive to disclose for these companies stems from the tool licensing business model. Technology licensing cannot occur without disclosing the technology to potential licensees. In some respects, these firms' technologies are always self-disclosing. While confidentiality agreements are a means of limiting disclosure, patents lower the transaction costs of technology licensing in comparison to trade secrecy and promote disclosure of the inventive idea to the public at large rather than only to licensees.

4. Effects of a Research Use Exemption on Patent Licensing Firms

Patents are the lifeblood of the research tool licensing business model. Since these firms are neither users nor manufacturers of research tools, they must license their technology either as trade secrets or through patents in order to obtain any revenue. They also use patents to signal their technical competence to potential investors.¹⁵⁹ The effects of a

159. See Heald, *supra* note 49, at 503–04; Long, *supra* note 49, at 637. But see JAMES BESSEN & MICHAEL MEURER, DO PATENTS WORK? THE EMPIRICAL EVIDENCE THAT TODAY'S PATENTS FAIL AS PROPERTY AND DISCOURAGE INNOVATION, AND HOW THEY MIGHT BE FIXED (forthcoming 2008) (discussing empirical evidence regarding the limited role that patents play for start-up firms).

research use exemption on such firms would vary drastically depending on the type of invention. If the invention is one that a researcher would choose to make in the lab or if it is a research method, a research use exemption would depress incentives to invent because users could easily free ride off the inventive efforts of the firm in such cases. Unless the company develops a business model based on providing services or materials ancillary to the invention, it would have no way to recoup its investments. Such business models have been successful with open source software, for instance. Nonetheless, a research use exemption would depress incentives for these firms to invent "user appropriable" research tools and methods, while preserving incentives to invent research tools to be licensed to commercial manufacturers. Hence, the net effect of such an exemption would be to channel the inventive efforts of tool licensing firms away from the types of inventions researchers will make or employ directly in their laboratories. As a social matter, this is not necessarily a bad result because those inventions are precisely the ones most likely to be invented by researchers themselves.

E. The Case of Dual-Purpose Inventions

While many research tools and methods are solely or primarily of use in doing research, some also have other commercial applications. Diagnostic tests are examples of this type of invention, as are many microscopes, lasers, common laboratory chemicals, and many other general-purpose scientific instruments and materials. Because the value of such inventions apart from their use in research is significant, user innovator incentives may not be critical to their development. For this type of dual-purpose invention, it may be particularly important to preserve incentives to serve the non-research commercial market. Importantly, a research use exemption would not affect those incentives.

If, on the other hand, a dual-purpose tool is invented by a researcher rather than a tool supplier, it may or may not be in the researcher's private interest to market the invention for its alternative use. In the absence of a research use exemption, a researcher innovator might choose to maintain exclusive use of the tool through patenting even though the socially optimal

course might be to market it for both consumer and researcher use. A research use exemption would preserve a researcher inventor's ability and motivation to license the invention for commercial sale, while limiting her ability to control tool-based research. Thus, a research use exemption would facilitate the availability of dual-purpose inventions for both types of uses.

F. Summary of Likely Effects of a Research Use Exemption

The likely effects of a research use exemption on the incentives of the four main types of research tool inventors are summarized in Table 4. For the most part, the effects are socially beneficial or minimal. Overall, effects on incentives to invent research tools and methods would be expected to be minimal, though the exemption would further differentiate the types of tools likely to be invented by researchers as opposed to tool suppliers and licensing firms. Effects on dissemination of research tools for use by other researchers would be unambiguously positive as a result either of the exemption itself or of a switch from patenting for exclusive use by researcher innovators to free revealing, commercialization of the tool, or even trade secrecy. It is worth reiterating that a switch from patenting to trade secrecy on the part of a researcher innovator will result in *earlier* availability of the invention for use by other researchers. A competitive researcher innovator would choose patent protection only if it afforded a *longer* period of exclusive use of the invention in research than trade secrecy. If a research use exemption drives such an inventor to choose trade secrecy, the period of exclusive use will be shorter than it would otherwise have been and the tool will be available for others' use at a correspondingly earlier date.

