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Making Room for Cooperative Innovation

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ABSTRACT

Patent law, created in response to a constitutional mandate to encourage innovation, may be discouraging important forms of cooperative innovation. Advances in technology have enabled new ways of pooling knowledge and computational capabilities, facilitating cooperation among many participants with complementary skills and motivations to collectively solve complex problems. But emerging models of cooperative innovation increasingly run into patent roadblocks.

Why might patent law sometimes thwart instead of support socially beneficial cooperative innovation? The problem lies in the tensions between the market-based incentives that patent law creates and the mechanisms that support emerging models of cooperative innovation. The complexity and cost of solving contemporary public challenges are nudging diverse participants together to collectively build their knowledge, but patents often serve to keep them apart. While digital technologies enable new forms of massively distributed, open and collaborative intellectual production, patents threaten the vitality and even the viability of these promising types of innovation.

In this Article I use two examples—the risk of crowding out crowd science and the battle between proprietary software companies and free open source software platforms—to illustrate how patent law in its current form may sometimes impede beneficial cooperation in innovation. I then suggest how we might limit the negative effects of patents in contexts of cooperative innovation without undermining the patent system.

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I. INTRODUCTION

"In the long history of humankind (and animal kind, too), those who learned to collaborate and improvise most effectively have prevailed."—Charles Darwin

Systems of decentralized, massively distributed open innovation are emerging with increasing frequency and with the ability to harness new resources in powerful new ways.[1] People with no prior in-

1. *See, e.g.*, Yochai Benkler, *Law, Policy, and Cooperation*, *in* GOVERNMENT AND MARKETS: TOWARD A NEW THEORY OF REGULATION 299 (Edward J. Balleisen & David A. Moss eds., 2010); *see also* ERIC VON HIPPEL, DEMOCRATIZING INNOVATION (2005). For a list

volvement in biotechnology contribute hours of their time to solve protein-folding puzzles posed by Foldit, an online video game that uses crowd science to solve complex scientific problems.[2] Data gathered from volunteer bird watchers through the global orthinological network eBird are used to detect important environmental changes that might otherwise go unnoticed.[3] The U.S. Air Force is harnessing collaborative online platforms to solicit input from students on complex technological problems,[4] and the National Institute of Health is enlisting the help of citizen scientist volunteers to collect and analyze data from bacteria samples as part of the American Gut project.[5] All of these processes of crowd science rely on cooperation among many participants with diverse motivations and skills to collectively and openly develop solutions to complex scientific or technological problems.[6]

Advances in technology have enabled greater computational capabilities and new ways of pooling knowledge. They have facilitated the growth of massively distributed open access innovation processes that rely upon voluntary participation by large numbers of people who bring with them a diversity of skills and perspectives.[7] These participants share their ideas and discoveries openly with other members of the innovation community in order to collectively and cumulatively advance the innovation process. I refer to these kinds of innovation processes as "cooperative innovation." Cooperative innovation can harness underutilized and unused human resources and combine existing disciplines and perspectives in new ways to solve previously intractable scientific problems. In some cases it may com-

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of some crowd science projects, see *Citizen Science*, SCI. AM., http://www.scientificamerican.com/citizen-science/ (last visited Mar. 22, 2014).

2. *See The Science Behind Foldit*, FOLDIT, http://fold.it/portal/info/about (last visited Mar. 22, 2014).

3. Jim Robbins, *Crowdsourcing, for the Birds*, N.Y. TIMES (Aug. 19, 2013), http://www.nytimes.com/2013/08/20/science/earth/crowdsourcing-for-the-birds.html?pagewanted=all&_r=0 (eBird aggregates data about bird sightings that could not be collected other than through individual observations and uses it to uncover changes in the environment).

4. Jane L. Levere, *Air Force Asks Students to Solve Real World Problems*, N.Y. TIMES (July 28, 2013), http://www.nytimes.com/2013/07/29/business/media/air-force-asks-students-to-solve-real-world-problems.html.

5. *See American Gut*, HUMAN FOOD PROJECT, http://humanfoodproject.com/americangut/ (last visited Mar. 22, 2014).

6. While these and other examples of what I am calling "cooperative innovation" have important similarities, an equally important distinction can be drawn between projects that rely primarily on cooperative data gathering, such as in the eBird and American Gut project examples, and projects that involve cooperative problem solving and free sharing of ideas, such as the Foldit and U.S. Air Force examples. The concerns that I address in this paper apply most strongly to the latter cases, where at least some participants are engaging in more than collecting data, although the lines between activities that generate data and activities that lead to invention are often blurred.

7. *See, e.g.*, VON HIPPEL, *supra* note 1; Benkler, *supra* note 1.

plement existing modes of market-driven innovation, and in other cases it may challenge them, increasing competition in important areas of intellectual production.[8] However, emerging models of cooperative innovation sometimes run into patent roadblocks.

The problems that patents pose for cooperation in processes of innovation are becoming difficult to ignore.[9] The patent litigation wars between major players in the smart phone industry such as Apple, Samsung, Google, and Microsoft illustrate the divisive role that patents can play in an industry that relies upon the shared development and use of technology standards to achieve interoperability, particularly when network effects are important. By some accounts Apple and Google now spend more on patent litigation than they do on R&D.[10] These problems are even greater for systems of cooperative innovation such as open source software and crowd science. Open source software systems like Linux challenge proprietary products like Microsoft Windows in the marketplace, only to find their viability threatened by patent lawsuits.[11] Ironically, the open source software community finds it necessary to spend substantial resources acquiring patents as a way of protecting free software use.[12] While harder to detect and measure, the problems

8. Scholars such as Yochai Benkler have argued that cooperative innovation is valuable in itself, offering a way of democratizing innovation. In this article I am not arguing that cooperative innovation is better than existing approaches, or even that cooperation is always good. I am simply arguing that some kinds of cooperative innovation have the potential to increase social welfare and deserve a chance to compete with alternative approaches.

9. *See, e.g.*, Rochelle Cooper Dreyfuss, *Does IP Need IP? Accommodating Intellectual Production Outside the Intellectual Property Paradigm*, 31 CARDOZO L. REV. 1437 (2010) (describing the need to change IP law to accommodate new forms of collaborative intellectual production); Aija Leiponen & Justin Byma, *If You Cannot Block, You Better Run: Small Firms, Cooperative Innovation, and Appropriation Strategies*, 38 RES. POL'Y 1478 (2009) ("Earlier research has emphasized patents and trade secrets as key strategies of appropriation, yet these strategies do not appear to be very beneficial for small firms engaged in cooperative innovation. These results raise policy questions regarding the functionality of the existing system of intellectual property rights."); Mark A. Lemley, *The Myth of the Sole Inventor*, 110 MICH. L. REV. 709, 709 (2012); Katherine J. Strandburg, *Evolving Innovation Paradigms and the Global Intellectual Property Regime*, 41 CONN. L. REV. 861, 863-65 (2009) (arguing that current IP regimes are not designed to cope with changes in the innovative process).

10. *See* Charles Duhigg & Steve Lohr, *The Patent, Used as a Sword*, N.Y. TIMES (Oct. 7, 2012), http://www.nytimes.com/2012/10/08/technology/patent-wars-among-tech-giants-can-stifle-competition.html?pagewanted=all.

11. *See* Roger Parloff, *Microsoft Takes on the Free World*, FORTUNE (May 14, 2007, 9:35 AM), *available at* http://money.cnn.com/magazines/fortune/fortune_archive/2007/05/28/100033867/ ("Microsoft claims that free software like Linux, which runs a big chunk of corporate America, violates 235 of its patents. It wants royalties from distributors and users. Users like you, maybe.").

12. *See* Clark D. Asay, *Enabling Patentless Innovation*, MD. L. REV. (forthcoming 2014) (manuscript at 47-48), *available at* http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2289326); Keith Bergelt & William Wong, *Interview: Keith Bergelt Discusses Open Invention*

that patents create for systems like Foldit that rely most heavily on non-market mechanisms might prove to be even more costly. Patents may interfere with the growth and vitality of these cooperative systems, limiting the opportunities that they provide for socially beneficial intellectual production.

Scholars of innovation such as Yochai Benkler and Eric von Hippel have already challenged us to consider what changes to the design of the legal and institutional system are necessary to sustain cooperative innovation.[13] They have identified intellectual property law, particularly patent law, as threatening the open, inclusive and collaborative nature of these systems. But they and other scholars following in their wake have left the precise contours and magnitude of the patent threats and specific proposals for patent law change for further study.[14] This Article responds to the challenge by identifying and addressing specific ways in which patent law may interfere with non-market mechanisms that support cooperative innovation. It focuses on three mechanisms that play a critical role in systems of cooperative innovation: trust, benefit-sharing, and reciprocity.[15] Patents interfere with these mechanisms by increasing incentives for group members to defect from the group and by increasing threats from third parties against the group. This can make it harder to sustain the intrinsic motivations and the related norms of trust and sharing that cooperative systems rely upon, as well as increasing the cost and risk of participation to potentially unsustainable levels. I argue that courts should take these negative effects into account when fashioning patent remedies in contexts of cooperative innovation.[16]

Network, ELEC. DESIGN (Mar. 6, 2014), http://electronicdesign.com/embedded/interview-keith-bergelt-discusses-open-invention-network.

13. "Policymakers . . . can design institutions and social systems to foster cooperation by shaping social and psychological dynamics, rather than by focusing on individual incentives. The question then becomes, what aspects of the design of an institution or system—be it technical platform, legal rule, business process, or policy intervention—are likely to lead to a stable cooperative social dynamic?" Benkler, *supra* note 1, at 302; *see also* VON HIPPEL, *supra* note 1.

14. See Katherine J. Strandburg, *Intellectual Property at the Boundary* (N.Y.U. Sch. of Law Pub. Law & Legal Theory Res. Paper Series, Working Paper No. 13-60, 2013) (setting out an agenda for investigating how IP rules impact cooperative innovation systems).

15. While these basic mechanisms seem to capture important ways in which many cooperative systems operate, there are many other aspects of cooperative systems that distinguish them from market-based systems, including a rich variety of non-economic motivations and incentives for participating. For a discussion of the variety of incentives, as well as some of the mechanisms, driving open source software systems, see, for example, Stephen M. Maurer & Suzanne Scotchmer, *Open Source Software: The New Intellectual Property Paradigm*, *in* 1 HANDBOOK OF ECON. & INFO. SYS. 285 (Terrence Hendershott ed., 2006).

16. Preventing cooperation may, however, sometimes be socially desirable. *See, e.g.*, F. Scott Kieff, *On Coordinating Transactions in Intellectual Property: A Response to Smith's* Delineating Entitlements in Information, 117 YALE L.J. POCKET PART 101 (2007); Klaus

The Article proceeds as follows. Part I explores the potential of cooperative innovation as an alternative to the traditional market-driven approach. It provides two examples of cooperative innovation, crowd science and open source software, to illustrate both the power of cooperative systems and their vulnerabilities to patent threats. Part II examines how and why patents may create problems for cooperative innovation.[17] Part III shows how patent law could be adapted to accommodate cooperative innovation through limited changes to patent remedies. It provides three principles for contextualizing patent remedies in ways that respond to and limit the costs of patents for socially beneficial cooperative innovation.[18] These principles would be triggered and applied by the courts only in contexts of cooperative innovation,[19] leaving other areas of patent law unchanged. Making room for cooperative innovation in this way will facilitate

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Kultti et al., *Patents Hinder Collusion* (Helsinki Ctr. of Econ. Res., Discussion Paper No. 144, 2007); *see also* Jonathan Barnett, *Dynamic Analysis of Intellectual Property: Theory, Evidence and Policy* (USC Gould Sch. of Law Ctr. in Law, Econ. & Org. Res. Papers Series, Research Paper No. C13-4, 2013) (noting that periods of weak patent protection may actually disadvantage new entrants).

17. *See, e.g.*, Dreyfuss, *supra* note 9; *see also* Gregory N. Mandel, *Left-Brain Versus Right-Brain: Competing Conceptions of Creativity in Intellectual Property Law*, 44 U.C. DAVIS L. REV. 283 (2010) (noting IP law has failed to recognize insights from psychology, neurobiology and cultural research about how to promote creativity, resulting in laws based on distorting stereotypes of creativity); Gregory N. Mandel, *To Promote the Creative Process: Intellectual Property Law and the Psychology of Creativity*, 86 NOTRE DAME L. REV. 1999, 2000 (2011) (noting patents may have psychological effects that alter incentives to innovate, particularly in collaborations); Michael Mattioli, *Communities of Innovation*, 106 NW. U. L. REV. 103, 103 (2012) (examining collective patent licensing as a form of collective behavior in the patent system).

18. For discussions of the need for principles to guide policy determinations about patent remedies, see, for example, Thomas F. Cotter, *Four Principles for Calculating Reasonable Royalties in Patent Infringement Litigation*, 27 SANTA CLARA COMPUTER & HIGH TECH. L.J. 725 (2011); John M. Golden, *Principles for Patent Remedies*, 88 TEX. L. REV. 505 (2010) (providing principles to guide policymakers in assessing the relative merits of alternative policy proposals); Paul J. Heald, *Optimal Remedies for Patent Infringement: A Transactional Model* (Univ. of Chi. Law Sch. John M. Olin Law & Econ., Working Paper No. 431, 2008), *available at* http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1278062.

19. The literature includes an increasing number of proposals for tailoring patent remedies in ways that take the public interest in supporting innovation into account. *See, e.g.*, Sarah R. Wasserman Rajec, *Tailoring Remedies to Spur Innovation*, 61 AM. U. L. REV. 733 (2012); Ted Sichelman, *Purging Patent Law of 'Private Law' Remedies*, 92 TEX. L. REV. 517 (2014); Samson Vermont, *Basing Patent Remedies on Harm to the World Instead of Harm to the Patentee* (May 12, 2012) (unpublished manuscript) (on file with author). It also includes proposals for tailoring patent remedies to reflect the relational or transactional aspects of patents. *See, e.g.*, Thomas F. Cotter, *Patent Holdup, Patent Remedies, and Antitrust Responses*, 34 J. CORP. L. 1151 (2009) (focusing on the relational value of patents and the importance of employing practical reason as an approach to patent remedies); Heald, *supra* note 18, at 1176 (stating that the goal of patent remedies is to provide incentives for efficient transactions to occur while minimizing cost of transacting).

competition among alternative modes of innovation without materially undermining the patent system.[20]

II. AN ALTERNATIVE WAY OF INNOVATING

"Gettin' good players is easy. Gettin' 'em to play together is the hard part."—Casey Stengel

In a controversial presidential campaign speech, now known as the "you didn't build that" speech, President Obama told his audience that "[i]f you were successful, somebody along the line gave you some help," referring to the essential role of shared infrastructure and collective knowledge in supporting individual achievement.[21] Since then, Obama has continued to challenge the image of the rugged individual inventor and entrepreneur, emphasizing the social context in which innovation takes place and the importance of cumulative contributions to business success.[22] An emphasis on collaboration and cooperation among stakeholders is now evident in both federal and state innovation policies.[23]

While the need for collaboration to solve scientific and technological problems is not new,[24] what is new is the scale and complexity of the problems that need to be solved and the large and diverse group of people who can come together to solve them using decentralized,

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20. I am not arguing that patents are always bad for cooperation. Patents may be useful, even essential, in supporting certain kinds of coordination and cooperation in innovation. *See, e.g.*, Jonathan M. Barnett, *The Illusion of the Commons*, 25 BERKELEY TECH. L.J. 1751 (2010) [hereinafter Barnett, *The Illusion of the Commons*]; Paul J. Heald, *A Transaction Costs Theory of Patent Law*, 66 OHIO ST. L.J. 473 (2005); F. Scott Kieff, *Coordination, Property, and Intellectual Property: An Unconventional Approach to Anticompetitive Effects and Downstream Access*, 56 EMORY L.J. 327 (2006). Moreover, firms have alternative appropriability strategies that they can use in place of patents, so weakening patents may not necessarily mean greater access. *See, e.g.*, Jonathan M. Barnett, *Is Intellectual Property Trivial?*, 157 U. PA. L. REV. 1691 (2009). I argue only that patents create systematic disadvantages for certain kinds of cooperative innovation that provide social benefits such as lower cost innovation, competition with existing proprietary systems, or the creation of new products and ideas that might otherwise be unavailable.

21. This speech now has its own spot on Wikipedia. See a full discussion of this and related speeches at *You Didn't Build That*, WIKIPEDIA.ORG, http://en.wikipedia.org/wiki/You_didn't_ build_that (last modified Jan. 19, 2014).

22. *SEE* BARACK OBAMA, U.S. PRESIDENT, REMARKS AT A CAMPAIGN EVENT IN ROANOKE, VIRGINIA (JULY 13, 2012) (TRANSCRIPT AVAILABLE AT HTTP://WWW.WHITEHOUSE.GOV/THE-PRESS-OFFICE/2012/07/13/REMARKS-PRESIDENT-CAMPAIGN-EVENT-ROANOKE-VIRGINIA).

23. *See, e.g.*, Steven C. Currall & Ed Frauenheim, *How the U.S. Can Lead on Technological Innovation*, SEATTLE TIMES (Mar. 7, 2014, 5:14 PM), http://seattletimes.com/html/opinion/2023076667_stevencurralledfrauenheimopedinnovationresearchxxxml.html; Bruce Katz & Judith Rodin, *Innovative State and City Government Solutions to Watch in 2012*, THE ATLANTIC (Jan. 17, 2012), http://www.theatlanticcities.com/jobs-and-economy/ 2012/01/innovative-local-government-solutions-watch-2012/951/.

24. *See generally* Ernan McMullin, *Openness and Secrecy in Science: Some Notes on Early History*, 10 SCI. TECH. & HUMAN VALUES 14 (1985) (examining the history of the ideal and reality of open science).

low-cost, web-based technologies. Emerging forms of cooperative innovation can harness new resources, bring multiple disciplines and perspectives to bear on previously intractable scientific problems, and increase competition in key areas of intellectual production. I argue that innovation policies need to respond to the opportunities of these cooperative innovation systems. To do so, however, requires an understanding of how these systems diverge from traditional market-driven modes of innovation in ways that leave them vulnerable to patents. I therefore explore the mechanisms on which cooperative systems of innovation rely and the potential effects of patents on these mechanisms. Two examples of cooperative innovation help to illustrate both the power of these models and their vulnerability to patents.

A. Distinct Features of Cooperative Innovation

> *"[W]hat really distinguishes open source is not just source, but an 'architecture of participation' . . . ."—Tim O'Reilly*

Cooperative innovation is used in this article to refer to open access innovation processes fueled by the voluntary participation of large numbers of people who share their ideas and discoveries freely and openly with other members of the innovation community. Entry is free, or close to free, and the cost to participate is low. Progress is highly sequential and dependent upon large numbers of small steps that build upon each other. This kind of innovation diverges from traditional market-based modes of innovation in its reliance on non-market mechanisms for sustaining cooperation.

Cooperation involves working together to advance common goals or obtain mutual benefits. It can occur among even purely selfish economically rational actors where individual economic interests align with the collective interest. Sustaining cooperation when individual economic interests diverge from the interests of the collective is more challenging. A number of studies have tried to identify the factors that are needed to sustain cooperation beyond situations in which rational economic actors have aligned interests.[25] Case studies

25. *See, e.g.*, YOCHAI BENKLER, THE PENGUIN AND THE LEVIATHAN (2011); SOCIAL DILEMMAS: PERSPECTIVES ON INDIVIDUALS AND GROUPS (David A. Schroeder ed., 1995) (giving an overview of different perspectives on decisions made by those in social dilemmas and the factors that influence choices to act in the interests of the group); Benkler, *supra* note 1; *see also* ROBERT C. ELLICKSON, ORDER WITHOUT LAW: HOW NEIGHBORS SETTLE DISPUTES (1991); ELINOR OSTROM, GOVERNING THE COMMONS: THE EVOLUTION OF INSTITUTIONS FOR COLLECTIVE ACTION (1990); Elinor Ostrom, *A General Framework for Analyzing Sustainability of Social-Ecological Systems*, 325 SCI. 419 (2009). For an organizational approach to understanding how patents influence knowledge communities, see, for example, Fiona Murray & Scott Stern, Learning To Live with Patents: A Dynamic Model of a Knowledge Community's Response to Legal Institutional Change (Nov. 2008) (unpublished manuscript) (on file with author).

of open source software communities have been particularly helpful in identifying the mechanisms that support cooperative intellectual production.[26] They have illustrated the importance of trust and reciprocity, and shown how these mechanisms can work when groups become large and relationships attenuated.