The likely net effect of a research use exemption on disclosure of research tool inventions is ambiguous. While tool supplier and licensing firms would continue to disclose their inventions through patenting and non-profit researcher innovators would continue to disclose their inventions regardless of patenting, commercial researcher innovators would sometimes delay disclosure of their tool inventions by opting for trade secrecy. The extent of this delay will vary. In many active research areas, and especially where non-profit researchers are involved, the time between invention and

publication of a patent application or issued patent is comparable to (or even longer than) the time during which trade secrecy is effectively available. On balance, it seems probable that the benefits of earlier availability of many inventions to researchers will outweigh the social costs of somewhat later disclosure of some research tools.

G. Proposals for a Research Use Exemption in Light of Researcher Innovation

1. A Blanket Exemption for Research Use of a Patented Invention

Previous proposals for “research tool use” exemptions have been concerned with preserving commercial returns on research tool inventions to provide sales-based incentives to invent.¹⁶⁰ The above analysis suggests that a research use exemption can enhance the availability of inventions for research use while preserving sales-based patent incentives for tool suppliers and licensing firms and having relatively minimal impact on the incentives of researcher innovators. Such a blanket research use exemption would remove transactional barriers to research due to private rent-seeking, mitigate a potential “arms race” in patenting research tools, and facilitate the cooperative development and selection of standardized research tools and methods. Because researchers both invent and use research tools and methods, they would reap benefits from the exemption even as they give up some control over their own inventions. A research use exemption also preserves sales-based incentives to invent dual-purpose inventions and has the side effect of a socially beneficial price discrimination: researchers who do not have the financial resources to purchase research tools can make “home-made” versions in the lab, while those with more resources will frequently choose to purchase convenient, standardized versions on the commercial market.

A research use exemption would also alleviate some concerns about the possibly distorting effects of patenting on university research. While some studies have suggested that the impact of research tool patenting on the direction of

160. See Strandburg, *supra* note 16, at 144–46; sources cited *supra* note 16.

research has been limited, the limited effects seem to have been due in large part to the fact that many researchers simply ignore patents and infringe them willy-nilly. We may not want to endorse such a scofflaw exemption and, perhaps more importantly, it is unclear whether this cavalier attitude toward patents can persist. The history of university attitudes toward copyright is certainly a cautionary tale. Moreover, recent studies raise red flags. One study suggests that a significant number of researchers have difficulty obtaining materials from other researchers.¹⁶¹ The motivations to maintain control of research that underlie these difficulties would also motivate refusals to license patented inventions for use in research if patent enforcement against researchers were to become more common. Another very recent survey by the AAAS of its members revealed that a substantial fraction of those who acquired patent rights experienced significant difficulties in doing so.¹⁶² A broad exemption for research use of patented inventions would help to align the law with present practice in the non-profit sector and preserve the current availability of research tools to non-profit researchers.

A research use exemption could lessen the incentives of commercial tool manufacturers to invest in developing general-purpose research tools that are expensive to invent but easy to make in the lab. To the extent that this subset of research tools is significant, collaborative efforts among researchers themselves might mitigate the reduced incentives for commercial tool suppliers. While such collaborations are susceptible to free rider problems, since by hypothesis all researchers would be able to use the collectively developed tool whether or not they contributed to developing it, social norms within research communities may demand contribution. In addition, as has been recognized in other areas of collective user innovation such as open source software, contributors may receive greater benefits than free riders. Such benefits include reputational advantages and the ability to tailor the tool for their particular research.¹⁶³ In the non-profit sector especially, large collaborative grants are a means of facilitating the

161. See Walsh et al., *supra* note 137, at 19–21.

162. See STEPHEN HANSEN ET AL., *THE EFFECTS OF PATENTING IN THE AAAS SCIENTIFIC COMMUNITY* 21 (2d ed. 2006).

163. See DEMOCRATIZING INNOVATION, *supra* note 9, at 86–87, 91; Lakhani & Wolf, *supra* note 26, at 14; Lerner & Tirole, *supra* note 26, at 213–15.

development of expensive general-purpose research tools, with research funding being one of the benefits of participation in the project (and reputational penalties controlling free riding).

I have argued elsewhere that “experimenting on” a patented invention for purposes of understanding, improving on, or designing around it should be exempt from infringement liability in order to effectuate the disclosure function of the patent system.¹⁶⁴ One criticism of that proposal, which is similar to the research exemptions available under the laws of many other countries, has been that it may be difficult to draw the line between “experimenting on” a patented invention and using that patented invention as a tool for researching some other topic.¹⁶⁵ The user innovation analysis suggests that it may not be necessary to draw that line. Incentives to invent, disclose, and disseminate research tool inventions would persist in the face of a blanket exemption for *any* use of a patented invention in research.

A blanket exemption for research use of patented inventions would not remove all line-drawing problems, of course. It would still be necessary to distinguish between use and making by researchers and commercial manufacturing for sale. If the researcher makes a tool in his or her own laboratory, clearly a research tool use exemption would apply. Having the university or company machine shop make the tool also seems like an easy case for applying the exemption. But what if tool manufacture is contracted out to a tool-making company? If the company makes a particular tool for several researchers, at what point does it cross over into infringing sales? A workable line can be drawn at the researching entity's doors, but such a line is rather arbitrary and favors large research entities. Nonetheless, a bright line might be sufficient to accomplish the purpose of a research tool use exemption—precluding unnecessary and socially harmful control over a

164. See Strandburg, *supra* note 16, at 122; see also *Integra Life Sciences I, Ltd. v. Merck KGaA*, 331 F.3d 860, 872–78 (Fed. Cir. 2003).

165. See WALSH ET AL., *supra* note 157; Dreyfuss, *supra* note 19. While most countries with statutory research exemptions distinguish between “experimenting on” and research tool use, Belgium has recently adopted a broad research exemption similar to the blanket exemption proposed here. See Strandburg, *supra* note 16, at note 88 and accompanying text; see also Geertrui Van Overwalle & Esther van Zimmeren, *Reshaping Belgian Patent Law: The Revision of the Research Exemption and the Introduction of a Compulsory License for Public Health*, 64 IIP FORUM 42 (2006).

research stream by a single researcher inventor. Another option would be to make a case-by-case determination of whether a contractor is serving as an agent of a particular researcher to make a particular tool or acting as a tool supplier competing in a market for sales of the tool.

To apply this or any other research use exemption one must also distinguish research use from other uses. While there will be many clear cases, there will also be gray areas, particularly where "research" consists of collecting data about how a particular invention performs in practice. In the medical arena, for example, a diagnostic test or drug may be administered for clinical purposes, while data about the accuracy of the test or efficacy of the drug is simultaneously collected. A manufacturing process may be used to produce items for commercial sale simultaneously with the collection of data about system malfunctions, which may be used to improve the process. Answers to this question in close cases will probably have to be developed on a case-by-case basis, possibly based on a standard of whether the use is *primarily* for research. Situations where research is a "side effect" of a primary practical application do not implicate the core concerns underlying a research exemption proposal.

2. A "Double-Edged Sword" Proposal

A blanket research use exemption proposal will encounter opposition, as is evident from the extensive briefing on the subject of research tools provoked by the Supreme Court's consideration of the statutory exemption in *Merck v. Integra*.¹⁶⁶ If such a broad exemption is deemed too risky with respect to its potential effects on incentives or too unpalatable as a political matter, a re-designed research exemption focused on non-profit researchers may be considered as a fallback proposal. Such a proposal can also mitigate the primary potential cost of a blanket research use exemption—increased trade secrecy by commercial researcher innovators.

Infringement liability exemptions in *favor* of non-profit researcher infringers have been proposed in the past.¹⁶⁷ Three

166. 545 U.S. 193 (2005); briefs cited *supra* note 110.

167. See de Larena, *supra* note 19, at 810–14; Derzko, *supra* note 19, at 390; Dreyfuss, *supra* note 19, at 471–72; Hoffman, *supra* note 19, at 1036–39; Mohr, *supra* note 19, at 685–91; Mueller, *No "Dilettante Affair": Rethinking the*

primary problems with such proposals have been identified. First, there is concern that an exemption for use in non-profit research might decrease incentives to sub-optimal levels to invent research tools used primarily in non-profit research.¹⁶⁸ Second is a concern about how non-profit entities enforce their own research tool patents. Giving them an exemption from liability while allowing them to enforce their own patents might amplify their propensity to use their patents to obtain “holdup” rents or to compete unfairly in the commercial arena.¹⁶⁹ Third, there is increasing entanglement between university and commercial research, raising the potential for strategic gamesmanship involving funding university research to obtain free access to research tools and the related potential for conflicts of interest for university faculty who own technology start-up companies spun off from their university research.¹⁷⁰