In open source software communities, people cooperate with each other even when they do not know each other and their interactions are limited. Team members must decide how much they can trust each other before joining the team and without the chance to establish personal relationships or forms of mutual control.[27] Instead of personal relationships, the decision to join the team is based on beliefs about the motivation of other team members to adhere to the mutual norms of the open source software community. Participants must believe that other members of the community will continue to act in ways that are consistent with the open source model of free sharing. This is an example of swift trust, a unique form of trust that occurs between people or groups who come together in temporary teams to solve collaborative tasks.[28] The maintenance of these communities depends on "their ability to a) develop and enforce rules of cooperation in a self-organized manner, and to b) develop self-enforcing swift trust which is based on generalized reciprocity between group members."[29] Keeping the cost of participation low is also essential to the sustainability of these groups.[30]

A growing body of empirical work in other areas involving self-governing systems of cooperative resource management and use supports these findings, emphasizing the importance of trust—particularly swift trust, benefit-sharing, and reciprocity in attracting

26. *See, e.g.*, Greg R. Vetter, *Commercial Free and Open Source Software: Knowledge Production, Hybrid Appropriability, and Patents*, 77 FORDHAM L. REV. 2087 (2009).

27. *See* Margit Osterloh & Sandra Rota, *Trust and Community in Open Source Software Production*, 26 ANALYSE & KRITIK 279 (2004).

28. For early development and use of "swift trust," see, for example, Debra Meyerson et al., *Swift Trust and Temporary Groups*, *in* TRUST IN ORGANIZATIONS 166, 168 (Roderick M. Kramer & Tom R. Tyler eds., 1996). For an interesting discussion of swift trust as it arises in different contexts and the factors affecting its formation, see Michael J. Fahy, Understanding "Swift Trust" To Improve Interagency Collaboration in New York City (Sept. 2012) (unpublished M.A. thesis, Naval Postgraduate School), *available at* http://hdl.handle.net/10945/17362.

29. Osterloh & Rota, *supra* note 27, at 280; *see also* C. Brad Crisp & Sirkaa L. Jarvenpaa, *Swift Trust in Global Virtual Teams: Trusting Beliefs and Normative Actions*, 12 J. PERSONNEL PSYCHOL. 45 (2013) (examining the role and vulnerabilities of swift trust in ad hoc global virtual teams).

30. Copyright law has provided a limited enforcement mechanism, through the use of licenses that impose varying commitments on users of open source software to make their own contributions open and accessible. Even with these licenses in place, however, trust remains an important part of sustaining open source software systems.

and sustaining participation.[31] This work also suggests that to sustain cooperation, laws need to be applied in ways that support, or at the very least minimize interference with, the norms, customs, and organizational structures that support these critical non-market mechanisms.[32] Where members of a group are contributing their time and ideas freely and voluntarily, their willingness to participate will be influenced by the behavior of other group members and even, to a lesser extent, by the behavior of non-group members.[33] Their willingness to make contributions will depend on the extent to which other group members act in accordance with shared group norms and reciprocate with their own contributions and the extent to which the contributions that group members freely provide remain free. Free riding and private appropriation of the benefits produced in the group by people outside of the group may also undermine internal motivations to contribute. Problems may arise for the group where legal rules or the incentives that these rules create undermine or conflict with the shared understandings and commitments of the group, leading to deviations from accepted and expected cooperative behavior.

These insights are making their way into at least some areas of the law. In contract law, for example, relational contract theory provides a view of contracts as relations rather than discrete transactions, with many of the contract terms left implicit and governed by trust between the parties.[34] Recent work on contracts and innovation illustrates how firms use incomplete contracts to sustain cooperative relationships in the face of imperfect information.[35] In corporate law,

31. *See, e.g.*, TRUST AND RECIPROCITY: INTERDISCIPLINARY LESSONS FROM EXPERIMENTAL RESEARCH (Elinor Ostrom & James Walker eds., 2003); UNDERSTANDING KNOWLEDGE AS A COMMONS (Charlotte Hess & Elinor Ostrom eds., 2007); STEVEN WEBER, THE SUCCESS OF OPEN SOURCE (2004); Benkler, *supra* note 1; Dan M. Kahan, *The Logic of Reciprocity: Trust, Collective Action, and Law*, 102 MICH. L. REV. 71 (2003); Osterloh & Rota, *supra* note 27; Margit Osterloh, Sandra Rota & Bernhard Kuster, Trust and Commerce in Open Source—A Contradiction? (Nov. 22, 2002) (unpublished manuscript), *available at* http://www.researchgate.net/publication/226907215_Trust_and_Commerce_in_Open_Source_A_Contradiction.

32. *See, e.g.*, TRUST AND RECIPROCITY: INTERDISCIPLINARY LESSONS FROM EXPERIMENTAL RESEARCH, *supra* note 31; UNDERSTANDING KNOWLEDGE AS A COMMONS, *supra* note 31.

33. *See, e.g.*, Osterloh, Rota & Kuster, *supra* note 31, at 9.

34. *See, e.g.*, Ian R. Macneil, *The Many Futures of Contract*, 47 S. CAL. L. REV. 691 (1974).

35. *See, e.g.*, Ronald J. Gilson et al., *Contracting for Innovation: Vertical Disintegration and Interfirm Collaboration*, 109 COLUM. L. REV. 431 (2009). Contracts allow parties to structure their relationships with each other in ways that foster trust and facilitate relationship-specific investments where the payoffs from the relationship cannot be predicted and contracted for in advance. In some cases the terms governing the division of payoffs from a shared innovation project are left open, the parties relying instead on the braiding of formal terms for sharing information about the progress and prospects of their joint activities with informal terms governing subsequent outcomes of the joint work. This information-sharing regime "braids" together the formal and informal elements of the contract in a way that endogenizes the growth of trust between the participants. *See* Ronald J. Gilson et al., *Braiding: The Interaction of Formal and Informal Contracting in Theory, Practice, and Doctrine*, 110 COLUM. L. REV. 1377 (2010).

behavioral theories based on trust and trustworthiness challenge conventional views of the firm.[36] This work cautions against excessive reliance on external sanctions that may undermine internal trust.[37] As new forms of collective production emerge, there have even been suggestions for creating an entirely new field of law, cooperation law, to reflect arrangements between people that are based on a variety of modes of sharing, cooperation, and collaboration—such as co-housing, barter, and community-financed businesses.[38] These legal responses aim to modify existing formal rules where needed to support and protect beneficial informal rules and understandings. I suggest that internalizing the negative effects that patents may have on non-market mechanisms of trust, benefit-sharing, and reciprocity in cooperative systems will begin to pull similar considerations into patent law in contexts, such as those described below, where they are most important.[39] The following two examples illustrate both the power of cooperative innovation and the vulnerabilities of such systems to the incentives and associated transaction costs that patents create.

B. Two Examples

1. Crowd Science: The Example of Foldit

The power of crowd science, the use of many volunteers working together to solve complex data intensive problems, has been illustrated in areas as diverse as finding planets, deciphering ancient texts, and building climate models.[40] Crowd science is increasingly informing what we know about diverse natural phenomena such as bird populations and their distributions,[41] the pollination habits of

36. *See, e.g.*, Margaret M. Blair & Lynn A. Stout, *A Team Production Theory of Corporate Law*, 85 VA. L. REV. 247 (1999); Margaret M. Blair & Lynn A. Stout, *Trust, Trustworthiness, and the Behavioral Foundations of Corporate Law*, 149 U. PA. L. REV. 1735 (2001) [hereinafter Blair & Stout, *Trust*] (arguing that the behavioral phenomena of internalized trust and trustworthiness play important roles in encouraging cooperation within firms); Donald C. Langevoort, *Behavioral Approaches to Corporate Law*, *in* RESEARCH HANDBOOK ON THE ECONOMICS OF CORPORATE LAW 442 (Claire A. Hill & Brett H. McDonnell eds., 2012).

37. *See* Blair & Stout, *Trust*, *supra* note 36.

38. *See, e.g.*, Janelle Orsi, *Cooperation Law for a Sharing Economy*, YES! MAG. (Sept. 23, 2010), http://www.yesmagazine.org/new-economy/cooperation-law-for-a-sharing-economy ("A new sharing economy is emerging—but how does it fit within our legal system? Time for a whole new field of cooperation law.").

39. For a discussion of how IP operates at the boundaries between groups, see, for example, Strandburg, *supra* note 14.

40. GAMING FOR THE GREATER GOOD, http://gamingforthegreatergood.com (last visited Mar. 22, 2014).

41. The Audubon Society's Christmas Bird Count began in 1900. A transformed version, eBird, was launched in 2002 by Cornell Lab of Ornithology in collaboration with the National Audubon Society. *About eBird*, EBIRD, http://ebird.org/content/ebird/about/

bees,[42] and the surface of the moon,[43] and is also helping to solve puzzles in quantum physics,[44] the anthropology of microbes,[45] and the early development stages of dinosaurs.[46] These divergent crowd science projects share a common foundation built upon open access, sharing, and cooperation between many heterogeneous participants with diverse motivations that may not be consistent with a price-based system. They illustrate the opportunities that cooperation outside of the marketplace offer for scaling up the collection and analysis of large amounts of data and for building knowledge through the accumulation of many incremental contributions of information and ideas.[47] Unfortunately they also share common vulnerabilities to a patent system that is not designed with them in mind. The story of Foldit, a particularly promising citizen science project, highlights both the risks and opportunities of these kinds of cooperative innovation.[48]

This story starts with the creation of a video game called Foldit that anybody can play.[49] Within ten days of their start on December 16, 2010, players of this new online protein folding game were able to solve the protein structure of a retrovirus similar to HIV, a structure that had eluded scientists for over ten years.[50] The results provided scientists with important insights into the treatment of AIDS and were published in a scientific journal with the video game team players as co-authors.[51] This is only one of a number of scientific advances made by Foldit players. Other contributions by Foldit players include

(last visited Mar. 22, 2014). eBird collects bird abundance and distribution data and enlists public participation in analyzing the over eighty million observations. *See id.*

42. The Great Sunflower Project was started by a single academic researcher interested in examining the pollination activities of bees, and it now has 90,000 registered volunteers planting sunflowers and taking observation samples. *See* GREAT SUNFLOWER PROJECT, http://www.greatsunflower.org (last visited Mar. 22, 2014).

43. *See, e.g.*, *Moon Zoo*, ZOONIVERSE, https://www.zooniverse.org/project/moonzoo (last visited Mar. 22, 2014).

44. *See, e.g.*, *The Story Behind "Quantum Moves,"* SCI. HOME, http://www.scienceathome.org (last visited Mar. 22, 2014) (describing Quantum Moves, a game that uses community efforts to help build a quantum computer).

45. *See American Gut*, *supra* note 5.

46. *See* OPEN DINOSAUR PROJECT, http://opendino.wordpress.com/ (last modified May 17, 2013).

47. *See, e.g.*, Clay Shirky, How the Internet Will (One Day) Transform Government, Address at TED Conference (June 2012), *available at* http://www.ted.com/talks/clay_shirky_how_the_internet_will_one_day_transform_government.

48. *See, e.g.*, Eric Hand, *People Power*, 466 NATURE 685 (2010) (discussing projects involving the concept of distributed thinking, featuring Foldit); Collins Kilgore, *Gaming for the Greater Good*, VAND. J. ENT. & TECH. L. (Sept. 27, 2011), http://www.jetlaw.org/?p=8381.

49. *See* FOLDIT, http://fold.it/portal/ (last visited Mar. 22, 2014).

50. *See* Firas Khatib et al., *Crystal Structure of a Monomeric Retroviral Protease Solved by Protein Folding Game Players*, 18 NATURE STRUCTURAL & MOLECULAR BIOLOGY 1175, 1177 (2011).

51. *Id.*

the discovery of a unique enzyme "backbone" configuration for the development of novel enzymes, a discovery described by scientists as the most detailed remodeling of a protein structure by humans working through a computer-based process.[52] This work moves beyond protein folding, which is critical for understanding how the human body works, and into the realm of protein design, which holds promise for advancing drug discovery. The protein design results were published in Nature Biotechnology, a prestigious scientific journal, with Foldit Players again included in the author list.[53]

Foldit was developed by David Baker, a protein research scientist at the University of Washington, together with Zoran Povic and Seth Cooper, computer scientists at the same university. The program is supported through a collaboration between the Biochemistry Department and the Center for Game Science at the University of Washington.[54] The vision behind Foldit is one of enabling public participation in large-scale distributed science. The project "aims to predict, design, and understand biochemical structures, and study how humans and computers can best work together to further these aims" through a growing community of game-developed expert volunteers.[55] Anybody can play the game simply by visiting the Foldit website, consenting to user-friendly terms of use that focus primarily on explaining how information is collected and shared, and downloading the free software needed to play the game.[56]

Participants in the game, most of who have little or no background in biochemistry, are introduced to some basic concepts of protein folding and then engaged in solving "puzzles" designed around specific protein structure problems that have been identified but not solved by scientists. The players collaborate with teammates while competing against other players to obtain the highest-scoring (lowest-energy) models. The scoring system includes different categories based on levels and types of contributions. The website identifies the

52. *See* Christopher B. Eiben et al., *Increased Diels-Alderase Activity Through Backbone Remodeling Guided by Foldit Players*, 30 NATURE BIOTECHNOLOGY 190, 192 (2012); *see also* David Baker, *More Amazing FoldIt Results and New Flu Virus Challenges*, FOLDIT (May 27, 2011, 6:41 PM), http://fold.it/portal/node/989769; Zoran, *Recent Exciting Discoveries by Foldit*, FOLDIT (Apr. 19, 2011, 5:15 PM), http://fold.it/portal/node/989576.

53. *See* Eiben et al., *supra* note 52 (showing that Foldit Players are included on the publication list; reporting the use of game-driven crowdsourcing to enhance the activity of a computationally designed enzyme through the functional remodeling of its structure).

54. *See* CENTER GAME SCI., http://centerforgamescience.com/site/ (last visited Mar. 22, 2014).

55. *See Foldit Terms of Service and Consent*, FOLDIT, http://fold.it/portal/legal (last updated Mar. 8, 2013).

56. New players begin by loading the game and watching tutorials that explain the game and the scientific concepts needed to understand it. *See How To Download and Start Playing Foldit!*, FOLDIT (Nov. 9, 2010, 11:47 PM), http://fold.it/portal/node/988864.

top players in each category and for each puzzle. It also provides rankings based on global scores and a hall of fame for the very top scorers. The game has separate rankings for soloists, who work on their projects alone, and evolvers, who work on and improve solutions that have been shared with other people. A high ranking is valued and sought after by the active players, and many of them carefully watch the scores and study the ways in which the rankings are calculated. Players are quick to point out areas where they believe the scoring is not accurately reflecting good performance or otherwise seems unfair.[57]

Three years into the life of the Foldit games, there is clear evidence that this massively multiplayer online game, which enlists players worldwide to solve challenging protein-structure prediction problems, offers improvements over the computational models currently being used by scientists.[58] "Obsessive gamers' hours at the computer have now topped scientists' efforts to improve a model enzyme, in what researchers say is the first crowd sourced redesign of a protein."[59] The use of games offers valuable ways for engaging citizen scientists, drawing on the vast amounts of free time that people are willing to devote to problem solving just because they want to. "[T]he average young person today in a country with a strong gamer culture will have spent 10,000 hours playing online games by the age of twenty-one. . . . [C]ollectively all the World of Warcraft gamers have spent 5.93 *million* years solving the virtual problems of [that particular game world]."[60] Foldit harnesses this energy to solve difficult and data-intensive problems, serving as the flagship game for the concept of using crowds to solve complex scientific problems.[61]

This system of intellectual production relies upon non-market mechanisms of trust, benefit-sharing, and reciprocity. While the game is structured as a competition to get the highest score, competi-

57. *See, e.g.*, Bruno Kestemont, *Actual Competitors for the Global Score*, FOLDIT (Oct. 25, 2013, 9:46 AM), http://fold.it/portal/node/996160.

58. *See* Seth Cooper et al., *Predicting Protein Structures with a Multiplayer Online Game*, 466 NATURE 756, 756 (2010).

59. Jessica Marshall, *Victory for Crowdsourced Biomolecule Design: Players of the Online Game Foldit Guide Researchers to a Better Enzyme*, NATURE (Jan. 22, 2012), http://www.nature.com/news/victory-for-crowdsourced-biomolecule-design-1.9872.

60. *See* Jane McGonigal, Gaming Can Make a Better World, Address at TED Conference (Feb. 2010) (emphasis added), *available at* http://www.ted.com/talks/jane_mcgonigal_gaming_can_make_a_better_world.

61. *See, e.g.*, John Walker, *The Inaugural Horace Awards for Forgotten IGF Entrants*, ROCK, PAPER, SHOTGUN (Jan. 8, 2013, 9:00 PM), http://www.rockpapershotgun.com/2013/01/08/the-inaugural-horace-awards-for-forgotten-igf-entrants/ (discussing the Foldit game in the wake of results on the winners of the Fifteenth Annual Independent Games Festival, which is well known in the video game industry, and suggesting it should be recognized with the Horace Award for Actually Advancing Science).

tion among the players is moderated by the fact that there are no monetary consequences attached to having a winning score. Moreover, the results of gameplay are portrayed as contributions to the public domain of scientific knowledge. The Foldit site explains that diversity advances this knowledge, so even those with lower scores feel they are doing something important. The low-level incentives to win are combined with norms of sharing and open communication to foster a collaborative environment.[62] Members are encouraged to communicate, share ideas, and troubleshoot through the Foldit blog, forum, wiki, or through sharing "recipes" useful in solving various puzzles. The importance of sharing as a fundamental value for the community is highlighted in the Foldit Terms of Service, which remind members that: "We are sharing what we learn with others from all over the world. That is how science is done. We have to share so others can learn, too."[63] Reciprocity in the exchange of ideas is also encouraged. It is encouraged through member interests in sustaining a robust forum for troubleshooting and a library of shared recipes to advance gameplay. There is also a built-in reciprocal exchange between the players and Foldit. With the consent of the players, the Foldit project continuously gathers and analyzes gameplay data such as biochemical structures, algorithms, and tool and algorithm usage that may have research benefits, and in return the project agrees to give attribution to the players who make discoveries and to make these discoveries publicly available.

Out of this collective effort has come publishable results and novel discoveries.[64] While scientific publications co-authored by video game players may seem unusual, this could become the norm in at least some areas of science if crowd science continues to progress at its current rate. The Foldit community is large and growing. In January 2012, the game had 240,000 registered players and approximately 2200 active players.[65] In January 2014 the game appears to have almost doubled this number of registered players and more than doubled the number of active players.[66] The game continues to expand not just its number of players, but also the reach of its problem-solving power. Most recently, the creators of the game have turned their eyes to the design of new therapeutic enzymes and even small

62. Foldit community rules can be found online at *Community Rules*, FOLDIT, http://fold.it/portal/communityrules (last updated Apr. 18, 2013).

63. *Foldit Terms of Service and Consent*, *supra* note 55.

64. *See, e.g.*, Khatib et al., *supra* note 49, at 1175 (listing authors as including the "Foldit Contenders Group" and the "Foldit Void Crushers Group").

65. Marshall, *supra* note 59 (noting that active players are players who have logged in and been active on the web site within the last week as measured on a particular day).

66. *See Top Evolvers*, FOLDIT, http://fold.it/portal/players (last visited Mar. 22, 2014).

molecule design, taking the crowdsourcing approach into the realm of drug development.[67]

As puzzles move into areas with more direct commercial potential, however, tensions between the non-market mechanisms on which Foldit relies and proprietary interests enabled by patenting are likely to emerge. Analogies can be drawn to the tensions that have emerged in many areas of academic science as the distinction between research and commercial application has blurred.[68] During its first few years the Foldit website provided little information on intellectual property ownership, not seeing it as something that was needed. In response to queries by its participants, the site administrators/founders stated that the "Foldit project was initiated with the goal of democratizing science, and we stand behind that. [T]he process of discovery and the eventual results of game play will all be open domain."[69] In line with the original game philosophy of democratic science, the founders of the game then asked the game participants for their views on intellectual property ownership. Developer chat discussions in 2012 were used to flesh out what a Foldit intellectual property ownership policy should look like.[70]

The community discussions about intellectual property ownership raised a number of important issues about how patents might impact Foldit. Some Foldit members focused on negative effects that patenting of results might have on the intrinsic motivations and norms of sharing that motivate the game. They expressed the view that Foldit is a public, volunteer-driven process, and therefore all ideas and contributions should remain public.[71] Others focused more on the challenges of benefit-sharing in a system that works best when it is collaborative and invites cumulative refinements of ideas by competing members of the game. Many of the contributions take the form of computer recipes for improving game play, contributions which may

67. Rebecca Hersher, *FoldIt Game's Next Play: Crowdsourcing Better Drug Design*, SPOONFUL OF MEDICINE, NATURE MED. (Apr. 13, 2012, 4:35 PM), http://blogs.nature.com/spoonful/2012/04/foldit-games-next-play-crowdsourcing-better-drug-design.html?WT.mc_id=TWT_NatureBlogs.