One way to address these concerns would be to combine an exemption for research use by non-profit entities with an exemption for research use *by anyone* of inventions patented by non-profit entities or their employees. Under such a “double-edged sword” exemption, commercial researchers could preclude their commercial competitors from using their research tool inventions and thus would be less likely to turn to trade secrecy to protect their research tool inventions. Non-profit entities would be able to make and use tools invented by anyone, while anyone would be able to make and use tools invented by non-profit entities.

The double-edged sword proposal goes some distance in addressing the three problems with non-profit research exemptions identified above. Concern about decreasing incentives to invent research tools primarily used in non-profit research is alleviated by the user innovation analysis itself. Those tools for which a non-profit research use exemption

Experimental Use Exception to Patent Infringement for Biomedical Research Tools, *supra* note 19, at 54–66; O'Rourke, *supra* note 19, at 1208–10; Pulsinelli, *supra* note 19, at 442–46; Sewell, *supra* note 19, at 776–78.

168. See Strandburg, *supra* note 16, at 137–38.

169. See Mark A. Lemley, *Are Universities Patent Trolls?* (2006) (unpublished manuscript, on file with the author) (discussing potential for universities to be “bad actors” in the patent system).

170. See Patricia C. Kuszler, *Curing Conflicts of Interest In Clinical Research: Impossible Dreams and Harsh Realities*, 8 WIDENER L. SYMP. J. 115 (2001); Jones & Strandburg, *supra* note 87, at 23.

substantially depresses incentives for seller innovation by removing a large share of the market are also likely to be invented by those researchers in the course of their research. To the extent that those researchers prefer to purchase standardized or improved versions of a tool, they can be developed and marketed by tool suppliers regardless of a research tool use exemption.

The second concern—that non-profit researchers might exploit their exemption from infringement liability to behave like patent trolls with respect to their own patents—is addressed directly by the proposal to exempt research tool use of non-profit researchers' tool inventions even by commercial researchers.

Finally, the “double-edged” nature of the proposal addresses at least in part the concern about strategic gamesmanship by industry in funding of and collaboration in non-profit research. Projects funded by industry but performed by or in conjunction with university researchers could be exempt from infringement liability for research tool use under the proposal, but any research tools coming out of the joint or industry-funded research would be subject to exempt use by other researchers. In this respect, the proposal has some of the flavor of Professor Rochelle Dreyfuss's waiver proposal, which awards a research exemption only if the researcher is willing to waive patenting the results of the research.¹⁷¹ Its advantage over that proposal is that it operates automatically without any need for researchers to take affirmative steps to identify themselves and to relinquish rights. Its disadvantage is that it applies only to research uses. A commercial entity could still take advantage of the non-profit research use exemption by funding university research and then obtaining an assignment of patent rights in the *results* of the research. While such reach-through rights have various pros and cons, that issue is independent of the problem of research hold-up tackled by a research use exemption.

Any reductions in incentives to invent, disclose, and disseminate research tools resulting from such a double-edged sword exemption will be even less significant than those resulting from the broader exemption discussed above. As noted, non-profit researchers have substantial incentives to

171. See Dreyfuss, *supra* note 19, at 462–63.

invent, disclose, and disseminate research tools without any need for patent exclusivity. Moreover, since non-profit researchers are research tool users as well as research tool inventors, the effects of a double-edged “research tool use” exemption should more or less wash out.

The effects of the exemption on commercial researcher innovators would also balance out to some extent. These researchers would benefit from the ability to use the inventions of non-profit researchers without compensating them, but would be less able to control the streams of research conducted with their own inventions and to collect revenue from licensing their tools to non-profit researchers. On the other hand, they would maintain the ability to exclude their commercial competitors from using their patented tools.

Finally, the double-edged sword exemption would have similar effects on tool suppliers and tool licensing firms as a complete research tool use exemption, except that the effects would be lessened by the fact that commercial firms could still be precluded (to the extent enforceable) from making and using patented research tools in their laboratories.