68. *See, e.g.*, Robert P. Merges, *Property Rights Theory and the Commons: The Case of Scientific Research*, *in* SCIENTIFIC INNOVATION, PHILOSOPHY, AND PUBLIC POLICY 145 (Ellen Frankel Paul, Fred D. Miller, Jr. & Jeffrey Paul eds., 1996). I have explored the challenges that patents create in biomedical research at greater length. Liza Vertinsky, *Universities as Guardians of Their Inventions*, 2012 UTAH L. REV. 1949.

69. Zoran, Comment to *Set My Mind at Ease*, FOLDIT (Mar. 22, 2009, 3:31 AM), http://fold.it/portal/node/267249.

70. *See Developer Chat*, FOLDIT (June 1, 2012), http://fold.it/portal/node/992849.

71. *See, e.g.*, GlaciusCool, Comment to *Foldit Ownership Policy*, FOLDIT (May 31, 2012, 1:25 AM), http://fold.it/portal/node/992792 ("That which is created by the public should remain in the hands of the public for the benefit of all human kind. Scientific discovery—even if it's just a molecular recipe—should be used by and available to all who seek the knowledge.").

not themselves be patentable or serve as patent-invalidating prior art but which could lead to the discovery of something that is. Participants might not be willing to share their recipes freely if they thought that someone else could use them to make and appropriate results for private commercial gain. Other issues raised by Foldit members focused on the practical challenges, transaction costs, and administrative headaches that patents might create. Participants worried about what formula would be used to allocate rights in a way that fairly rewarded performance, and whether it would be possible to discern who the co-inventors of an invention are in the context of cumulative contributions. The possibility that some contributions might come from employees with preexisting obligations to their companies created a further layer of complexity and concern.

Ultimately, the Foldit administrators proposed the following ownership provision, guided no doubt by the University of Washington Center for Commercialization:

> Scientific discoveries will be made publicly available and the University of Washington will handle ownership of discoveries. All significant scientific discoveries (such as structures, algorithms, etc) made in game will be made publicly available. In the event that some discoveries may warrant patent protection, University of Washington will handle the patent application process. US patent law will govern IP attribution for each discovery. Individual players who contributed to the discovery will be considered co-inventors for any discovery produced through play.[72]

A few things are notable about this policy. First, the University of Washington plays a direct role in managing patent choices. The University of Washington has an active technology transfer center, the Center for Commercialization, and its intellectual property policies and licensing practices reflect traditional assumptions about patenting and technology transfer. The University's intellectual property policies are "intended to show the University's positive attitude toward transfer of results of its research to the private sector" and are based on the assumption that "it is generally in the best interests of the University and the public that patents be obtained and/or licenses granted."[73] This approach conflicts with one focused on the free and open sharing and use of ideas.

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72. *Foldit Terms of Service and Consent*, *supra* note 55; *see also* Seth Cooper, Comment to *Foldit Ownership Policy*, FOLDIT (June 4, 2012, 5:48 PM), http://fold.it/portal/node/992792 (announcing a draft ownership policy).

73. PRESIDENT OF THE UNIV. OF WASH., EXEC. ORD. NO. 37: PATENT, INVENTION, AND COPYRIGHT POLICY (last updated Oct. 27, 2003), *available at* http://www.washington.edu/admin/rules/policies/PO/EO36.html.

Second, while the implication is that inventors will be the owners of their inventions, the policy is not clear about what rights the University will have, what rights the inventors will have, and what restrictions will be imposed on participant inventors who end up with ownership rights over a patented invention. The policy indicates only that the University will handle ownership and that significant scientific discoveries will be made publicly available. Perhaps in response to concerns about the sustainability of a public domain approach, the Foldit developers, who are University of Washington employees, have announced to the Foldit community that they have committed to assign all proceeds from any patents on inventions that they discover back to the development of the Foldit community.

Third, although the policy provides that "[i]ndividual players who contributed to the discovery will be considered co-inventors for any discovery produced through play,"[74] joint inventorship is determined solely by patent law.[75] In some cases, individuals might think that they are co-inventors when they are not, since the statutory definition of joint inventorship is narrower than the policy suggests.[76]

Finally, the Foldit Terms of Service can be changed at any time, leaving the University to reconsider its stance on ownership should the Foldit game start to yield results that are commercially lucrative.

While the concerns of the Foldit members have yet to be realized, the potential of the game to aid in areas of commercial interest, such as drug discovery, will inevitably increase tensions between the system of volunteer contributions and sharing on the one hand and patenting and revenue sharing on the other hand.[77] One of the remark-

74. *Foldit Terms of Service and Consent*, *supra* note 55.

75. Joint inventorship is legally determined under patent law based on involvement by each inventor in the original conception of the invention. *See, e.g.*, Burroughs Wellcome Co. v. Barr Labs. Inc., 40 F.3d 1223, 1227 (Fed. Cir. 1994). The contributor must have in mind and be contributing to the idea of the complete and operative invention, which would require knowledge of the entire invention and not just an understanding that some kind of discovery is likely to result. Reducing the invention to practice, while a valuable contribution, is not an inventorship contribution. *Id.* at 1228. While each joint inventor must contribute to the conception of the invention, it is enough to contribute to one claim. 35 U.S.C. § 116 (2012). While there must be some element of joint behavior involved, a loose collaboration, "working under common direction," or even "one inventor seeing a relevant report and building upon it," may be enough. Kimberly-Clark Corp. v. Procter & Gamble Distrib. Co., 973 F.2d 911, 916-17 (Fed. Cir. 1992). If joint inventorship has occurred, the U.S. patent application must name all of the inventors. In the absence of any agreement to the contrary, the joint inventors are joint owners of the patent and can independently exploit the benefits of the patent. 35 U.S.C. § 262 (2012).

76. For an interesting discussion of some of the problems caused by this disconnect between common understandings and legal definitions of joint inventorship, see Aaron Fellmeth, *Conception and Misconception in Joint Inventorship*, 2 N.Y.U. J. INTELL. PROP. & ENT. L. 73, 77-78 (2012).

77. *See, e.g.*, Merges, *supra* note 68 (noting the tensions that patents create in academic science).

able features of the Foldit community is the willingness of game players to share the recipes that they develop to solve protein structure puzzles.[78] This sharing helps to sustain the evolvers, who copy and build on the game strategies used by others, and also aids the general population of game players. These recipes function like research tools, serving as critical inputs into the processes that lead to discoveries about protein folding without describing such discoveries or being independently patentable.

The ability to patent a discovery that may have commercial value will make participants less willing to share their game strategies for a number of reasons. First, participants will be less willing to reveal game strategies, including the software code that enables these strategies, if there is a chance that a third party will take this information and use it to make proprietary discoveries that are not in turn shared with the group. The nature of the information that is shared in the exchange of recipes is unlikely to give these participants any claim as a joint inventor and is unlikely to constitute prior art, leaving them with little ability to either block the patent or share in its control.

Second, patenting will shift attention from the intrinsic motivation of obtaining a high score to the extrinsic motivation of obtaining commercially valuable intellectual property. Those who have contributed significant ideas that are not patentable may have to sit by and watch as their contributions lead to commercially lucrative patentable inventions that benefit others. The rules around coauthorship and the ability to be expansive in attributing coauthorship at low cost make joint authorship a useful way of respecting group contributions. The approach does not translate well into situations of joint inventorship, since contributions will typically take the form of tools that make discovery more likely rather than contributions to the conception of the invention.[79] Members may even have incentives to drop out of the game and seek patent protection for discoveries that they would not have made but for access to the ideas contributed by other players.

78. As one high-scoring player of Foldit explained during an interview, "I shared BF [blue fuse tool] fully because Foldit is so much more than a game—the competition is serious and fierce, but we are also trying to improve the understanding of huge biological proteins. We collaborate and compete at the same time." *Researchers Uncover Foldit Gamers' Strategies*, DRUG DISCOVERY & DEV. (Nov. 8, 2011, 11:16 AM), http://www.dddmag.com/news/2011/11/researchers-uncover-foldit-gamers'-strategies.

79. In the scientific world, journal articles often include a variety of contributors, including those who have performed experiments or contributed hard work to generate the results. In contrast, joint inventorship is legally determined under patent law based on involvement by each inventor in the original conception of the invention. For further discussion of joint inventorship, see *supra* notes 75-76.

Third, if and when Foldit moves into areas where it competes with commercial players, particularly if it partners with pharmaceutical companies or other private companies, there will be stronger pressures on the administrators of the Foldit game to limit the public use of the discoveries generated. Where discoveries have identifiable commercial applications, the financial incentives to limit information sharing and to restrict use of the discoveries will be larger. In addition, if commercial partners play a bigger role in the game, the very different norms and rules governing commercial drug development will influence the ways in which the game is organized and the results are shared.

While these harms remain primarily prospective for now, the risks that market-based incentives may crowd out non-market mechanisms of cooperation have been well documented in other similar areas and should not be ignored.[80] Crowding out occurs when one approach to incentivizing participation has a negative impact on another.[81] It can occur in a variety of different ways, including internal displacement of intrinsic motivations and disruptions of the system through the actions and pressures of participants from outside of the system.[82] In projects like Foldit, the social value of contributing to the project and the enjoyment derived from playing games in an open science context, as well as the commitment of Foldit administrators to open science, may eventually be overshadowed by financial incen-

80. As described by Yochai Benkler, "[w]e have now . . . almost two decades of literature in experimental economics, game theory, anthropology, political science field studies, that shows that cooperation in fact does happen much more often than the standard economics textbooks predict, and that under certain structural conditions non-price-based production is extraordinarily robust. The same literature also suggests that there is crowding-out, or displacement, between monetary and non-monetary motivations as well as between different institutional systems: [sic] social, as opposed to market, as opposed to state." Yochai Benkler, Comment to *Calacanis's Wallet and the Web 2.0 Dream*, ROUGH TYPE (July 28, 2006, 11:22 AM), http://www.roughtype.com/?p=466; *see also* Yochai Benkler, *Coase's Penguin, or, Linux and* The Nature of the Firm, 112 YALE L.J. 369 (2002) [hereinafter Benkler, *Coase's Penguin*].

81. "Crowding out, or the non-separability of social preferences from the introduction of explicit extrinsic motivation, poses a systemic challenge to using traditional, incentives-based mechanisms, both private and public, for eliciting desirable behavior." Benkler, *supra* note 1, at 307; *see also* Samuel Bowles, *Policies Designed for Self-Interested Citizens May Undermine "The Moral Sentiments": Evidence from Economic Experiments*, 320 SCI. 1605 (2008). One of the most widely debated examples of crowding out is the use of payments to encourage blood donations, which pits an economic framework for blood donations against a system of altruistic unpaid donors. *See, e.g.*, RICHARD M. TITMUSS, THE GIFT RELATIONSHIP 158-59 (1971); Alena M. Buyx, *Blood Donation, Payment, and Non-Cash Incentives: Classical Questions Drawing Renewed Interest*, 36 TRANSFUSION MED. & HEMOTHERAPY 329, 329-30 (2009) (exploring strategies for creating well-designed non-cash incentives which cut across the rigid dichotomy of altruistic donation versus payment).

82. *See, e.g.*, OSTROM, *supra* note 25; SUCCESSFUL MANAGEMENT BY MOTIVATION: BALANCING INTRINSIC AND EXTRINSIC INCENTIVES (Bruno S. Frey & Margit Osterloh eds., 2002).

tives, such as patent royalties. The financial incentives might thus crowd out social motivations. This kind of displacement poses an undeniable risk for open source, volunteer-driven models of innovation like Foldit.[83] Sustaining the kinds of non-market mechanisms that support Foldit, including the important mechanisms of trust, benefit-sharing, and reciprocity, will undoubtedly become harder in the presence of patents.[84] Ironically, the more successful the non-market mechanisms are in generating inventions, the more likely it is that they will come under challenge.

2. Open Source Software: The Example of Linux

> *"No one 'owns' the software in the traditional sense . . . . The result has been the emergence of a vibrant, innovative and productive collaboration, whose participants are not organized in firms and do not choose their projects in response to price signals."—Yochai Benkler* [85]

The second example is drawn from open source software.[86] Open source software projects have proven to be a significant economic and social phenomenon, particularly in the context of software development.[87] Sourceforge, which is one of the main internet sites hosting open source software projects, lists more than 4.8 million daily downloads, more than 430,000 open source software projects involving more than 3.7 million developers. Its directory connects more than 41.8 million consumers with these open source projects.[88] While most of these projects are small, some, such as the Linux operating system, the Apache web server software, the MySQL database, and the Firefox web browser, are massive and compete with established proprietary software products. The open source smartphone operating

83. For discussions of intrinsic versus extrinsic motivations and the crowding-out effects of carrot and stick approaches, see DANIEL H. PINK, DRIVE: THE SURPRISING TRUTH ABOUT WHAT MOTIVATES US 3-4, 8-9, 17-21 (2009).

84. As noted earlier, there are many reasons why people become involved in projects like Foldit, and the three mechanisms described here are meant simply to capture the ways in which these cooperative systems sustain the involvement of these diverse participants with their diverse motivations and interests.

85. Benkler, *Coase's Penguin*, *supra* note 80.

86. Much has been written about the free and open source software movement. For a good overview from an intellectual property perspective, see Vetter, *supra* note 26.

87. *See, e.g.*, Eric von Hippel & Georg von Krogh, *Open Source Software and the "Private-Collective" Innovation Model: Issues for Organization Science*, 14 ORG. SCI. 209, 209 (2003) (discussing history of open source software and its emergence as major cultural and economic phenomenon); *see also* ERIC S. RAYMOND, THE CATHEDRAL AND THE BAZAAR: MUSINGS ON LINUX AND OPEN SOURCE BY AN ACCIDENTAL REVOLUTIONARY (1999).

88. SOURCEFORGE, http://sourceforge.net/about (last visited Mar. 22, 2014).

system Android, for example, which is closely tied to Linux, was estimated to have seventy percent of the smartphone market in 2012.[89]

Open source software projects deviate from private proprietary models of software development in at least two important ways.[90] First, most truly open source software projects are fueled at least in part by software developers who are primarily intrinsically rather than extrinsically motivated to participate. People contribute to the project because they want to, whether to solve their own problems, contribute to a community that they have benefited from in the past, gain a reputation, or as an outlet for creativity.[91] Second, participants freely reveal the software that they have developed in ways that allow other participants not only to use it, but also to modify and build upon it.[92] These characteristics are combined with organizational innovations that allow people to contribute to the software project in a massively distributed, decentralized way, and with very low transaction costs. These open source software systems show how valuable products can be developed in systems that are based upon the free contribution and sharing of ideas.[93]

While a few open source software systems, such as Linux and its stepchild Android, have been able to compete with proprietary products, the costs of doing so in the presence of an increasing number of software patents have been large. These costs include millions of dollars spent by Linux and Android users in obtaining patents solely for defensive purposes, the development and refinement of defensive patent pooling and licensing organizations and strategies, time spent trying to invalidate patents that might impede use of Linux, and foreclosure of potentially valuable development paths for Linux

89. *See, e.g.*, Nirav Patel, *Apple's iPhone Is Losing Market Share as Android Gets 70% of the Smartphone Market*, GADGET MASTERS (Jan. 28, 2013), http://www.thegadgetmasters.com/2013/01/28/apple-iphone-is-losing-market-share-as-android-gets-70-of-the-smartphone-market/.

90. For an overview of open source software and its implications and intersections with intellectual property, see, for example, Maurer & Scotchmer, *supra* note 15.

91. *See, e.g.*, Jürgen Bitzer et al., *Intrinsic Motivation in Open Source Software Development*, 35 J. COMP. ECON. 160, 162 (2007); Georg von Krogh et al., *Carrots and Rainbows: Motivation and Social Practice in Open Source Software Development*, 36 MIS Q. 649, 652 (2012); Chorng-Guang Wu et al., *An Empirical Analysis of Open Source Software Developers' Motivations and Continuance Intentions*, 44 INFO. & MGMT. 253, 254-55 (2007). *But see, e.g.*, Sharon Belenzon & Mark Schankerman, Motivation and Sorting in Open Source Software Innovation (Nov. 5, 2012) (unpublished manuscript), *available at* https://faculty.fuqua.duke.edu/~sb135/bio/Belenzon%20Schankerman%20OSS%20July%202012.pdf (examining observed pattern of contributions to open source software projects to extract revealed preferences of developers and illustrating the importance of understanding incentives heterogeneity in open source contributions).

92. *See* von Hippel & von Krogh, *supra* note 87 (describing open source software development systems, referring to them as illustrations of a private-collective model of innovation that occupies the middle ground between private investment and collective action).

93. *Id.*

where such paths fall outside of the protective boundaries established by large corporate users of open source.[94] Moreover, other promising open source systems switch course or even shut down when confronted with real or imagined patent threats.[95] I focus on the story of Linux and the patent shadows created by Microsoft's patents for two reasons. First, this story illustrates the susceptibility of even the most successful open source models to patent threats. Second, it demonstrates the difficulties that open source software supporters face in reducing patent threats.[96]

Linux was one of the pioneering free and open source software projects. It has its roots in the intertwined ideologies and development models generated by early free software and open source software movements, which are collectively referred to as Free and Open Source Software (FOSS).[97] At a general level, FOSS is software which is made freely available, in both object and source code form, for anyone to use, copy, modify, and distribute, thus enabling people to voluntarily improve the design of the software.[98] On a closer look, however, FOSS refers both to an ideology about the freedom to use, modify, and share this resource, which lies at the core of the Free Software Movement, and to a methodology for peer-to-peer development, which is the focus of the Open Source Movement.[99]

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94. For a discussion of some of these costs, see, for example, Deborah Nicholson, *Open Invention Network: A Defensive Patent Pool for Open Source Projects and Businesses*, 2012 TECH. INNOVATION MGMT. REV. 12. For a discussion of recent efforts by Microsoft to raise the costs for a number of Android manufacturers through threats of patent infringement suits and licensing deals with large royalties and very restrictive licensing terms, see, for example, Michele Boldrin & David K. Levine, *The Case Against Patents* (Fed. Reserve Bank of St. Louis, Working Paper No. 2012-035A, 2012), *available at* http://research.stlouisfed.org/wp/2012/2012-035.pdf (discussing impact of patents in Android context); Tom Warren, *Barnes & Noble "Exposes" Microsoft's Android Patent Fees and Strategy*, WINRUMORS (Nov. 14, 2011, 6:53 PM), http://www.winrumors.com/barnes-noble-exposes-microsofts-android-patent-fees-and-strategy/.

95. *See, e.g.*, Nicholson, *supra* note 94, at 14 (discussing chilling effect of potential patent threats on small companies and smaller projects even when no actual patent is asserted); Wen Wen et al., *Patent Commons, Thickets, and Open Source Software Entry by Start-Up Firms*, (Nat'l Bureau of Econ. Res., Working Paper No. 19394, 2013), *available at* http://www.nber.org/papers/w19394 (empirical study showing that rate of entry of start-up software firms increases with the size of open source software communities).

96. For an example of the power of open source software models as a substitute for traditional standard-setting approaches, see Greg R. Vetter, *Open Source Licensing and Scattering Opportunism in Software Standards*, 48 B.C. L. REV. 225 (2007).

97. *See, e.g.*, Vetter, *supra* note 26; *see also* WOLFGANG LEISTER ET AL., OPEN SOURCE, OPEN COLLABORATION AND INNOVATION 15-26, 47-78 (Wolfgang Leister & Nils Christophersen eds., 2012).

98. *See, e.g.*, *The Open Source Definition*, OPEN SOURCE INITIATIVE, http://opensource.org/osd (last visited Mar. 22, 2014); *What Is Free Software and Why Is It So Important for Society?*, FREE SOFTWARE FOUND., http://www.fsf.org/about/what-is-free-software (last visited Mar. 22, 2014).