While a non-profit research tool use exemption of this type might be politically more palatable than a complete research tool use exemption, it raises the question of how to determine to whom the exemption would apply. The rules that determine whether a particular patent is considered to have a “non-profit” inventor and whether a research group is “non-profit” could have implications for university-industry collaborations. With respect to determining whether a particular *patent* is subject to the exemption, a simple rule based on whether any of the inventors is employed by a non-profit entity could be used. With respect to determining whether a particular *user* is entitled to the exemption, a similar rule could be used, exempting any research in which one of the collaborators is employed by a non-profit entity, as could an alternative rule based on whether the research is funded in part by a non-profit entity. The effects on industry-university collaborations would seem to average out under such a rule: industry collaborators would lose the ability to control research use of inventions resulting from collaboration, but would gain the ability to use any patented invention in the collaborative research. Because university collaboration comes with pros and cons in this respect, the temptation to “game” the system is mitigated.

Moreover, having established that the potential incentive effects of a research tool use exemption are less than one might have imagined, we may perhaps be less concerned about getting the line in exactly the right place and opt instead for a bright line erring on the side of exemption.

In sum, a "double-edged sword" non-profit research tool use exemption may accomplish many of the same objectives as a blanket research use exemption while raising fewer concerns about depressing commercial incentives to develop and disclose research tools. The National Institutes of Health ("NIH") has recently issued guidelines for grant recipients reflecting a similar concept.¹⁷² These Principles and Guidelines seek to "promote utilization, commercialization, and public availability of [NIH funded] inventions" and note that for research tools for which "further research, development and private investment are [not] needed to realize" their primary usefulness, the goals of technology transfer "can be met through publication, deposit in an appropriate databank or repository, widespread non-exclusive licensing or any other number of dissemination techniques. Restrictive licensing of such an invention, such as to a for-profit sponsor for exclusive internal use, is antithetical to [these goals]."¹⁷³ More recently, the NIH has adopted "Best Practices for the Licensing of Genomic Inventions" which state that funding recipients should "consider whether significant further research and development by the private sector is required to bring the invention to practical and commercial use," and when this is not the case "best practices dictate that patent protection rarely should be sought."¹⁷⁴ The Best Practices also urge that "whenever possible, non-exclusive licensing should be pursued."

The proposed double-edged sword exemption recognizes that research tools are inventions for which, categorically, "research, development, and private investment are not needed" to make them useful as a general matter.¹⁷⁵ It

172. Principles and Guidelines for Recipients of NIH Research Grants and Contracts on Obtaining and Disseminating Biomedical Research Resources: Final Notice, 64 Fed. Reg. 72,090 (Dec. 23, 1999).

173. *Id.* at 72,093.

174. Best Practices for the Licensing of Genomic Inventions: Final Notice, 70 Fed. Reg. 18,413 (Apr. 11, 2005).

175. See also Arti K. Rai & Rebecca S. Eisenberg, *Bayh-Dole Reform and the Progress of Biomedicine*, 66 LAW & CONTEMP. PROBS. 289 (2003), which proposes that the NIH make a determination as to whether NIH-funded inventions should

improves upon the approach of the NIH guidelines by permitting patenting—thus making room, for example, for the enforcement of patents against competing sellers and non-research users and retaining the possibility that a non-profit entity could license a research tool invention exclusively to a commercial firm for development and eventual sale of a standard or optimized version.

V. CONCLUSIONS

The growing importance of user innovation challenges the predominance of the seller innovator paradigm that has dominated patent law analysis. If patent law doctrine ignores the ways in which user innovator incentives to invent, disclose, and disseminate their inventions differ from those of seller innovators, a broad swath of potential creativity and progress may be stymied. The intrinsic rewards of invention to user innovators decrease the benefits of patent protection in inducing the types of innovation that users will make, enhancing the relative importance of patenting's social costs. User innovation also brings questions of disclosure and dissemination, which often take a back seat in patent analysis, to the fore.

In this Article, I have applied the concept of user innovation in some detail to the question of an infringement exemption for research use of patented inventions. However, the general characteristics of user innovation are likely to have implications for other aspects of patent law doctrine, including the patentability of products of nature, principles of nature, and abstract ideas; business method patentability; attempts to use patenting for non-economic ends; and the issue of repair, reconstruction, and reproduction of patented artifacts.