99. For a related discussion of the causal factors underlying FOSS, see Greg R. Vetter, *Exit and Voice in Free and Open Source Software Licensing: Moderating the Rein over Software Users*, 85 OR. L. REV. 183 (2006). For the Free Software Movement's description of how they

While these two camps share many features, they have different views about what FOSS requires—disparities that quickly become apparent in their responses to proprietary uses of software.[100] The Free Software Movement believes that software should be free. To promote this goal and to protect the free use of software, it advocates that uses of and improvements to open source software should be made available on open source terms. Beliefs about freedom, fairness, and reciprocity lie at the center of the free software movement. The Open Source Software movement is less worried about proprietary software and proprietary use of FOSS, viewing open source more as a development methodology and less as a social movement.[101] Both groups share a reliance on swift trust and reciprocity, however, and beliefs about the value of open source software help to sustain norms of open access and sharing that are critical to open source software.[102] The entanglement of ideology and development methodology is important in explaining both the strengths and the vulnerabilities of even large and successful open source projects like Linux.[103]

Linux was developed pursuant to a unique collaborative development project,[104] and it remains one of the largest systems of collaborative development in the history of computing. As described by Eric Raymond in his seminal article *The Cathedral and the Bazaar*, "Who would have thought even five years ago (1991) that a world-class operating system could coalesce as if by magic out of part-time hacking by several thousand developers scattered all over the planet, connected only by the tenuous strands of the Internet?"[105] It encapsu-

differ from the Open Source Movement, see *Why "Free Software" Is Better Than Open Source*, GNU OPERATING SYS., https://www.gnu.org/philosophy/free-software-for-freedom.html (last visited Mar. 22, 2014) (noting that the movements "disagree on the basic principles, but agree more or less on the practical recommendations").

100. *See, e.g.*, Richard Stallman, *Free Software as a Social Movement*, ZNET (Dec. 18, 2005), http://www.zcommunications.org/free-software-as-a-social-movement-by-richard-stallman.

101. *See, e.g.*, Anne Barron, *Free Software Production as Critical Social Practice*, 42 ECON. & SOC'Y 597 (2013) (describing the contrast between the ideological approach of the free software movement and the pragmatic approach of the subsequent open source software movement).

102. *See, e.g.*, Osterloh & Rota, *supra* note 27; Osterloh, Rota & Kuster, *supra* note 31, at 2 ("The fragile balance between intrinsically and extrinsically motivated developers may be disturbed by the entrance of extrinsically motivated commercial firms into the world of open source.").

103. *See, e.g.*, Vetter, *supra* note 99 (exploring important aspects of this entanglement between ideology and methodology).

104. *See, e.g.*, LINUX FOUNDATION, http://www.linuxfoundation.org (last visited Mar. 22, 2014) (describing how Linux is built).

105. *See* Eric Steven Raymond, *The Cathedral and the Bazaar*, http://www.catb.org/~esr/writings/cathedral-bazaar/cathedral-bazaar/index.html (last updated Aug. 2, 2002) (contrasting two forms of software development, the hierarchical cathedral approach used in proprietary software and the decentralized, open, Internet-based development style used by Linux).

lates the powerful idea of software as a modular and communal Internet-based effort.[106] The source code of Linux is made available without charge, and with the ability to freely modify and use this code, pursuant to version two of a well-known free and open source copyright license called the General Public License (GPL).[107] The licensing model is a legal innovation, what has been referred to as legal jujitsu, designed to use intellectual property rights to preserve the open source nature of the project.[108] The GPL embodies principles of open access, free sharing, and reciprocity in its license restrictions and contractual obligations as a way of preserving and expanding the domain of open source software. While open source licensing strategies such as this one have helped to sustain open source efforts, the need for additional strategies to preserve open source has been widely acknowledged by proponents of open source.[109] In the case of Linux, backing by large corporate players was an essential part of its survival.

Linux rapidly gained popularity as an alternative to Microsoft's proprietary software operating system. In response, Microsoft began a concerted strategy to disadvantage Linux by encouraging companies to trade open source participation for financial gain and by getting the users of Linux to pay royalties to Microsoft. This included a controversial joint patent agreement between Microsoft and a company called Novell, Inc., a software company that had initially set itself up to compete with Microsoft using Linux-based open source

106. *See, e.g.*, LEISTER ET AL., *supra* note 97, at 47-78.

107. The GPL provides that software licensed under the GPL can be freely used, copied and modified, provided that any modifications and improvements to this software are also made available to the public in source code form under the same license terms. The first two versions of the GPL focused primarily on copyright, but a third version has been developed to address the significant challenges that software patents create for the open source process. *See GNU General Public License, Version 2*, GNU OPERATING SYS. (June, 1991), http://www.gnu.org/licenses/gpl-2.0.html; *GNU General Public License, Version 3*, GNU OPERATING SYS. (June 29, 2007), http://www.gnu.org/licenses/gpl.html; *see also* Robert W. Gomulkiewicz, *A First Look at General Public License 3.0*, 24 COMPUTER & INTERNET L. 15, 15 (2007). For critiques of GPL version 3 see, for example, James E.J. Bottomley et al., *Kernel Developers' Position on GPLv3: The Dangers and Problems with GPLv3*, LWN.NET (Sept. 15, 2006), http://lwn.net/Articles/200422/; John Carroll, *The Crux of the GPL Problem*, ZDNET (June 4, 2007, 7:42 AM), http://www.zdnet.com/blog/carroll/the-crux-of-the-gpl-problem/1707.

108. The GNU/Linux computer operating system includes the Linux kernel, an open source project initiated by Linus Torvalds in 1991, and GNU software emerging from the free software movement founded by Richard Stallman in 1985. Richard Stallman, *Linux and the GNU System*, GNU OPERATING SYS., http://www.gnu.org/gnu/linux-and-gnu.html (last updated Apr. 12, 2014). I focus here on the development of the Linux kernel, although the issues extend to the broader GNU/Linux operating system.

109. *See, e.g.*, Clark D. Asay, *A Case for the Public Domain*, 74 OHIO ST. L.J. 753 (2013); Jason Schultz & Jennifer M. Urban, *Protecting Open Innovation: The Defensive Patent License as a New Approach to Patent Threats, Transaction Costs, and Tactical Disarmament*, 26 HARV. J.L. & TECH. 1 (2012); Greg R. Vetter, *A Public Domain Approach to Free and Open Source Software?*, 75 OHIO ST. L.J. FURTHERMORE (forthcoming 2014).

software products.[110] Novell received large payments pursuant to its deal with Microsoft, and when the deal ended, a technology consortium led by Microsoft acquired key intellectual property assets from Novell for $450 million.[111] Members of the FOSS community criticized Novell for what they saw as a defection from group norms and a compromise of the interests of the free software community. Novell was seen as free-riding on the value created by the open source community and capitalizing on the holdup value of patents covering inventions used by the open source community. More importantly, the deal was seen as providing unwarranted legitimacy for patent claims made against Linux, creating a cloud of uncertainty and fear for users of Linux and deterring open source developers.[112]

Shortly after the first agreement with Novell was signed, Microsoft began making public claims that Linux violated more than 200 of Microsoft's patents—no fewer than 235 according to Microsoft's general counsel at that time.[113] The fact that the Linux source code is freely available allows patent holders to scrutinize the code for areas that might implicate their patents. The fact that the system involves combining and building on incremental contributions means that patents covering even small parts of the system may have tremendous holdup power. Since its initial claims of infringement, Microsoft has focused on systematically securing patent licensing deals from Linux users, although it has also relied on patent infringement litigation against select users of Linux.[114] Patent assertion entities such as IP Innovations, a subsidiary of Acacia Technologies, have also brought patent suits against prominent users of Linux such as Red Hat. Some speculate that Microsoft backed the Acacia litigation against Red Hat.[115] Red Hat, which provides services based

110. *See, e.g.*, Elizabeth Montalbano, *Update: Microsoft, Novell Strike Linux Deal*, COMPUTERWORLD (Nov. 2, 2006, 12:00 PM), http://www.computerworld.com/s/article/9004723/Update_Microsoft_Novell_strike_Linux_deal; Paul Krill, *The Microsoft-Novell Linux Deal: Two Years Later*, INFOWORLD (Nov. 18, 2008), http://www.infoworld.com/d/open-source/microsoft-novell-linux-deal-two-years-later-858.

111. *See* sources cited *supra* note 104.

112. *See, e.g.*, Katherine Noyes, *Microsoft's Hand in Novell Deal Bodes Ill for Linux*, PCWORLD (Nov. 22, 2010, 3:12 PM), http://www.pcworld.com/article/211414/microsofts_hand_in_novell_deal_bodes_ill_for_linux.html; TECHRIGHTS, http://www.techrights.org/home/ (last visited Mar. 22, 2014) (showing Roy Schestowitz is editor of the site).

113. *See, e.g.*, Mary Jo Foley, *Microsoft: Free and Open Source Software Violates 235 Microsoft Patents*, ZDNET (May 13, 2007, 4:46 PM), http://www.zdnet.com/blog/microsoft/microsoft-free-and-open-source-software-violates-235-microsoft-patents/436; Peter Lattman, *Patent Litigation's Battle Royale: Microsoft v. Open Source*, WALL ST. J., LAW BLOG (May 15, 2007. 9:21 AM), http://blogs.wsj.com/law/2007/05/15/patent-litigations-battle-royale-microsoft-v-open-source/.

114. *See, e.g.*, John C. Dvorak, *Microsoft's Nuisance Suit Strategy*, PC MAG. (Sept. 21, 2011), http://www.pcmag.com/article2/0,2817,2393361,00.asp.

115. *See, e.g.*, J. Nicholas Hoover, *Acacia Research, Linux Patent Adversary, Has Long Litigation History*, INFORMATIONWEEK (Oct. 12, 2007, 4:32 PM), http://www.information

on Linux, is often heralded as one of the open source software company success stories, making it a natural target for opponents of Linux. The company complains of having to routinely address "attempts to impede the innovative forces of open source via allegations of patent infringement."[116] General and widespread threats like those made by Microsoft increase the real and perceived risks and the transaction costs of contributing to and using open source software for all participants in the open source system, with the largest impact on developers and users who are not affiliated with and protected by large companies. Even small changes in cost and risk may deter many users of the resulting software, chill development efforts, and alter otherwise promising development paths.

The availability of software patents increased the commercial attractiveness of defecting from the FOSS community for Novell and increased the risks of third party patent infringement suits against community members.[117] These risks ultimately forced community members to rely heavily on the resources of large commercial participants such as IBM to protect Linux through defensive patenting strategies. Linux survived despite patent risks and costs largely by becoming an established part of the business model of major participants in the software industry.[118] By some estimates more than half of the companies in the Fortune 500 are using Linux in their data centers.[119] These large corporate users have invested significant resources both in the development and the protection of the Linux project.[120] In response to patent infringement threats made by Microsoft against Linux, large corporate users of Linux—i.e. IBM, NEC, Novell, Phillips, Red Hat, and Sony—set up the Open Invention Network

week.com/acacia-research-linux-patent-adversary-has-long-litigation-history/d/d-id/106 0255?; Roy Schestowitz, *Red Hat Pays Microsoft-Linked Patent Troll Again, Refuses to Provide Details*, TECHRIGHTS (May 25, 2013, 7:16 AM), http://techrights.org/2013/05/25/acacia-red-hat/.

116. *See, e.g.*, Soulskill, *Red Hat Settles Patent Case*, SLASHDOT (Oct. 4, 2010, 6:45 PM), http://linux.slashdot.org/story/10/10/04/2148218/red-hat-settles-patent-case?sdsrc=rel.

117. *See, e.g.*, Krill, supra note 110.

118. *See, e.g.*, Oliver Alexy & Markus Reitzig, *Private-Collective Innovation, Competition, and Firms' Counterintuitive Appropriation Strategies*, 42 RES. POL'Y 895 (2013) (examining role of exclusion rights for technology in competition between private-collective and other innovators); Joel West, *How Open Is Open Enough? Melding Proprietary and Open Source Platform Strategies*, 32 RES. POL'Y 1259 (2003) (examining hybrid strategies and contrasting them with purely open and purely proprietary software alternatives).

119. Parloff, *supra* note 11.

120. *See, e.g.*, Dan Woods, *Can Intel Heal the Hadoop Open Source Ecosystem?*, FORBES (Feb. 26, 2013, 9:22 AM), http://www.forbes.com/sites/danwoods/2013/02/26/can-intel-heal-the-hadoop-open-source-ecosystem/2/ ("In the Linux community the primary contributors are those who benefit from using Linux in their businesses. IBM, Intel, Google, HP, Oracle all make a pile of money because Linux solves a variety of problems for them. The amount of value that they receive from this use dwarfs that captured by Red Hat or Suse, the Linux distributors. Linux thrives because the big players take part of the massive revenue from the use value and invest heavily in large development teams.").

(OIN) in 2005 to acquire a portfolio of patents that could create problems for companies like Microsoft should they create problems for Linux users.[121] OIN is self-described as "an intellectual property company that was formed to promote the Linux system by using patents to create a collaborative ecosystem."[122] "Patents owned by OIN are available royalty-free to any [entity] or individual that agrees not to assert its patents against [the] Linux" system.[123] In addition, Open Source Development Labs, which is the consortium that promotes and coordinates Linux development, established its own patent commons to accept donations of rights to use patents.[124] The Patent Commons Project is self-described as creating an area of safety, "a preserve where developers and users of software can innovate, collaborate, and access patent resources in an environment of enhanced safety, protected by pledges of support made by holders of software patents."[125]

These patent pooling efforts can be seen as a way of trying to preserve the trust and reciprocity on which open source systems depend. Compliance with group norms is achieved by providing a patent shield for members who adhere to group norms. Reciprocity is enforced through contingent protections that are available only to participants who do not themselves assert their patents against other group members or protected open source projects. Other community responses to the patent threats have included Linux Defenders, an online clearinghouse for prior art designed to invalidate poor-quality software patents,[126] and a project called A Patent a Day, with its goal of identifying one Microsoft-owned patent every day that Linux potentially infringes with the goal of helping to get rid of the dependency on these patents and/or get rid of the patents.[127] These efforts illustrate the ways in which open source communities must participate in the patent system simply as a way of protecting their nonproprietary software systems from extinction.

Such efforts come with a very steep price tag both in terms of cost and in terms of increasingly centralized control over open source. Monitoring and acquiring patents are ironic ways for an open source

121. Nicholson, *supra* note 94, at 16; *see also* OPEN INVENTION NETWORK, http://www.openinventionnetwork.com (last visited Mar. 22, 2014).

122. Nicholson, *supra* note 94, at 16.

123. OPEN INVENTION NETWORK, *supra* note 121.

124. *See, e.g.*, Steve Hamm, *Linux Marches On*, BLOOMBERG BUSINESSWEEK (Nov. 16, 2005), http://www.businessweek.com/the_thread/techbeat/archives/2005/11/linux_marches_o.html; *see also* PATENT COMMONS, http://www.patentcommons.org (last visited Mar. 22, 2014).

125. PATENT COMMONS, *supra* note 124.

126. LINUX DEFENDERS, http://linuxdefenders.org (last visited Mar. 22, 2014).

127. *See* PatentSleuth, *Introduction Post: A Patent a Day Project*, LINUX PATENTS (July 4, 2009, 8:26 AM), http://linuxpatents.blogspot.com/2009/07/introduction-post-patent-day-project.html.

community to spend its funds. Reliance on defensive patenting and pooling strategies also changes the balance of power within the open source community, giving corporate participants with large patent holdings control over the directions that open source projects take. One of the largest corporate supporters of Linux, IBM, also regularly tops the list of patents filed at the U.S. Patent and Trademark Office.[128] Corporate patent holders like IBM have significant power in shaping the boundaries of protected open source software spaces, aligning the boundaries with their own private business interests and strategies. In addition to favoring some open source software projects but not others, commercial partners of the open source community tend to favor hybrid models in which proprietary and open source software development coexists.[129] While not everybody sees this shift towards hybrid models as a problem,[130] many members of the open source software community are skeptical that a balance of closed and open source software will survive.[131] Their concerns include the negative impact of hybrid models on the motivations supporting open source software communities, the shift in control over development paths for software that impacts private business interests, the high direct and indirect costs of defensive patents strategies that pervade this hybrid world, and the threats that patents will continue to pose for open source models not backed by large corporate users.[132]

Thus, while private orderings of intellectual property rights such as defensive patent pooling may serve to mitigate patent threats for open source software, they do so in a limited and costly way. Patents continue to challenge the viability of FOSS systems that rely on

128. *See, e.g.*, *IBM Earns Most U.S. Patents for 17th Consecutive Year; Will Offer Licenses to Patent Portfolio Management Know-How*, IBM (Jan. 12, 2010), http://www-03.ibm.com/press/us/en/pressrelease/29168.wss.

129. *See, e.g.*, *Open-Source Software: Going Hybrid*, ECONOMIST, (July 25, 2002), *available at* http://www.economist.com/node/1251254; Rosa Maria Ballardini, Proprietary Software vs. FOSS: Challenges with Hybrid Protection Models (May 2012) (Ph.D. dissertation, IPR Univ. Ctr.), *available at* http://www.iprinfo.com/julkaisut/verkkojulkaisut/ipr-series-b/en_GB/proprietary-software-vs-foss/_files/88742337887406149/default/B4_Ballardini_eng.pdf.

130. *See, e.g.*, Dreyfuss, *supra* note 9; Ronald J. Mann, *Commercializing Open Source Software: Do Property Rights Still Matter?*, 20 HARV. J.L. & TECH. 1, 3 (2006) (exploring the symbiotic relationship between proprietary and open source software); Jay P. Kesan, *The Fallacy of OSS Discrimination by FRAND Licensing: An Empirical Analysis* (Univ. of Ill. Coll. of Law Pub. Law & Legal Theory Res. Paper Series, Paper No. 10-14, 2011), *available at* http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1767083 (examining compatibility of OSS licenses with proprietary uses).

131. *See, e.g.*, Sonali K. Shah, *Motivation, Governance, and the Viability of Hybrid Forms in Open Source Software Development*, 52 MGMT. SCI. 1000 (2006). For a discussion of hybrid models and the issues that may arise, see, for example, Vetter, *supra* note 26.

132. *See, e.g.*, Arnold Polanski, *Is the General Public License a Rational Choice?*, 55 J. INDUS. ECON. 691 (2007) (showing that proprietary licensing can lead to a holdup problem which may terminate a sequence of innovation prematurely, and that free open source licensing may be able to avoid this).

keeping costs and risks low and adherence to community norms based on openness, trust, and reciprocity high.[133] I suggest that in the absence of larger patent reforms addressing concerns with software patents,[134] systematic efforts by courts to take into account the costs of patents in cooperative contexts may help to limit these costs and to support a greater diversity of open source software projects.

III. PATENT ROADBLOCKS

As cooperative systems such as crowd science and free and open source software develop, they must confront patent laws that are designed with a very different model of cooperation in mind. In some cases the incentives that patents create may interfere with the mechanisms of trust, benefit-sharing, and reciprocity on which these and other cooperative innovation systems rely, increasing collective action problems. In other cases, patent laws may help to solve collective action problems. Fashioning the right policy response requires closer scrutiny of the relationship between patent laws and intellectual production when private incentives and public interests diverge.[135]

Patents may impede the collective action needed to sustain cooperative innovation in two different ways. First, patents increase the incentives for individual members of a cooperative system to defect from group norms of open access and sharing. Where a member of a group has the opportunity to patent and privately exploit an invention that is useful to the group, this member will be less willing to share her ideas with the group and may be more likely to free ride on

133. For studies of the survival factors of open source software, see, for example, Kevin Crowston et al., *Free/Libre Open-Source Software Development: What We Know and What We Do Not Know*, 44 ACM COMPUTING SURV. 7:1 (2012); Vishal Midha & Prashant Palvia, *Factors Affecting the Success of Open Source Software*, 85 J. SYS. & SOFTWARE 895 (2012); Jing Wang, *Survival Factors for Free Open Source Software Projects: A Multi-Stage Perspective*, 30 EUR. MGMT. J. 352 (2012).

134. There is a rich literature identifying and responding to problems with software patents. *See, e.g.*, Kevin Emerson Collins, *Patent Law's Functionality Malfunction and the Problem of Overbroad, Functional Software Patents*, 90 WASH. U. L. REV. 1399 (2013); Mark A. Lemley, *Software Patents and the Return of Functional Claiming*, 2013 WIS. L. REV. 905 (2013); James Bessen, *A Generation of Software Patents*, (Bos. Univ. Sch. of Law, Working Paper No. 11-31, 2011) (critically examining software patenting practices and impact on social welfare).

135. For use of game-theoretic models to explore opportunities for using patents to improve cooperative outcomes, see, for example, Shubha Ghosh, *Patent Law and the Assurance Game: Refitting Intellectual Property in the Box of Regulation*, 18 CAN. J.L. & JURISPRUDENCE 307 (2005) (referencing the assurance game as an alternative way of thinking about the role of patent law in regulating innovation). Under the assurance game, more commonly known as the stag hunt, two hunters can jointly hunt a stag for high payoffs or individually hunt rabbits for smaller payoffs. If either hunts a stag alone, the chance of success is minimal. Hunting stags is most beneficial for the group but requires significant trust among its members. *See also* Ted Sichelman, *Quantum Game Theory and Coordination in Intellectual Property* (San Diego Legal Studs., Paper No. 10-035, 2010).

and exploit the ideas generated by the group. Additionally, a member may be driven against her interest to seek patent protection for protective reasons, fearing that others will appropriate the benefits from her contribution without sharing in return. Patents thus increase the individual payoffs from defecting from group norms and may reduce the payoffs from adhering to group norms. As a result, members of the group will have reduced expectations that other members will behave in accordance with group norms of open and free sharing, further weakening these norms. Members of the group might also place less value on non-market rewards within the group such as reputation.

Second, patents increase the risks to group members posed by third parties. The open and transparent nature of intellectual production in contexts of cooperative innovation makes it easy for third parties to assert patents against the group, and where third parties have patents covering technologies that are widely used by the group the third parties will have the ability to hold up the group and collect more than the incremental value of their technological contribution. Third parties may also be able to free ride on the intellectual production of the group without any reciprocating contributions. Even generalized threats of third party litigation increase transaction costs for developers and users of open source software by forcing them into defensive patent licensing and pooling arrangements which need to be maintained and enforced. This requires them to spend time examining potential patent risks and planning for potential patent infringement claims, and in some cases induces them to enter licenses and make royalty payments simply as a way of averting threats from aggressive patent holders.[136] Cooperative systems are particularly sensitive to these kinds of transaction costs, since they rely on large numbers of volunteers freely sharing ideas. Even small changes in the cost of participation—such as the need to reserve funds to respond to cease-and-desist letters from third parties, the learning costs associated with participating in defensive patent pools, the administrative costs associated with making and using software covered by a growing family of different open source software license agreements, and small changes in the risk of participation—may therefore interfere with the continuing operations of the group. In some cases, these groups survive only by aligning the activities of the group with the private interests of one or a few large players with deep pockets and vested interests in the innovation system. By increasing defections from group norms, and by increasing threats from

136. *See, e.g.*, Schultz & Urban, *supra* note 109 (surveying options and some of the costs involved with these options); *see also* Nicholson, *supra* note 94, at 14 (discussing some of the transaction costs and chilling effects of patents for open source software participants).

outside the groups, patents may sometimes threaten or distort valuable processes of cooperative innovation.

The disconnect between the needs of cooperative innovation and the incentives that patents create can be explained in part by patent law's attachment to an outdated model of innovation. The U.S. patent statute, as well as the broader international patent law framework now in place, is anchored on a paradigm of market-based, producer-driven innovation.[137] As a result, the patent statute and implementing laws and regulations deal primarily with the creation, definition, and enforcement of ownership rights over inventions and the administration of this process.[138] The right of the patent owner to exclude others from use of the invention forms the backbone of patent law, and most of the statute is devoted to defining and policing these rights. Patent remedies are designed to restore the patent owner to the status quo before infringement through the award of reasonable royalties, lost profits resulting from lost sales or price erosion,[139] and/or injunctive relief.[140] The statute pays much less attention to the source and nature of the inputs leading to invention,[141] and to how the subsequent patents are managed and used,[142] or, even more importantly, not used.[143]

Patent law does address issues of team production, but it does so largely with a focus on identifying the true inventors and protecting their collective rights through rules governing derivation and joint

137. *See, e.g.*, Rochelle Cooper Dreyfuss, *Commodifying Collaborative Research*, *in* THE COMMODIFICATION OF INFORMATION 397 (Niva Elkin-Koren & Neil Weinstock Netanel eds., 2002) (examining myth of the individual inventor and disjuncture between current IP law and issues of importance to collaborators).

138. *See* 35 U.S.C. (2012). Part I of the statute deals with the establishment and operation of the USPTO, and Part II focuses primarily on how to obtain a patent, including requirements for patentability. Part III focuses on protection of patent rights. Part IV deals with the Patent Cooperation Treaty, addressing international issues relevant to the Act.

139. Compensation to the patent owner extends even to harm from offers to sell. *See, e.g.*, Timothy R. Holbrook, *Liability for the "Threat of a Sale": Assessing Patent Infringement for Offering To Sell an Invention and Implications for the On-Sale Patentability Bar and Other Forms of Infringement*, 43 SANTA CLARA L. REV. 751, 756-64 (2003).

140. For a description and critique of this private law focus of patent remedies, see Sichelman, *supra* note 19.

141. *See, e.g.*, Mark A. Lemley, *Point of Novelty*, 105 NW. U. L. REV. 1253 (2011); Lemley, *supra* note 9; Sean B. Seymore, *Rethinking Novelty in Patent Law*, 60 DUKE L. J. 919, 929 (2011) (exploring complexity of ensuring that a patent does not issue if the public already possesses the invention, and joining "a larger project to bridge the disconnect between patent law and the norms of science").

142. *See, e.g.*, Herbert Hovenkamp, *Innovation and the Domain of Competition Policy*, 60 ALA. L. REV. 103 (2008) (discussing rules dealing with patent management confined to defining what constitutes infringement, remedies, and patent misuse).

143. *See, e.g.*, Oskar Liivak & Eduardo M. Peñalver, *The Right Not to Use in Property and Patent Law* (Cornell Law Sch. Legal Studs. Res. Paper Series, Research Paper No. 12-62, 2012), *available at* http://ssrn.com/abstract=2162667.

inventorship. Doctrines of derivation[144] and the shared ownership rules for co-inventors[145] protect the rights of those team members who have either made an invention that is misappropriated or made inventorship contributions to a collective invention. Pursuing derivation or joint inventorship claims is costly, however, and involves evidentiary burdens that may be difficult to satisfy in contexts of massively distributed innovation. In addition, these doctrines do little to recognize or protect many kinds of valuable contributions to the collective process of intellectual production. To be a joint inventor, an individual must contribute to the conception of the invention. This leaves out individuals who make contributions that increase the likelihood of discovery but do not contemplate the discovery and individuals who work hard to reduce the invention to practice. Derivation proceedings address only situations in which it can be shown that members of the group actually made an invention that the patent applicant took without authorization.[146] Again, this leaves out many situations in which the group performs the hard work needed to make discovery more likely through contributions such as research tools and ideas about paths not to take, as well as situations in which the group contributes to the reduction of the invention to practice. Moreover, both doctrines will be of limited practical relevance for many cooperative innovation projects that have limited budgets and

144. Derivation refers to situations in which an alleged inventor has derived the claimed invention from another. *See* 35 U.S.C. § 135 (2012). Derivation proceedings are costly and evidence intensive, requiring the challenging inventor(s) to file their own patent application, file a derivation petition within one year of the first publication of the claimed invention, show that the invention is "the same or substantially the same" as the earlier claim to the invention, provided a detailed explanation for claiming unauthorized derivation, and provide substantial evidence to support the petition. *See, e.g.*, *Derivation Proceeding: Overview*, AM. INVENTS ACT, http://www.aiarulemaking.com/rulemaking-topics/group-3/derivation-proceedings.php (last visited Mar. 22, 2014). For concerns about the limits of derivation proceedings, see, for example, N. Scott Pierce, *The Effects of the Leahy-Smith America Invents Act on Collaborative Research*, 94 J. PAT. & TRADEMARK OFF. SOC'Y 133 (2012); Joshua D. Sarnoff, *Derivation and Prior Art Problems with the New Patent Act*, 2011 PATENTLY-O PAT. L.J. 12; Dennis Crouch, *With 102(f) Eliminated, Is Inventorship Now Codified in 35 U.S.C. 101? Maybe, but not Restrictions on Patenting Obvious Variants of Derived Information*, PATENTLY-O (Oct. 4, 2012), http://www.patentlyo.com/patent/2012/10/with-102f-eliminated-is-inventorship-now-codified-in-35-usc-101.html.

145. Where an invention is made by two or more persons jointly, they are considered joint inventors even if they did not work together or make the same kinds or amount of contribution. 35 U.S.C. § 116 (2006). Unless otherwise agreed by contract, they are joint owners of the resulting patent and are free to use and authorize others to use the invention without the consent of or accounting to the other owners and all must join in an infringement suit based on the patent. 35 U.S.C. § 262 (2006).

146. *See supra* note 138; *see also* Gene Quinn, *First Inventor to File: USPTO Derivation Proceedings Go Final*, IPWATCHDOG (Sept. 10, 2012, 11:26 AM), http://www.ipwatchdog.com/2012/09/10/first-inventor-to-file-uspto-derivation-proceedings-go-final/id=27986/ (describing derivation proceedings).

a decentralized, volunteer-based project design that is poorly suited to the pursuit of legal measures.[147]

In addition to the doctrines relevant to team production discussed above, patent law has been amended in response to the special needs of collaborations among different entities, but once again its response has been largely confined to ensuring that inventions can be patented by at least one of the collaborators. When different entities collaborate to innovate, patent law has been adjusted to limit the barriers that sharing information may pose for patenting inventions that emerge from the collaboration.[148]

With respect to how subsequent patents are managed and used, or not used, the focus in patent law remains on the patent owner's rights to exclude others from using the patented invention. Little effort has been made to distinguish between socially beneficial and detrimental kinds of unauthorized patent use.[149] Defenses to infringement based on special circumstances of creation and use, such as independent discovery or experimental use, remain narrow even after changes introduced to patent law by the America Invents Act (AIA) to expand protections for prior inventors.[150] Third parties are generally not free to use the patented invention for any purposes, not even for experimentation or to confirm that the invention actually works as disclosed in the patent. Concepts of protecting certain kinds of publicly beneficial uses, such as the fair use found in copyright law, are missing altogether from the patent statute.[151]

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147. *See* Aaron X. Fellmeth, *Conception and Misconception in Joint Inventorship*, 2 N.Y.U. J. INTELL. PROP. & ENT. L. 73 (2012) (discussing problems with claim fixation in inventorship and consequences for collaborative research).

148. *See* Cooperative Research and Technology Enhancement (CREATE) Act of 2004, Pub. L. No. 108-453, 118 Stat. 3596 (amending Section 103 of the Patent Act). For a discussion of the CREATE Act, including some potential concerns that it may pose for participants in collaborations, see Liza S. Vertinsky, *Understanding and Applying the CREATE Act in Collaborations*, *in* 3 AUTM TECHNOLOGY TRANSFER PRACTICE MANUAL (3d ed. 2008); *see also* Pierce, *supra* note 144.

149. This may be changing, albeit in a limited way, as courts and perhaps even Congress respond to the challenges that patents covering standards essential to critical technologies have created. *See* Part IV.A.

150. *See, e.g.*, Lemley, *supra* note 9 (examining the disconnect between traditional theories of patent law and real-world experience, particularly in the context of independent invention). The AIA expands the protection for prior inventors. It provides a "prior use defense" to patent infringement that protects parties who can establish that they have in good faith commercially used a product or process covered by a patent at least one year before the earlier of the public disclosure or the effective filling date of the patent disclosing the invention. Although more robust than the one it replaced, it includes a number of limitations. *See* U.S. PAT. & TRADEMARK OFF., REPORT ON THE PRIOR USER RIGHTS DEFENSE (2012), *available at* http://www.uspto.gov/aia_implementation/20120113-pur_report.pdf.

151. *See, e.g.*, Maureen A. O'Rourke, *Toward a Doctrine of Fair Use in Patent Law*, 100 COLUM. L. REV. 1177 (2000) (arguing that new technology has put pressure on patent laws that increasingly interfere with follow on innovation, and proposes a doctrine of fair use in patent law to relieve some of this pressure); Katherine J. Strandburg, *Patent Fair Use 2.0*, 1 U.C.

Members of a community that contribute valuable ideas to the inventor are simply out of luck unless they have the resources and the ability to show that they are joint inventors, that their invention was derived from them, or that the patented invention would be obvious to individual community members in light of the combined knowledge and effort of the community.[152] Determining who contributed what to an invention in a collaborative effort is difficult, particularly where innovation takes the form of cumulative, incremental contributions by many participants.[153] Showing that an invention was derived from the cumulative, widely-shared discoveries of the group is likely to be both costly and challenging. The limits that non-obviousness imposes on patentability are also unlikely to provide adequate protection for collective intellectual production.[154] Even if a group can find and present prior art challenging the novelty of a patent, they must overcome the legal presumption that the patent is valid. This presumption holds regardless of whether the U.S. Patent and Trademark Office considered the prior art when granting the patent.[155] Patent law, both on the books and as applied, remains too heavily oriented around the patent ownership rights of the pioneering lone inventors and their assignees. In doing so, patent law neglects the needs of other very different forms of intellectual production such as cooperative innovation.[156]

This is not to suggest that patents are always or even mostly a constraint on innovation or that innovation would increase in the ab-

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IRVINE L. REV. 265 (2011) (arguing that there should be greater use of defenses and exemptions to patent infringement to respond to the different contexts in which inventions are used); *see also* 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) (arguing that a doctrine of fair use will help reduce negative externalities and clarify expectations on what type of infringement is actionable).

152. *See* 35 U.S.C. § 103 (2012) (addressing conditions for patentability and non-obvious subject matter); *supra* note 75 (discussing joint inventorship); *supra* note 144 (discussing derivation).

153. *See also* Dennis Crouch, *Inventorship: Limits of Collaboration*, PATENTLY-O (Apr. 1, 2013), http://patentlyo.com/patent/2013/04/inventorship-limits-of-collaboration.html (discussing outcome of Rubin v. Gen. Hosp. Corp., 523 F. App'x 719 (Fed. Cir. 2013)).

154. *See, e.g.*, Shawn P. Miller, *Where's the Innovation: An Analysis of the Quantity and Qualities of Anticipated and Obvious Patents*, 18 VA. J.L. & TECH. 1 (2012) (suggesting patents are being awarded with negligible innovation value); *see also* Gregory Mandel, *The Non-Obvious Problem: How the Indeterminate Nonobviousness Standard Produces Excessive Patent Grants*, 42 U.C. DAVIS L. REV. 57 (2008).

155. *See, e.g.*, Sciele Pharma Inc. v. Lupin Ltd., 684 F.3d 1253, 1260 (Fed. Cir. 2012).

156. While the requirement to disclose the invention could be seen as facilitating sharing, it is at best a limited form of sharing. *See* Timothy R. Holbrook, *Possession in Patent Law*, 59 SMU L. REV. 123, 132-34 (pointing out the disconnect between role of disclosure as teaching and theory of combating free-riding, suggests that we think of the function of disclosure as possession).

sence of patents.[157] Patents play important roles in attracting resources and providing market incentives for proprietary, producer-driven innovation.[158] Patents can also enable limited departures from closed, producer-driven systems of innovation by supporting open innovation models in which companies sell or license out unused technologies and acquire or license in third party discoveries.[159] Where patents interfere with cooperation that patent owners are interested in preserving, the patent owners can create their own contract-based forms of sharing and pooling patent rights. Patent pools,[160] licensing strategies that incorporate broader public objectives and public uses into the license terms,[161] and patent licensing strategies modeled on those employed by open source software,[162] can and do operate to preserve areas of cooperation.[163] Moreover, existing rules and doctrines such as joint inventorship and the limiting effects of prior art and derivation on patentability in contexts of cumulative intellectual production mitigate some of the incentive problems that patents might otherwise create for cooperative innovation.

While these legal tools and private arrangements are helpful in making room for cooperative innovation, they do not adequately address the harmful incentive effects of patents on non-market mecha-

157. *See, e.g.*, Jonathan M. Barnett, *Intellectual Property as a Law of Organization*, 84 S. CAL. L. REV. 785 (2011) [hereinafter Barnett, *Law of Organization*] (discussing the role of patents in supporting disaggregation of innovation process); Barnett, *The Illusion of the Commons*, *supra* note 20 (examining the importance of property in supporting sharing regimes).

158. Strong patent rights may facilitate coordination among many different market players by reducing transaction costs, solving problems of incomplete contracting, signaling firm value, or facilitating bargains over use of the patent rights. *See, e.g.*, Ashish Arora & Robert P. Merges, *Specialized Supply Firms, Property Rights and Firm Boundaries*, 13 INDUS. & CORP. CHANGE 451 (2004); Barnett, *Law of Organization*, *supra* note 157 (patents as facilitating specialization); Heald, *supra* note 20 (discussing the role of patents in solving team production problems and facilitating technology transfer through transaction cost savings); Kieff, *supra* note 20 (focusing on the role of patents in facilitating coordination among many diverse complementary users of an asset in a way that increases competition and access).

159. *See, e.g.*, Henry Chesbrough, *Open Innovation: A New Paradigm for Understanding Industrial Innovation*, *in* OPEN INNOVATION: RESEARCHING A NEW PARADIGM (Henry Chesbrough, Wim Vanhaverbeke & Joel West eds., 2006) (defining open innovation as "a paradigm that assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to market, as they look to advance their technology"); *see also* Barnett, *Law of Organization*, *supra* note 157.

160. *See, e.g.*, Robert P. Merges, *Institutions for Intellectual Property Transactions: The Case of Patent Pools*, BERKELEY L. (1999), https://2048.berkeley.edu/files/pools.pdf.

161. *See, e.g.*, Amy Kapczynski et al., *Addressing Global Health Inequities: An Open Licensing Approach for University Innovations*, 20 BERKELEY TECH. L.J. 1031 (2005); Peter Lee, *Contracting To Preserve Open Science: Consideration-Based Regulation in Patent Law*, 58 EMORY L.J. 889, 915 (2009).

162. *See, e.g.*, Schultz & Urban, *supra* note 109.

163. *See, e.g.*, Robert P. Merges, *A New Dynamism in the Public Domain*, 71 U. CHI. L. REV. 183 (2004) (examining private efforts to self-correct for excesses of patents).

nisms important to some forms of cooperative innovation. The doctrinal tools available to support collaboration remain tethered to a market-based, producer-driven model of innovation. They do little to support the kinds of exchanges that are needed in a volunteer-driven system of combined intellectual production. In many cases, the private measures are inherently incomplete, primarily or even solely defensive in nature, and often extremely expensive.[164] Some of the strategies used to preserve openness may even backfire if patents obtained for defensive purposes later become litigation tools.

Despite mitigating doctrines and private market responses,[165] patents as currently enforced can and do systematically and significantly disadvantage some forms of cooperative innovation.[166] Since it is effectively impossible to opt out of the patent system, change may be needed from within patent law to give forms of cooperative innovation that are vulnerable to patents a chance to compete.[167] In addition, the public nature of a change in the law might have expressive effects missing from private efforts to circumvent the law, effects that would help to strengthen group norms and values important to cooperative systems.[168]

In Part IV, I propose one way for courts to respond to the vulnerabilities of cooperative innovation systems without radically changing

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164. *See, e.g.*, Asay, *supra* note 109, at 805 (describing the costs involved in trying to preserve open systems of knowledge exchange through private orderings); Mattioli, *supra* note 17, at 108 (examining question of whether patent sharing reflects a form of market self-regulation, and critiquing view that private ordering can always correct for excessive apportionment of patent rights).

165. *See, e.g.*, U.S. DEP'T OF JUST. & FED. TRADE COMM'N, ANTITRUST GUIDELINES FOR THE LICENSING OF INTELLECTUAL PROPERTY §§ 3.4, 4, and 5.6 (1995), *available at* http://www.justice.gov/atr/public/guidelines/0558.pdf (discussing the use of the rule of reason to evaluate various kinds of IP agreements and arrangements); Sheila F. Anthony, *Antitrust and Intellectual Property Law: From Adversaries to Partners*, 28 AIPLA Q.J. 1 (2000) (discussing intersection of IP and antitrust, key focus of antitrust on precompetitive nature of various agreements and arrangements involving IP).

166. For example, as work by Nobel Prize winner Elinor Ostrom and others on the management of common pool resources has shown, external legal rights that control allocations within the group may interfere with valuable non-market forms of cooperation that could achieve better collective outcomes. *See, e.g.*, UNDERSTANDING KNOWLEDGE AS A COMMONS, *supra* note 31, at 7 (including design principles for managing the production of knowledge, viewed as a common pool resource; emphasizing importance of trust and reciprocity in sustaining cooperative systems; and emphasizing role of locally designed rules).