A thorough consideration of user innovation should be part of a more general appreciation of the important role of non-sales motivations in producing technological progress. Though both patents and copyrights are primarily viewed by judges and legal scholars as providing economic motivations for creative endeavors, copyright theory has a significant history of

be patented, and Pulsinelli, *supra* note 19 (discussing the Rai and Eisenberg proposal and suggesting a research exemption which would apply whenever publicly funded researchers make use of patented inventions resulting from publicly funded research).

debate about the importance of commercial sale of works relative to other factors—such as artistic inspiration and the inherent rewards of creative expression—in motivating intellectual efforts. This debate is reflected not only in the recent discord between the “content industries” and amateur and cooperative creators¹⁷⁶ but also in the longstanding divide between the United States and continental Europe on the question of “moral rights.”¹⁷⁷

Perhaps because patentable inventions are the purview of the “skilled in the art,” which, despite romantic images of basement inventors, is widely understood to mean the expert, the engineer, or the professional, discussion of non-sale motivations for technological creativity (except with regard to fundamental research) has been minimal. Whatever the reason for the focus on sales motivations in the past, it is time to explore the important role that other motivations play in producing progress in the useful arts.

176. See, e.g., Benkler, *supra* note 14; Hunter & Lastowka, *supra* note 14.

177. See, e.g., Kwall, *supra* note 14; Cyril P. Rigamonti, *Deconstructing Moral Rights*, 47 HARV. INT'L L.J. 353 (2006) (comparing U.S. and European approaches to moral rights).

Table 1: *Role of Patents in Incentivizing Invention, Disclosure, and Dissemination*

Role of Patents in Incentivizing:	Invention	Disclosure	Dissemination
Self-disclosing-in-use User Innovation	Not needed	Not needed	Usually not needed, patents may restrict
Non-self-disclosing-in-use User Innovation	Not needed	If no free revealing, patent may incentivize disclosure	Usually not needed once disclosed, patents may restrict
Self-Disclosing Seller Innovation	Patent needed to protect against free riding competing seller	Not needed	Facilitates licensing in cases where inventor cannot commercialize
Non-self-disclosing Seller Innovation	Not needed	If no free revealing, patent may incentivize disclosure	Facilitates licensing in cases where inventor cannot commercialize

Table 2: *Who Invents? Results of Studies of Various Classes of Innovations**

Innovation Type	User	Manufacturer	Supplier	Other
Scientific instruments	77%	23%	0%	0%
Semiconductor and printed circuit board process	67	21	0	12
Pultrusion process	90	10	0	0
Tractor shovel-related	6	94	0	0
Engineering plastics	10	90	0	0
Plastics additives	8	92	0	0
Industrial gas-using	42	17	33	8
Thermoplastics-using	43	14	36	7
Wire termination	11	33	56	0

* Table taken with permission from DEMOCRATIZING INNOVATION, *supra* note 9, at 97.

Table 3: *Source of Innovations by Nature of Improvement Effected***

Type of improvement	Innovation developed by:				Mean Importance	
	<u>%User</u>	<u>User</u>	<u>Mfr</u>	<u>Total</u>	<u>Scientific</u>	<u>Comml</u>
(1) New functional capability	82%	14	3	17	3.33	2.87
(2) Convenience or reliability improvement	13%	3	21	24	2.28	3.46
Sensitivity, resolution, or accuracy improvement	48%	11	12	23	2.74	3.36
			Total	64		

** Table taken with permission from Riggs & Von Hippel, *supra* note 8, at 464.

Table 4: *Anticipated Effects of a Research Use Exemption*

Effect of Research Use Exemption on:	Invention	Dissemination	Disclosure
Non-Profit Researcher Innovator	Minimal	Increased due to researcher use	Minimal
Commercial Researcher Innovator	Minimal (Trade Secrecy Likely Available)	Increased whether choice is to opt for trade secrecy, free revealing, or patenting	Ambiguous: Decreased where choice is for trade secrecy; Increased where choice is for free revealing
Commercial Tool Supplier	Further channeled away from tools that can be “home-made”	Unaffected	Unaffected
Tool Licensing Firm	Channeled away from tools that can be “home-made”	Unaffected	Unaffected