167. *See, e.g.*, Schultz & Urban, *supra* note 109, at 10.

168. *See, e.g.*, Jeanne C. Fromer, *Expressive Incentives in Intellectual Property*, 98 VA. L. REV. 1745, 1746 (2012) (exploring the role of expressive incentives, those that express solicitude for and protect a creator's strong personhood and labor interests, in patent law); Timothy R. Holbrook, *The Expressive Impact of Patents*, 84 WASH. U. L. REV. 573, 613 (2006) (exploring the expressive impact that patent law can have, looking at how the grant of a patent could communicate a message of inferiority to groups whose identity is tied to their biology); William Hubbard, *Inventing Norms*, 44 CONN. L. REV. 369, 391 (2011) (arguing that patent law has an important role to play in supporting "inventing norms" and that these inventing norms should be incorporated into traditional patent law analysis).

the patent system. Recent pressures on the patent system fueled by patent wars over the use of critical technology standards have created opportunities to make room for cooperative innovation in discussions about patent remedies. Rather than adding to the costs and uncertainties associated with broader judicial discretion in patent remedies, the principles I suggest might even act to limit existing uncertainties by providing a focal point for how patent remedies should be adjusted and limiting the areas in which they are to be adjusted.

IV. PATENT REMEDIES WITH COOPERATION IN MIND

Patent remedies have become the topic of increasing public interest and debate as the social costs of patent litigation mount and the divergence of public and private interests in laws governing patent remedies become more apparent.[169] In the pages that follow I show why, when, and how we should make patent remedies more responsive to the needs of cooperative innovation.

A. Remedies Without Context

Patent remedies have historically been based on measuring and awarding reasonable compensation for past infringement to the owner of a valid, infringed patent, generally accompanied by injunctive relief to preclude future infringement.[170] The patent owner has been entitled to no less than a reasonable royalty, generally defined as the royalty that a willing licensor and licensee would have agreed to at the time of the initial infringement.[171] Historically, courts would also routinely provide the plaintiff patent owner with injunctive relief preclud-

169. *See* James Boyle, *Open Source Innovation, Patent Injunctions, and the Public Interest*, 11 DUKE L. & TECH. REV. 30 (2012); Thomas F. Cotter, *Reining in Remedies in Patent Litigation: Three (Increasingly Immodest) Proposals*, 30 SANTA CLARA COMPUTER & HIGH TECH. L.J. 1 (2014); Ghosh, *supra* note 135; Golden, *supra* note 18, at 507 ("In legislative debates, public-choice concerns loom large, as proposed reforms appear commonly to track private, rather than necessarily public, interests."); Megan M. La Belle, *Patent Law As Public Law*, 20 GEO. MASON L. REV. 41 (2012); Rajec, *supra* note 19; Sichelman, *supra* note 19.

170. *See also* 35 U.S.C. § 284 (2006). The Patent Act provides that the owner of a valid, infringed patent is entitled to damages that are "adequate to compensate for the infringement, but in no event less than a reasonable royalty for the use made of the invention by the infringer" with the possibility of punitive damages for willful infringement. *Id.*

171. *See, e.g.*, Christopher B. Seaman, *Reconsidering the* Georgia-Pacific *Standard for Reasonable Royalty Patent Damages*, 2011 BYU L. REV. 1661, 1676-81 (discussing Federal Circuit approach to reasonable royalties). Monetary remedies for patent infringement may take the form of either lost profits or lost royalties. In practice, however, determining what the appropriate monetary remedies are has been "a complicated and confusing task." Roger D. Blair & Thomas F. Cotter, *Rethinking Patent Damages*, 10 TEX. INTELL. PROP. L. J. 1, 2 (2001) (providing overview of traditional approaches to lost profits and reasonable royalties and suggesting economic framework to aid in rethinking how patent damages are calculated).

ing further infringing activity by the defendant.[172] This approach to patent remedies aligns roughly with the reward function of patents within the traditional paradigm of producer-driven, market-based innovation. Focusing on compensation to the patent owner, however, may result in patent remedies that decrease rather than increase innovation in some contexts of cooperative intellectual production.[173]

One of the biggest limitations of the traditional approach to patent remedies has been its focus on the interests of the patent owner, to the exclusion of the interests of additional participants in the innovation process and the broader public interests in socially optimal levels of innovation.[174] Interests beyond those of the patent owner, including both the infringer and the public more generally, started to play a bigger role in the calculation of patent remedies following the Supreme Court decision in *eBay v. MercExchange* in 2006.[175] The Supreme Court held in *eBay* that injunctive relief in patent cases, just as in other types of cases, should not be presumed but rather should be determined based on the conventional four-factor test for injunctive relief.[176] The Supreme Court thus shifted the calculus used by courts when determining whether to award injunctive relief to the owner of an infringed patent by requiring courts to take the harm of an injunction to the public and the defendant explicitly into account.[177] Justice Kennedy's influential concurring opinion went on to

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172. *See, e.g.*, Richardson v. Suzuki Motor Co., 868 F.2d 1226, 1247 (Fed. Cir. 1989) ("It is the general rule that an injunction will issue when infringement has been adjudged, absent a sound reason for denying it.").

173. *See, e.g.*, Ted Sichelman, *Purging Patent Law of "Private Law" Remedies*, 92 TEX. L. REV. 517 (2014); *see also* Boyle, *supra* note 169, at 32-34 (outlining some of the ways in which open source innovation is particularly vulnerable to patent injunctions); Thomas R. Cotter, *Make No Little Plans: Response to Ted Sichelman,* Purging Patent Law of "Private Law" Remedies, 92 TEX. L. REV. 25 (2014); Paul J. Heald, *Optimal Remedies for Patent Infringement: A Transactional Model*, 45 HOUS. L. REV. 1165 (2008).

174. Patent remedies take the form of injunctive relief and damages. Damages are based on calculations of loss to the patent owner, either in the form of a patent owner's lost profits, price erosion, or reasonable royalties. *See, e.g.*, THOMAS F. COTTER, COMPARATIVE PATENT REMEDIES: A LEGAL AND ECONOMIC ANALYSIS (2013) (comprehensively discussing patent remedies in the United States and selected other countries). The works referenced in footnote 171 highlight various limitations of the traditional approach to remedies taken by the courts.

175. eBay Inc. v. MercExchange, LLC, 547 U.S. 388, 394 (2006) (holding that the well-established principles of equitable relief apply with equal force to disputes under the Patent Act).

176. *Id.* at 391-93. This case replaced the Federal Circuit's "general rule" in favor of granting injunctions based on a presumption of irreparable harm with a required balancing of interests. To obtain injunctive relief, the plaintiff must show that it has suffered irreparable harm, remedies available under the law are inadequate to compensate, the balance of hardships associated with injunctive relief favor the plaintiff, and the public interest will not suffer by the issuance of the requested injunction. *Id.*

177. *See, e.g.*, FED. TRADE COMM'N, THE EVOLVING IP MARKETPLACE: ALIGNING PATENT NOTICE AND REMEDIES WITH COMPETITION 253 (2011) [hereinafter FTC REPORT]; *see also*

suggest specific situations in which district courts might find injunctive relief inappropriate, such as patent assertion by non-practicing entities and situations of patent holdup.[178]

While *eBay* has made the role of the public interest explicit in determinations of injunctive relief, the case fails to provide principles to guide courts in their determinations of what the public interest is or how it should be measured.[179] Courts have taken into account a greater variety of factors when determining whether an injunction should be awarded, although many of these considerations remain focused on whether the patent owner will suffer irreparable harm due to the infringement through loss of market share, price erosion, difficulty in calculating damages, or harm to reputation or goodwill.[180] Whether the patent owner and infringer compete and whether the patent owner is a practicing entity appear to be important but not determining factors in predicting the availability of injunctive relief, and factors such as market structure and the relationship of the patented invention to the infringing product increasingly inform court decisions.[181] Despite the more contextualized analysis of the effects of infringement and injunctive relief, however, detailed analysis of the effects of injunctive relief on the broader public interest

Mark P. Gergen, John M. Golden & Henry E. Smith, *The Supreme Court's Accidental Revolution? The Test for Permanent Injunctions*, 112 COLUM. L. REV. 203, 204-05 (2012) (suggesting that the *eBay* case has launched a revolution in the law of equitable remedies beyond patent law).

178. *See, e.g.*, *eBay Inc.*, 547 U.S. at 395-97 (Kennedy, J., concurring).

179. *See, e.g.*, FTC REPORT, *supra* note 177, at 255 ("After enumerating the four equitable factors in the *eBay* decision, the opinion of the full Court gave little guidance on their application."); *see also* Scott A. Allen, *"Justifying" the Public Interest in Patent Litigation*, 88 IND. L.J. 1047, 1051 (2013).

180. FTC REPORT, *supra* note 177, at 215 (discussing the ways in which courts have considered and applied the four factors in the test for injunctive relief); *see also* James M. Fischer, *What Hath* eBay v. MercExchange *Wrought?*, 14 LEWIS & CLARK L. REV. 555, 564-65 (2010); Stephen E. Noona, *Permanent Injunctions for Patent Infringement in a Post* eBay *World*, INSIDE BUS. (Dec. 9, 2010, 4:12 AM), http://insidebiz.com/blogs/kaufman-canoles/permanent-injunctions-patent-infringement-post-ebay-world; Bryan J. Vogel & Shane St. Hill, *IP: Injunctions and Irreparable Harm After* eBay, INSIDECOUNSEL (June 19, 2012), http://www.insidecounsel.com/2012/06/19/ip-injunctions-and-irreparable-harm-after-ebay.

181. *See, e.g.*, FTC REPORT, *supra* note 177, at 259 (showing results of survey of case law); *see also eBay*, 547 U.S. at 393 (Supreme Court's warning against categorical rules in injunction analysis); Andrew Beckerman-Rodau, *The Aftermath of* eBay v. MercExchange*, 126 S. Ct. 1837 (2006): A Review of Subsequent Judicial Decisions*, 89 J. PAT. & TRADEMARK OFF. SOC'Y 631 (2007); Bernard H. Chao, *After* eBay, Inc. v. MercExchange*: The Changing Landscape for Patent Remedies*, 9 MINN. J.L. SCI. & TECH. 543 (2008) (arguing the importance of factors such as whether infringer is a competitor and showing of irreparable harm in post-*eBay* cases). For a more recent update that largely affirms the importance of whether the parties were competitors and the ability to show irreparable harm, see, for example, Barbara A. Fiacco, The Impact of *eBay v. MercExchange*, Presentation at the Duke Pat. Law Inst. (May 16, 2013) (presentation available at http://law.duke.edu/sites/default/files/centers/judicialstudies/patentlawintensive/Fiacco-May%2016%20eBay%20v%20MercExchange.pdf).

remains rare except in situations in which injunctions would have severe consequences for public health and safety or would significantly disrupt markets, or more recently in situations where patents cover important industry standards.[182] Instead of conducting a broader inquiry into the effects of injunctions on innovation, some courts still simply equate the public interest with supporting innovation through a strong patent system.[183] Although injunctive relief is no longer routine in the wake of *eBay*, injunctive relief seems to be based most frequently on a showing of irreparable harm to the patent owner and continues to be granted in the majority of cases.[184] Thus, while determinations of injunctive relief following *eBay* have moved patent remedies in the direction of reflecting a richer range of entitlements, I suggest that courts still have not adequately captured the public interest in limiting injunctive relief or given it sufficient context or weight.

This limited approach to the public interest may be starting to change, particularly in the context of cases involving patents that are essential to the use of important industry-wide technology stand-

182. *See, e.g.*, FTC REPORT, *supra* note 177, at 232-34 (discussing the role of public interest, including survey of cases that address public interest explicitly as part of decision to award or deny injunctive relief). Greater attention to the public interest does seem to occur in cases involving substantial network effects that are threatened by patents. *See, e.g.*, Apple, Inc. v. Samsung Elecs. Co., 909 F. Supp. 2d 1147, 1163 (N.D. Cal. 2012) (taking impact on consumers into account and denying injunctive relief despite status of parties as direct competitors); Apple Inc. v. Samsung Elecs. Co., 735 F.3d 1352, 1375 (Fed. Cir. 2013) (affirming District Court's denial of injunctive relief despite status of parties as direct competitors for design patents, but vacating denial of injunctive relief for utility patents).

183. FTC REPORT, *supra* note 177, at 270-271 ("Only a small number of post-*eBay* cases have provided an extended discussion of this factor in deciding whether to grant an injunction. In the majority of cases, courts simply recognize that the 'public has an interest in maintaining a strong patent system. This interest is served by enforcing an adequate remedy for patent infringement.' " (quoting TiVo Inc. v. Echostar Commc'ns Corp., 446 F. Supp. 2d 664, 670 (E.D. Tex. 2006)); *see also, e.g.*, Pozen Inc. v. Par Pharm., Inc., 800 F. Supp. 2d 789, 825 (E.D. Tex. 2011) (reasoning that an injunction served the public interest because it encouraged innovation by upholding patent owner's "right to exclude"); Zen Design Grp., Ltd. v. Clint, No. 08-cv-14309, 2009 WL 4050247, at *6 (E.D. Mich. Nov. 23, 2009) (reasoning that a permanent injunction served the public interest because, without it, the patent's actual value would be reduced to "a fraction of its intended value"); Funai Elecs. Co., Ltd. v. Daewoo Elecs. Corp., 593 F. Supp. 2d 1088, 1111 (N.D. Cal. 2009) ("Protection of the rights of patent holders is generally in the public interest.").

184. *See, e.g.*, FTC REPORT, *supra* note 177, at 217-218 ("Surveys of post-*eBay* cases reveal that district courts have granted approximately 72%–77% of permanent injunction requests."); *see also* Ernest Grumbles III et al., *The Three Year Anniversary of* eBay v. MercExchange*: A Statistical Analysis of Permanent Injunctions*, INTELL. PROP. TODAY, Nov. 2009, at 25, 26 (noting that seventy two percent of requests were granted through May 1, 2009, based on review of decisions available through Lexis); Erin Coe, *Injunctions Harder To Win in Post-*EBay *Courts*, LAW360 (Oct. 30, 2008, 12:00 AM), http://www.law360.com/articles/74829/injunctions-harder-to-win-in-post-ebay-courts; *Post-*eBay *Permanent Injunction Rulings in Patent Cases*, PATSTATS.ORG, http://www.patstats.org/Patstats2.html (last updated May 26, 2013) (showing that injunctions were granted in 167 cases and denied in 55 cases, that is, granted seventy-five percent of the time).

ards.[185] In a series of high-profile patent infringement cases involving patents covering technology standards used in the smartphone industry, courts have had to consider whether injunctive relief should be available where patent owners have previously agreed to license patents essential to the use of these standards on reasonable and non-discriminatory terms. In one of the first court decisions to weigh in on this matter, Judge Posner suggested that injunctive relief should not be available, emphasizing the harm to the public interest that such relief would impose.[186] Judge Posner went on to suggest that if the patent owner and infringer cannot agree on licensing terms, compulsory licensing with ongoing royalties should be used to resolve the dispute in a way that appropriately balances the harm to the patentee from infringement with the harm to the infringer and to the public from an injunction.[187] This approach focuses explicitly on what the public interest is and how it should be reflected in determinations of patent remedies in standard setting contexts.[188] While Judge Posner's willingness to radically reshape how remedies are calculated diverges from the mainstream,[189] his underlying message about the need to reconsider patent remedies in contexts where they may threaten important forms of coordination and cooperation is being taken seriously by policymakers. So far, however, this reconsid-

185. For an optimistic view of this change more generally, see, for example, Boyle, *supra* note 169. On the other hand, one fragmented opinion from the Federal Circuit illustrates the divergence of views held by judges in that court about when injunctive relieve should be available in the context of patents covering important industry standards. *See* Apple Inc. v. Motorola, Inc., Nos. 12-1548, 12-1549, 2014 WL 1646435, at *30-35 (Fed. Cir. April 25, 2014); *id.* at *36-37 (Rader, C.J., dissenting in part); *id.* at *43-46 (Prost, J., concurring in part and dissenting in part).

186. *See* Apple, Inc. v. Motorola, Inc. 869 F. Supp. 2d 901, 913-14 (N.D. Ill. 2012), *aff'd in part*, *rev'd in part*, *Apple Inc.*, 2014 WL 1646435. (suggesting that the purpose of the fair, reasonable, and non-discriminatory terms (FRAND) requirement is "to confine the patentee's royalty demand to the value conferred by the patent itself as distinct from the additional value—the hold-up value—conferred by the patent's being designated as standard-essential"). *But see Apple, Inc.*, 2014 WL 1646435, at *35 (affirming Judge Posner's ruling that this particular holder of the patent subject to FRAND requirements was not entitled to injunctive relief, but insisting that *eBay* analysis of factors, with particular attention to whether patent holder will suffer irreparable harm as a result of the infringement, is required).

187. *Apple Inc.*, 869 F. Supp. 2d at 918.

188. *See* eBay Inc. v. MercExchange, LLC, 547 U.S. 388, 395-97 (2006) (Kennedy, J., concurring).

189. *See, e.g.*, Gene Quinn, *Chief Judge Rader on the Supreme Court and Judge Posner*, IPWATCHDOG (Mar. 17, 2013, 12:07 PM), http://www.ipwatchdog.com/2013/03/17/chief-judge-rader-on-the-supreme-court-and-judge-posner/id=37620/; *see also Apple, Inc.*, 2014 WL 1646435, at *35 (holding that Judge Posner erred in his district court opinion by applying "a per se rule that injunctions are unavailable for [standard-essential patents]"); *id.* at *36-37 (Rader, C.J., dissenting in part) (reasoning that the district court's failure to consider the appropriate factors left it "adrift without a map"); *id.* at *45 (Prost, J., concurring in part and dissenting in part) (rejecting the district court's "categorical rule that a patentee can never obtain an injunction on a FRAND-committed patent").

eration has been limited primarily to the context of standard-essential patents encumbered by contractual commitments to license on reasonable and non-discriminatory terms.[190]

Calculations of patent damages have also moved in the direction of a more contextualized analysis, driven largely by decisions in the standard setting context. In the first court decision to confront and calculate reasonable and non-discriminatory royalties for patents essential to the use of industry standards, Judge Robart concluded in *Microsoft v. Motorola* that the traditional factors used to determine reasonable royalties, referred to as the *Georgia-Pacific* factors, should be explicitly modified to take the standard-setting context into account.[191] Judge Robart, as Judge Posner had before him, emphasized the importance of the public interest in access to the standards and

190. Judge Posner's approach in *Apple v. Motorola* is contrasted with Judge Robart's ruling on FRAND damages in *Microsoft Corp. v. Motorola, Inc.*, No. C10-1823JLR, 2013 WL 2111217, at *18-19 (W.D. Wash. April 25, 2013). Areas of divergence include Judge Robart's reliance on the traditional *Georgia-Pacific* factors as a good way of calculating patent damages, and Judge Posner's rejection of this framework. *Compare id.* (summarizing Judge Robart's position), *with Apple, Inc.*, 869 F. Supp. 2d at 910-11 (giving Judge Posner's take). Judge Posner also insists that the FRAND value of a standard-essential patent should be determined ex ante, pre-standardization, as compared to the traditional approach based on the date that infringement began. *See, e.g.*, Florian Mueller, *A Closer Look at the 207-Page, Landmark FRAND Rate-Setting Decision in* Microsoft v. Motorola, FOSS PATENTS (Apr. 28, 2013, 11:49 PM), http://www.fosspatents.com/2013/04/a-closer-look-at-207-page-landmark.html#judgesrobartandposner. Both decisions, however, point to the importance of the public interest in access to standard-essential patents and the need to exclude the holdup value of patents covering standards from royalty determinations.

191. *See, e.g.*, *Microsoft Corp.*, 2013 WL 2111217, at *1, 18 (deciding in contract dispute over whether Motorola had breached contract to offer patents on FRAND terms by asking for royalties that were unreasonably high). Judge Robart's decision seems to explicitly modify the traditional *Georgia-Pacific* factors to account for the standard-setting context. *Id.* at *18-20. He recognizes that the licensing of standard-essential patents takes on a public character and must be conducted and reviewed with those public benefits in mind. He emphasizes, for example, that patent royalties should not incorporate the holdup value that may result after a standard incorporating the patent has been chosen, and attention to royalty stacking. *Id.*; *see also* Thomas F. Cotter, *Some Initial Reactions to Judge Robart's Opinion in* Microsoft v. Motorola, INTELLECTUALIP (May 3, 2013), http://intellectualip.com/2013/05/03/some-initial-reactions-to-judge-robarts-opinion-in-microsoft-v-motorola/; Michael Carrier, *A US Court Issues First Analysis of an Appropriate Royalty that a Patentee Could Obtain After Promising To License Its Patent on Reasonable and Nondiscriminatory (RAND) Terms (*Microsoft v Motorola*)*, E-COMPETITIONS BULL. (Inst. of Competition Law, New York, N.Y.), May 2013; Jorge L. Contreras, *So That's What "RAND" Means?: A Brief Report on the Findings of Fact and Conclusions of Law in* Microsoft v. Motorola, PATENTLY-O (Apr. 27, 2013), http://patentlyo.com/patent/2013/04/so-thats-what-rand-means-a-brief-report-on-the-findings-of-fact-and-conclusions-of-law-in-microsoft-v-motorola.html; Thomas F. Cotter, *Day 2 of the University of Florida Workshop on Standard Essential Patents and FRAND: Page on "Judging Monopolistic Pricing: F/RAND and Antitrust Injury"*, COMP. PAT. REMEDIES BLOG (Sept. 12, 2013), http://comparativepatentremedies.blogspot.com/2013/09/day-2-of-university-of-florida-workshop_12.html (summarizing comments by William Page suggesting that while the form of FRAND royalties was as a hypothetical bilateral negotiation, in reality it was a calculation in light of the economic consensus of what FRAND rates should be).

the need to exclude any patent holdup value arising from the collective adoption of a standard covered by the patent from the calculation of damages. Judge Robart's approach, including the emphasis on excluding the value of standardization in royalty determinations, has been followed in a second court ruling on reasonable and nondiscriminatory royalty rates.[192] Recognizing the strong public interest in using standards as mechanisms for coordinating interoperable technologies, the Federal Trade Commission, the Department of Justice, the U.S. Patent and Trademark Office, and even the U.S. Trade Representative have all offered similar opinions about limiting injunctive relief and damages.[193] Courts and policymakers alike are thus emphasizing the public interest in preserving access to innovative standards, and their responses illustrate ways in which the broader effects of patent remedies on cooperation in innovation can be incorporated into remedy determinations.[194] So far, however, they remain limited primarily to patents essential to common industry technology standards.[195] They also remain focused primarily on determinations of injunctive relief and damages for past infringement, leaving open questions about whether the public interest will similar-

192. *See In re* Innovatio IP Ventures, LLC Patent Litig., 921 F. Supp. 2d 903, 915-17 (N.D. Ill. 2013); *see also* Michael Carrier, *A US Court Issues Second Ruling Determining RAND Rate for Standard Essential Patent (*Innovatio*)*, E-COMPETITIONS BULL. (Inst. of Competition Law, New York, N.Y.), Oct. 2013.

193. *See, e.g.*, Editorial Board, *FTC/DOJ/USPTO Take Action on Standards-Essential Patents*, ANTITRUST & COMPETITION NEWSL., ORRICK (Feb. 4, 2013), http://blogs.orrick.com/antitrust/2013/02/04/dojftcuspto-take-action-on-standards-essential-patents/ (summarizing recent actions by FTC, DOJ, and USPTO with regard to standard-essential patents); John Ribeiro, *Google Withdraws Standard-Essential Patent Claims in Xbox Complaint*, COMPUTERWORLD (Jan. 9 2013, 12:20 PM), http://www.computerworld.com/s/article/9235502/google_withdraws_standard_essential_patent_claims_in_Xbox_complaint; *see also* Letter from Michael B.G. Froman, Ambassador, Exec. Off. of the President, to Irving A. Williamson, Chairman, U.S. Int'l Trade Comm'n (Aug. 3, 2013) *available at* http://www.ustr.gov/sites/default/files/08032013%20Letter_1.PDF (discussing a policy decision to disapprove Commission's determination to enjoin Apple from importing and selling infringing devices, after review in light of public interest concerns).

194. *See, e.g.*, Thomas F. Cotter, *Remedies for the Infringement of Standard Essential Patents Subject to a FRAND Commitment*, COMP. PAT. REMEDIES BLOG (May 8, 2013, 9:40 AM), http://comparativepatentremedies.blogspot.com/2013/05/remedies-for-infringement-of-standard.html.

195. Existing proposals in the literature focus primarily on risks of patent holdup and related forms of opportunistic behavior by patent holders. *See, e.g.*, Cotter, *supra* note 19; Mark A. Lemley & Carl Shapiro, *Patent Holdup and Royalty Stacking*, 85 TEX. L. REV. 1991 (2007); Mark A. Lemley, *Ten Things To Do About Patent Holdup of Standards (and One* Not *To)*, 48 B.C. L. REV. 149 (2007); Robert P. Merges & Jeffrey M. Kuhn, *An Estoppel Doctrine for Patented Standards*, 97 CALIF. L. REV. 1 (2009); Joseph Scott Miller, *Standard Setting, Patents, and Access Lock-in: RAND Licensing and the Theory of the Firm*, 40 IND. L. REV. 351 (2007). While I am also concerned with patent holdup, my concerns extend to other ways in which patents might interfere with cooperative innovation, and my goal is to limit patent remedies when, and to the extent, that the presence of patents makes useful cooperative systems of innovation unviable.

ly inform determinations of ongoing royalties where injunctive relief is denied.[196]

These responses to cooperative contexts, while creating opportunities to inject broader public interests into determinations of patent remedies, leave open important questions about how tensions between patents and systems that rely more heavily on non-market mechanisms of cooperation should be handled. They address only problems arising from commercial participants in standard setting organizations who do not honor their obligations to each other relating to standard-essential patents. They limit their focus to the potential harms to the public from refusals of both patent-holding members of standard setting and the users of patented standards to negotiate licenses to patents essential to innovative standards on terms that are reasonable and non-discriminatory. Moreover, they fail to acknowledge or protect the public interest in sustaining non-market mechanisms of cooperation that are valuable to innovation. The principles proposed below are largely consistent with but go further than existing policy responses. They provide the courts with a way of systematically incorporating the harm that patents impose on cooperative systems into determinations of patent remedies.[197]

B. Principles for the Design of Remedies

Where patent rights impact systems of cooperative innovation, these negative effects should be included in determinations of patent remedies.[198] As the examples of Foldit and open source software demonstrated, three key non-market mechanisms play important roles in sustaining cooperative innovation: trust, benefit-sharing, and reciprocity.[199] Patents under the current system directly threaten

196. *See, e.g.*, Thomas F. Cotter, *Four Principles for Calculating Reasonable Royalties in Patent Infringement Litigation*, 27 SANTA CLARA COMPUTER & HIGH TECH. L.J. 725 (2011); Mark A. Lemley, *The Ongoing Confusion over Ongoing Royalties*, 76 MO. L. REV. 695 (2011); *see also* Thomas F. Cotter, *U.S. District Court Awards Carnegie Mellon $1.5 Billion in Patent Damages*, COMP. PAT. REMEDIES BLOG (Apr. 21, 2014), http://comparativepatentremedies.blogspot.com/2014/04/us-district-court-awards-carnegie.html (suggesting decision not to award a higher ongoing royalty than the reasonable royalties awarded for past infringement is consistent with view that courts should take socially optimal incentives to innovate into account).

197. Ideally this is just a first step in thinking more systematically about where patent laws need to change in response to changing forms of collaborative and cooperative innovation.

198. For a related discussion and insights into the challenges of cumulative and sequential innovation and the disconnect with current approaches to patent remedies, see, for example, J. H. Reichman, *Of Green Tulips and Legal Kudzu: Repackaging Rights in Subpatentable Innovation*, 53 VAND. L. REV. 1743 (2000). For a similar discussion focusing on open source innovation, see, for example, James Boyle, *supra* note 169.

199. As noted earlier, there are other important aspects of cooperative innovation systems that may not be fully captured by these three mechanisms. I focus on them for

each of these mechanisms, putting such cooperative innovation systems at risk. In response, I provide three principles for courts to use in determining patent remedies that are designed to protect the operation of these mechanisms in situations of socially beneficial cooperative innovation. The three principles are: (1) protect reliance interests in norms of open access and sharing;[200] (2) limit the private appropriation of collective value;[201] and (3) reinforce reciprocity in free, open systems of innovation. Where the negative effects of patents on cooperative mechanisms are likely to be strong, the principles provide a reasoned way of incorporating these patent harms into determinations of patent remedies. This approach would lead not only to changes in how courts determine remedies for patents that arise from or cover the activities of cooperative systems of innovation, but also, and more importantly, to changes in ex ante decisions by members of a cooperative innovation system about whether to defect from the system and decisions by third parties about whether and when to obtain and enforce patents against members of the cooperative system in the first place.[202] It is these ex ante effects on decisions to de-

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the purpose of this analysis because they seem to play an important role in many of the cooperative systems and also seem to capture many of the effects that patents might have on the rich variety of non-economic factors and motivations that drive cooperative innovation.

200. The idea of respecting the reliance interests of firms in standards that are adopted by the industry has been suggested in Merges & Kuhn, *supra* note 195. This principle goes further, extending to any situation in which multiple participants work collectively to advance a particular product or field and either must coordinate their activities through standards and/or find it necessary to use certain core technologies as research tools or platform technologies on which to build their contributions. There are also similarities here to an essential-facilities doctrine approach to intellectual property. *See, e.g.*, M. Elaine Johnston, *Intellectual Property As an "Essential Facility"*, 22 COMPUTER & INTERNET L. 17 (2005) (summarizing case law and trends in applying essential-facilities doctrine to intellectual property contexts). Jorge Contreras proposes a "market reliance" approach in the context of promises not to assert patents on FRAND terms, focusing on the importance of protecting the reasonable reliance of third-party market participants on such promises. His work provides additional ideas about how this kind of principle might work in the context of cooperative innovation. *See* Jorge L. Contreras, *Market Reliance and Patent Pledges*, UTAH L. REV. (forthcoming Spring 2015), *available at* http://ssrn.com/abstract=2309023.

201. *See, e.g.*, Cotter, *supra* note 169 (arguing that damages should be apportioned according to relative value of patent to the whole product); Lemley & Shapiro, *supra* note 195 (exploring problems of patent holdup, royalty-stacking, and consequent royalty overcharges).

202. The principles will have the effect of limiting injunctive relief and patent damages in ways that reduce the payoffs that group members might expect from defecting and their expectations that others might defect. This will, in turn, reduce the incentives of group members to defect from the group in the first place, and will also strengthen the motivations of group members to continue to adhere to group norms of open access and sharing. The principles will also limit the ability of outside parties to appropriate the value arising from collective efforts and their ability to threaten the activities of the group. Third parties will have lower expected payoffs from asserting or threatening to assert patents against the group in contexts where they are seeking to tax or free ride on the collective

fect and decisions to threaten and enforce patents against the group that are most important to the survival of cooperative innovation.

1. First Principle

The first principle requires courts to protect reliance interests in norms of open access and sharing. Where the norms are supporting socially valuable innovation, reliance interests in continued access to an invention based on this norm should be treated as part of the public interest in continued access, to be balanced against the interests of a patent owner in restricting access when fashioning patent remedies.[203] To receive protection, the reliance must be reasonable in light of widely adopted and publicly known norms governing when and how knowledge will be shared and used. It must be reliance on a norm of open access and sharing that is relevant to the cooperative process of innovation. Defining what is reasonable reliance would thus be context-specific, depending on the scope and nature of the norms and customs of the innovation community, the extent to which these norms are publicly known, the relationship of the inventor and patent owner to the community, and the balancing of collective interests in access and private incentives to make and develop the patented technology.

This approach provides courts with a way of respecting and reinforcing informal rules that establish socially beneficial uses of knowledge by giving them weight when balancing public and private interests. Pursuant to this principle, reasonable reliance on norms of open access and sharing would become an important factor that weighs against injunctive relief. This reliance would also become a factor limiting damages for infringement of patented inventions that are used in the context of cooperative innovation.[204] Calculations of reasonable royalties should be lower where reliance interests are

efforts of the group and less bargaining power in situations where injunctive relief is likely to be unavailable. This may discourage them from asserting claims or making threats and will also limit the deterrent effects of potential third-party claims on participation rates in cooperative-innovation projects. Where licenses are required, third parties will settle for lower royalties based on expectations that courts will limit injunctive relief and damages.

203. This principle finds support in studies of the role that informal norms play in knowledge communities. *See, e.g.*, Robert P. Merges, *From Medieval Guilds to Open Source Software: Informal Norms, Appropriability Institutions, and Innovation* (Univ. of Wis. Law Sch. Conf. on the Legal Hist. of Intell. Prop., Working Paper, 2004).

204. For discussions of the effects of patents on norms, see, for example, Merges, *supra* note 68; Katherine J. Strandburg, *User Innovator Community Norms: At the Boundary Between Academic and Industry Research*, 77 FORDHAM L. REV. 2237 (2009) (exploring implications of convergence of academic research with commercial interests and implications for norms of sharing research tools and materials and suggesting need for policies to enhance sharing); Murray & Stern, *supra* note 25; Fiona Murray, The Oncomouse that Roared: Resistance & Accommodation to Patenting in Academic Science (March 2006) (unpublished manuscript) (on file with author).

higher and royalties should reflect the economic constraints of the group. Courts would apply this principle with the goal of reducing the attractiveness for members of a cooperative system to deviate from sharing norms, and to limit at least some of the third-party actions that increase the cost of adhering to group norms of sharing. While finding a way to measure and account for this reliance interest will be difficult, courts, as a starting point, can look to the emerging framework for determining when injunctive relief should be available and what reasonable and nondiscriminatory royalties are in the standard-setting context.

While existing doctrines of implied license and estoppel, as well as the shop rights that a company may have over its employees' inventions, go part of the way towards recognizing and protecting reasonable reliance in continued group use of inventions, this first principle goes beyond the limits of these doctrines.[205] The principle would encompass the reliance interests of participants who are not in contractual privity, or even in direct or indirect communication, with the patent owner, as long as the norms of open access and sharing that the group relies upon are widely adopted and publicly known and are associated with a socially valuable system of innovation. Protection of the reliance interest in continued use will be strongest for inventions discovered by members of the group that are used by the group. It will extend in a more limited way to inventions made by group members working on independent projects entirely outside of the group, and in an even more limited way to inventions owned by third parties that the group uses. In these latter two cases, the reliance interest will play a role only for inventions that are both closely related and important to the activities of the group and additionally made accessible to the group in ways that encourage, whether directly or indirectly, widespread use by the group. If a software company benefits from Linux and makes available software tools with a reasonable expectation that members of the Linux community will pick up and widely use the tools, for example, the principle would limit the remedies that the software company might expect from asserting patents covering this software. The principle would also weigh against injunctive relief and limit damages in situations such as the generalized patent threats made by Microsoft to Linux users. Knowing that

205. *See, e.g.*, Barnes & Noble, Inc. v. LSI Corp., 849 F. Supp. 2d 925, 939-40 (N.D. Cal. 2012) (holding that a competitor's adoption of set standards can constitute reasonable reliance); Lautzenhiser Techs., LLC v. Sunrise Med. HHG, Inc., 752 F. Supp. 2d 988, 1009 (S.D. Ind. 2010) (holding that amicable dealings over a period of years may be enough to constitute misleading conduct that induces reasonable reliance). Similar trends are evident in contract law, where courts are increasingly willing to protect reasonable reliance interests of negotiating parties prior to or in the absence of a final contract. *See, e.g.*, Alan Schwartz & Robert E. Scott, *Precontractual Liability and Preliminary Agreements*, 120 HARV. L. REV. 661 (2007).

injunctive relief and remedies will be limited, Linux users would feel more comfortable continuing to participate in open source software, and Microsoft would find its divide-and-conquer strategies less effective. In contrast, this principle would not block injunctive relief or limit damages in situations of blatant copying of an independent proprietary product for the purpose of making it open source.

Where established norms of open access and sharing govern intellectual production and members have expectations of continued access to and use of inventions based on these norms, protecting their reliance interests in this way makes it easier to maintain the swift trust that both open source software systems and crowd science systems rely on.[206] Participants in cooperative innovation make contributions and adhere to group rules with the expectation that others will do the same. Sustaining this kind of trust in the behavior of the group requires participation by most, if not almost all, members of the group. Anything that increases the ability and incentives of group members to defect from group norms will threaten this equilibrium state of general trust and make it harder to sustain norms of open access and free sharing. In the Linux example, one of the reasons that the license between Novell and Microsoft was so troubling to the open source community was its negative impact on expectations that open source norms would continue to govern open source software. Patents covering open source software provided Novell with an opportunity for significant private commercial gain, leading to a defection from open access norms. Not surprisingly, additional license deals between Microsoft and other open source software companies followed in the wake of the Novell deal.[207] Without the backing and defensive patenting of large companies like IBM, such defections might have led to unraveling of cooperation and the future of Linux might have been questionable. While Linux survived, this survival has come at a high cost, both in terms of centralized corporate control over development paths and the costs of defensive patenting. Application of this proposed principle would have limited the ability of Novell or any third party acquirer to obtain injunctive relief or damages from the assertion of Novell's open source patents against the open source community. This would have made the patents less commercially attractive and reduced Novell's incentives to defect.

In the context of Foldit, the commitment of the Foldit administrators and Foldit players to ensuring that scientific discoveries and the

206. For a discussion of swift trust and its role in open source software communities, see Part II.A.

207. *See, e.g.*, Mary Jo Foley, *Microsoft and SUSE Extend Microsoft's Controversial Novell Linux Pact*, ZDNET (July 25, 2011), http://www.zdnet.com/blog/microsoft/microsoft-and-suse-extend-microsofts-controversial-novell-linux-pact/10164; Paul Krill, *supra* note 110.

research tools that enable such discoveries are made publicly available is critical to its success. Members of Foldit are willing to freely contribute their energy and ideas because they expect and believe both that other participants will behave similarly and that the results of their collective efforts will be freely shared with each other and with the scientific community. While defensive publishing of results may limit the ability of Foldit players to patent their discoveries, and claims of joint inventorship may limit the ability of any individual to obtain exclusive control, much of what the game members contribute and share are software tools and problem solving techniques rather than the ultimate discovery. Moreover, the fact that participants make their results public now does not mean that they will continue to do so if commercial considerations play a larger role.[208] This additional protection is therefore necessary to protect Foldit norms of open and free sharing.

2. Second Principle

The second principle is to limit the private appropriation of collective value by a patent owner, with the goal of supporting benefit-sharing in contexts of cooperative innovation. The principle would limit patent remedies where patents are used to hold up group production or extract rents from the group based on the group's adoption and collective use of the invention.[209] While this is analogous to the patent holdup concerns that arise when patents cover the use of standards adopted by industry members, it is broader, encompassing situations in which a group widely adopts and uses inventions that further the innovation objectives of the group. Concerns about the appropriation of collective value through patent holdup will be strongest in situations where the cost of switching to another technology would be high and where the fact that the group has used the patented invention has made it more valuable to the group and to people outside the group. This principle would weigh strongly against

208. Similar considerations and concerns about the effects of patents on sharing have arisen in academic science. Academic science is characterized by norms that support open dissemination and use of research results. The more scientists can rely on these norms, the more willing they will be to continue to share their own discoveries and to use and experiment with the discoveries of other scientists, encouraging trust and reciprocity. These norms are public knowledge, there are social benefits from encouraging reliance on these norms, and it appears that many scientists do indeed rely on these norms. *See, e.g.*, Mark A. Lemley, *Ignoring Patents*, 2008 MICH. ST. L. REV. 19. *But see* Merges, *supra* note 68.

209. There is an extensive literature on patent holdup, and this principle adopts and extends the recommendations that many patent scholars have made in the context of patents covering one component of a larger product. *See, e.g.*, Lemley, *supra* note 195. *But see* F. Scott Kieff & Anne Layne-Farrar, *Incentive Effects from Different Approaches to Holdup Mitigation Surrounding Patent Remedies and Standard-Setting Organizations*, 9 J. COMPETITION L. & ECON. 1091 (2013) (emphasizing importance of context but in this case to limit the situations of patent holdup that deserve a patent remedy response).

awarding injunctive relief where the value of a patented invention is largely attributable to its widespread adoption and use by the group.[210] The interests of the group would nevertheless still be balanced against the interests of the patent owner, and the principle will have most application for patents covering inventions that are made by members of the group or third-party patent owners who collaborate with or directly benefit from the activities of the group. This principle would also factor into the determination of damages by excluding the value that the patented invention has as a result of its widespread adoption and use by the group.[211]

The principle will also limit patent remedies to account for the benefits, if any**,** received by the patent owner from the group—primarily but not exclusively patent owners who are members of the group or who obtained their rights to the invention from a member of the group. First, the group will have limited ability to patent and restrict use of inventions discovered by the group, making bargaining with third-party patent owners and members of the group who defect and patent their own inventions more difficult.[212] Determining when an invention has emerged, who the inventors are, and whether and how patenting should be pursued, as well as handling negotiations with a third party regarding use of their patented technology, can be extremely difficult in contexts of massively distributed collective intellectual production. In addition, many systems of cooperative innovation rely on a set of beliefs that are not consistent with patenting and enforcing patents. This puts the group at a disadvantage when

210. For a similar line of reasoning in the context of FRAND promises, see Jorge Contrerras, *supra* note 200 (manuscript at 11-12).

211. This approach was adopted by Judge Robart in his modification of the *Georgia-Pacific* factors in the *Microsoft v. Motorola* decision. *See, e.g.*, Contreras, *supra* note 191. Thomas Cotter and Norman Siebrasse have suggested an alternative way of thinking about the ex ante hypothetical negotiation, focusing on the ex ante contingent value of patented technologies that might be adopted as part of a standard and, if adopted, would have higher value. This approach provides a way of thinking about a reasonable ex ante negotiation that is not based on holdup value, but rather on the incremental contribution that the patented technology makes to the standard as compared with the next best alternative technology. *See, e.g.*, Norman Siebrasse, *Comments on Sidak Part 2: The Ex Ante Contingent Value Approach (Siebrasse)*, COMP. PAT. REMEDIES BLOG (Dec. 6, 2013), http://comparativepatentremedies.blogspot.com/2013/12/comments-on-sidak-part-2-ex-ante.html; Thomas F. Cotter, *Comments on Sidak, Part 3: Should a FRAND Royalty be Higher than a Reasonable Royalty? (Cotter)*, COMP. PAT. REMEDIES BLOG (Dec. 18, 2013), http://comparativepatentremedies.blogspot.com/2013/12/comments-on-sidak-part-3-should-frand.html. Comparing and evaluating alternative approaches and their implications for contexts of cooperative innovation is left for further discussion.

212. This principle may actually make it even harder for the group to obtain their own patents, making defensive patenting and licensing strategies harder. While I think that the benefits of the principle will likely outweigh the costs in the contexts I am focusing on, this potential cost should not be ignored.

they are forced to pay for their use of a third party's technology but cannot charge for the use of their technology.

Second, the group will have limited ability to extract payment for the use of its non-patentable contributions by either a group member or a third party who obtains a patent covering an invention that was discovered through the use of the group's knowledge. As a result of these limits, third parties or defectors from the group may be able to capture the benefits of group production for free while extracting payment for their own incremental contributions. Where a member of the group is able to defect from the group, that is, patent and privately benefit from an invention that builds on the efforts of the group, this erodes the group members' trust that other members of the group will adhere to its norms of sharing and reciprocity. Where the incremental improvement is made and patented by a third party, the result is less harmful to group dynamics but still increases the cost of innovation for the group and reduces the incentives of the group members to freely and openly share their ideas. If the patent can be used to block the future efforts of the group or to extract rents from the group through licensing, benefit-sharing is even more skewed, and the transaction costs for participants in the cooperative project increase. This problem is not unique to systems of cooperative innovation, but it is particularly harmful to them because it disrupts the non-market mechanisms upon which they rely.

While existing patent law doctrines of derivation, joint inventorship and prior art significantly limit the ability of an individual to patent inventions that utilize, borrow from, or build on group discoveries, these protections do not adequately address the following problems that patents create for group investments in intellectual production.[213] One of the biggest limits of these existing patent law doctrines is their failure to remove the ex ante incentive problems that are created when individual members of the group see chances to limit their sharing of knowledge so as to increase the chances of their own individual discovery and patenting for monetary gain. These doctrines also do not address and protect many of the valuable contributions made by group members. Member contributions often take the form of tools that increase the chances of invention but are not themselves either patentable or prior art for the resulting invention. In Foldit, for example, participants develop software programs that help to increase scores in the game, and these programs, along with observations about how to solve problems in game play, are some-

213. *See supra* Part II (discussion of limits of these doctrines in cooperative innovation contexts).

times shared among the players.[214] Although the software programs and strategies may increase the likelihood that a patentable discovery about proteins will be made, they do not themselves describe such a discovery and therefore do not constitute prior art for such a discovery. The people contributing the programs are not joint inventors of the resulting discovery. Moreover, although providing valuable information that increases the chances of a patentable discovery, it is unlikely that the software programs or strategies for gameplay will themselves be patentable discoveries.

Even where the doctrines do apply, they may be difficult and costly for the group to utilize. Where the group wants to challenge third-party inventorship claims on the grounds of joint inventorship or derivation, it is forced to undertake the costs of pursuing these claims and may find it difficult to satisfy the evidentiary requirements under patent law despite the value of its contributions. The massively distributed nature of the group and the importance of keeping transaction costs low similarly limit the usefulness of these doctrines. In addition, where the group wants the value of its contributions reflected in negotiations for the use of third-party patents, it may be forced to explore patenting, and this can be inconsistent with and potentially undermine group beliefs and values. Additional help from the law is needed to fill these gaps and address these limits. In response to some of these gaps, I am suggesting that where a patented invention benefits from the knowledge provided by the group, the benefits received from the group should be considered and sometimes limit the remedy that a patent owner receives.

This principle, like the first, builds on and finds support in existing proposals to address patent holdup by limiting the ability of patent holders to obtain injunctive relief and by restricting what can be included in the calculation of damages.[215] It is also consistent with recent court decisions in the context of standard-essential patents that seek to limit patent damages to the value of the technology and exclude the value conferred by the standardization of this technology.[216] The principle goes further than these existing ap-

214. *See Public-Shared Recipes*, FOLDIT, https://fold.it/portal/recipes/public (last visited Mar. 22, 2014).

215. *See, e.g.*, Cotter, *supra* note 19, at 1174-87 (explaining how patent law should play a role in responding to, or enabling private parties to avoid, patent holdup); Lemley & Shapiro, *supra* note 195 (explaining how patent law should be modified to respond to problems of patent holdup and royalty-stacking, including limits on injunctive relief and damages).

216. *See* Microsoft Corp. v. Motorola, Inc., No. C10-1823JLR, 2013 WL 2111217, at *98-101 (W.D. Wash. Apr. 25, 2013). There are also proposals designed to address patent holdup in context of standard-setting. Jay P. Kesan & Carol M. Hayes, *FRAND's Forever: Standards, Patent Transfers, and Licensing Commitments*, 89 IND. L.J. 231 (2014) (suggesting combination of contract and property principles to govern FRAND commitments);

proaches, however. It is not limited to technology standards and patents covering those standards, but instead applies when a group adopts an invention as part of its research platform and this adoption and use confers value on the invention. Where the value arising from widespread adoption and use is large, this should be a factor weighing against injunctive relief, and this value should be excluded from royalty calculations to the extent that the value reflects simply its use as a standard. The principle also requires courts to look at whether knowledge contributions from the group were instrumental in leading to the invention. If the knowledge contribution was substantial, this should weigh against injunctive relief and should be reflected in reduced royalties. In this way courts will play a role in enforcing benefit-sharing and promoting fairness, making members of the group more willing to participate and freely contribute their work to the group.

This principle would play the strongest role in situations where members of a cooperative innovation project, such as Linux or Foldit, defect with an invention, patent it, and either seek to assert it against the group or to assign it to a third party who then asserts it against the group. In this case the combination of benefits from group production and public interest in continued group use of the invention would weigh against injunctive relief and would substantially limit royalties where the invention relates closely to the intellectual production of the group. This principle would also extend, although with less force, to limit patent damages where a third party who is not a member of the group benefits from the intellectual production of the group and/or seeks to hold up the production of the group. In the Linux example, Novell and its assignees would have found it harder to enforce their patents against the open source community, and knowing this, the open source community would have been less worried, and the patents would have been less valuable. Novell would therefore have had less incentive to defect from the community in the

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Merges & Kuhn, *supra* note 195 (arguing for a standards estoppel doctrine to check for good-faith behavior by the patentee). As well, there are proposals designed to protect areas of innovation that rely on free sharing of information. Strandburg, *supra* note 150. Alternative approaches have included improving incentives of private parties to agree through limits on injunctive relief, mandatory arbitration, and other mechanisms for improving private ordering. *See, e.g.*, Jorge L. Contreras, *Fixing FRAND: A Pseudo-Pool Approach to Standards-Based Patent Licensing*, 79 ANTITRUST L.J. 47 (2013) (adapting patent pool approach to standard-setting organizations); Mark A. Lemley & Carl Shapiro, *A Simple Approach to Setting Reasonable Royalties for Standard-Essential Patents*, 28 BERKELEY TECH. L.J. 1135 (2013) (discussing a mandatory arbitration mechanism where owner of standard-essential patent and standard implementer do not agree on FRAND terms); Timothy Simcoe, Governing the Anti-Commons: Institutional Design for Standard Setting Organizations (July 1, 2013) (unpublished manuscript) (on file with the National Bureau of Economic Research) (examining SSO practices and debates using Elinor Ostrom's self-governing common pool framework).

first place. Microsoft might have found its patent threats and licensing strategies less effective, reducing the need for defensive patenting.

This principle could limit incentive problems in Foldit as well. Foldit members will have less incentive to use patents opportunistically and will be more willing to continue to volunteer their efforts without compensation if they all know that the contribution of ideas by the group will factor heavily in determining remedies for any invention made and patented by a group member. This principle will also limit the ability of third parties with inventions that build upon or are heavily utilized by the group to the benefit of the patent owner to obtain injunctive relief and damages from these infringing uses.[217]

The key challenge in employing this principle is to provide the courts with tools or specific guidelines for how to identify and value these contributions. Indeed, concerns with the ability of the courts to measure the contribution of an invention to a larger product or project have stalled changes in patent remedies in the past. Courts are now confronting and finding ways to navigate analogous measurement problems, however, in the context of determining reasonable royalties for standard-essential patents.[218] This provides a starting point for courts seeking to take into account the value of group knowledge contributions and group use when assessing patent damages.[219] In the hypothetical negotiation of a license to a patented invention, the court would consider not just the value of the patented technology but also the value of the intellectual contributions of the cooperative innovation community. In this hypothetical exchange, the contributions from the group would reduce the royalty owed to the patent owner. In addition, royalties to the patent owner would exclude any value that the invention has as a result of its widespread adoption by the group. This hypothetical licensing negotiation should reflect the reduced bargaining power of the patent owner where injunctive relief is unlikely, and the increased bargaining power of the group where they are providing value through their activities.

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217. This approach could also address the practical limits of prior art and derivation doctrines by presuming that the community has some rights over the invention, leaving the patent owner with the burden of showing that the invention did not benefit from community production and did not derive its value from adoption by the community as a standard technology.

218. *See, e.g.*, Cotter, *supra* note 19, at 1180-88; Mark A. Lemley & Carl Shapiro, *Patent Holdup and Royalty Stacking*, 85 TEX. L. REV. 1991, 1994 (2007); Mark A. Lemley, *Ten Things To Do About Patent Holdup of Standards (and One* Not *To)*, 48 B.C. L. REV. 149, 153 (2007).

219. How royalties should be determined in this context is an area in which the law and commentary are in flux. *See, e.g.*, J. Gregory Sidak, *The Meaning of FRAND, Part I: Royalties*, 9 J. COMPETITION L. & ECON. 931 (2013); Cotter, *supra* note 211.

3. Third Principle

The third principle is to reinforce reciprocity in free, open systems of innovation.[220] This principle would treat both formal and informal rules governing open access and sharing of ideas and discoveries as commitments by participants to share their own contributions with other participants in the project. Where discoveries relevant to free and open source projects are made by members of the project, free and open access and use of the discoveries by the group should be presumed unless the members of the group have explicitly agreed otherwise. In this way the law reinforces informal rules and norms of reciprocity and reduces the payoffs from defecting from group norms.[221] Provided that people know about this change in the law in advance, it makes it easier for members of the group to commit to behavior in compliance with these rules and norms, in addition to facilitating ex ante bargaining. The principle would also apply to limit relief for industry members who know about and maybe even benefit from the use of their invention by the cooperative innovation project unless these parties have taken reasonable precautions to put the community on notice of their proprietary rights before the invention is in use. Where third parties develop inventions that rely on the work done by an open source project and relate to the open source project, this principle would weigh heavily against allowing this third party to block the use of the discovery by the group, either through an injunction or royalties that are not feasible for group participants to pay. The impact of this principle should become larger the closer the relationship of the patent owner to the group and the greater the benefit to the patent owner of the group's activities.

Open access and reciprocity play critical roles in both open source software and crowd science projects.[222] In cooperative systems such as these, discoveries that benefit from the productive efforts of the group should be available for use by the group at either no cost or, where the discovery is made outside of the project, at a cost that is reasonable in light of the competing interests and investments of the group and the patent owner. Efforts have been made to build reciprocity into open source communities through the use of licenses such

220. For thoughts on motivating reciprocity, see, for example, Stephen Leider et al., *Directed Altruism and Enforced Reciprocity in Social Networks*, 124 Q.J. ECON. 1815 (2009).

221. For a related idea on how open source systems can reduce opportunism in the context of open standards, see, for example, Vetter, *supra* note 96.

222. *See, e.g.*, Jane Kaye et al, *Data Sharing in Genomics—Re-Shaping Scientific Practices*, 10 NATURE REVS. GENETICS 331 (2009); Jennifer C. Molloy, *The Open Knowledge Foundation: Open Data Means Better Science*, 9 PUB. LIBR. SCI. BIOLOGY 1.

as the General Public License and the Reciprocal Public License.[223] These contracting approaches are generally limited to the world of free and open source software, however, and questions about the enforceability and transaction costs associated with these licenses remain.[224] Large public funding agencies such as the National Institute of Health have sought to build reciprocity into public funding requirements, but again with high transaction costs and questionable enforceability.[225] The principle that I propose can complement these efforts. It can also expand upon them, applying in situations where there is no contractual privity and without depending upon the organizational structure that underpins open source software production or publicly funded research.

In the Foldit context, this principle would limit the ability of both members of Foldit and third parties to impede the free use of scientific discoveries by Foldit members for the non-commercial purposes of solving Foldit puzzles. It would thus operate in ways that are analogous both to proposed concepts of patent fair use and proposals for research use exemptions, but in both cases limited to the context of crowd science.[226] This principle would be most valuable in sustaining non-mainstream, volunteer-based open source projects, which are among the most vulnerable to transaction costs and the least able to engage in defensive patenting activities.

All three of these principles draw from a rich body of research that critiques the lack of safe harbors within patent law for publicly beneficial uses of patented technology, particularly where the patented technologies have been created through the use of public funds.[227] The patent literature includes a number of carefully constructed proposals for research use exemptions and patent fair use.[228] Instead of

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223. *See, e.g.*, *Reciprocal Public License 1.5 (RPL-1.5)*, OPEN SOURCE INITIATIVE (July 15, 2007), http://opensource.org/licenses/rpl-1.5; *see also* Tom Hall, *Open Source—Reciprocal Licenses*, TECH L. GUY BLOG (Sept. 18, 2013, 12:21 PM), http://techlawguy.blogspot.com/2013/09/p-margin-bottom-0.html (including a list of reciprocal open source licenses as determined by GNU).

224. *See, e.g.*, Gomulkiewicz, *supra* note 107 (examining the most recent version of general public license that tries to deal with issues such as patents and digital rights management); Sapna Kumar, *Enforcing the GNU GPL*, 2006 U. ILL. J.L. TECH. & POL'Y 1.

225. *See, e.g.*, Arti K. Rai & Bhaven N. Sampat, *Accountability in Patenting of Federally Funded Research*, 30 NATURE BIOTECH. 953 (2012).

226. *See, e.g.*, Joshua I. Miller, *Towards a Doctrine of Fair Use in Some of Patent Law*, 2 INTELL. PROP. BRIEF 56 (2011); O'Rourke, *supra* note 151; Strandburg, *supra* note 150.

227. *See, e.g.*, Strandburg, *supra* note 150 (arguing for the use of defenses and exemptions from infringement as a way of responding to the fact that different uses of patented technology can have different social costs and benefits).

228. *See id.*; *see also* Rochelle Dreyfuss, *Protecting the Public Domain of Science: Has the Time for an Experimental Use Defense Arrived?*, 46 ARIZ. L. REV. 457, 464 (2004); Rebecca S. Eisenberg, *Patents and the Progress of Science: Exclusive Rights and Experimental Use*, 56 U. CHI. L. REV. 1017 (1989) (proposing research-use defense that

focusing on the types of uses, however, the focus here is on preserving non-market mechanisms for cooperative innovation. Moreover, the principles are not intended as rules that dictate particular patent remedies, but rather as mechanisms for expanding the range of interests that courts are required to think about when fashioning patent remedies.[229] These principles require courts to systematically take into account the broader costs of patents on socially beneficial cooperative innovation when fashioning patent remedies.[230] Ideally, the principles would also be adopted by agencies such as the Federal Trade Commission, the Department of Justice and the International Trade Commission, and used to guide future changes in the patent statute made by legislators.[231] The principles provide a focal point for all of these patent policymakers to use when fashioning their responses to patent problems in contexts of cooperative innovation.

V. CONCLUSION

"Many ideas grow better when transplanted into another mind than the one where they sprang up."—Oliver Wendell Holmes

Cooperative innovation can bring together diverse perspectives and ideas and harness underutilized human resources in new ways to solve previously intractable scientific problems. In some cases, systems of cooperative innovation that rely at least partially on non-market mechanisms may complement existing modes of market-driven innovation. In other cases, they may challenge incumbent systems of intellectual production and intensify competition in ways that accelerate scientific and technological progress. The potential of

distinguishes between situations requiring payment and those not requiring payment, with a focus on protecting robust domain for basic research uses); O'Rourke, *supra* note 151, at 1204-05; Katherine J. Strandburg, *What Does the Public Get? Experimental Use and the Patent Bargain*, 2004 WIS. L. REV. 81.

229. *But* s*ee, e.g.*, Michael A. Carrier, *Cabining Intellectual Property Through a Property Paradigm*, 54 DUKE L.J. 1 (2004) (stating the idea that propertization of patent rights can lead to the narrowing of IP, providing for limits based on development, necessity, and equity).

230. Efforts have been made to provide general principles or principles for determining patent remedies. *See, e.g.*, Thomas F. Cotter, *Patent Remedies and Practical Reason*, 88 TEX. L. REV. *SEE ALSO* 125 (2010); Golden, *supra* note 18. I am not providing principles that govern the application of remedies generally, but rather specific principles that require policymakers to consider the effects of patent remedies on the viability of cooperative innovation.

231. The patent statute provides little guidance for courts in how they determine patent remedies, leaving the implementation primarily to common law. I focus on the role of the courts in responding to cooperation through their approach to patent remedies, utilizing the ability of courts to operate through what Burk and Lemley have termed "policy levers." *See* Dan L. Burk & Mark A. Lemley, *Policy Levers in Patent Law*, 89 VA. L. REV. 1575 (2003).

these emerging systems of innovation may be limited, however, by patent roadblocks.

This Article has shown that patents may sometimes interfere with important non-market mechanisms that sustain systems of cooperative innovation by increasing both the costs of participating and the benefits of defecting from these systems. While some forms of open, collaborative innovation persist in the face of patent threats, they do so only at great cost and with uncertainty about their future sustainability. To these costs and uncertainties we must add the social loss from potentially valuable innovation paths foreclosed.

In response to these concerns, I suggest that courts and other patent policymakers need to pay more attention to the ways in which patent law may systematically disadvantage cooperative innovation. As a starting point, I take advantage of current areas of opportunity in judicial thinking about patent remedies to propose modest changes in the ways that courts implement patent remedies where non-market mechanisms of cooperation are important. Three principles are provided to guide courts in their determinations of patent remedies with cooperative contexts in mind. The principles are intended to support cooperation where patents are not already accomplishing this goal, and only to the extent that patents are impeding this goal. Limiting the negative incentive effects of patents on non-market mechanisms in this way may give cooperative innovation systems chances to complement and to compete against market-driven systems of innovation. In addition, a greater legal commitment to balancing individual interests with broader public interests in cooperative innovation may improve the relationships that cooperative innovative communities have to patent law. Implementing patent law in ways that take the interests and needs of these communities into account may move us closer towards a patent system that can accommodate alternative paradigms of innovation.