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Balancing Open Source Paradigms and Traditional Intellectual Property Models to Optimize Innovation

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I. INTRODUCTION

Copyrights and patents grant property rights to creators and inventors in order to spur further innovation through the dual approach of increasing the amount of material in the public domain and rewarding inventors and creators for their efforts. However, in recent years, it has been postulated that extensive granting of copyrights and patents may in fact stifle additional creation and development. This led to a revolt in the computer programming industry and spawned the open source movement, which provides software with its source code and a license allowing for free creation and distribution of works. This movement attempts to spur innovation in an alternative manner,[1] primarily by promoting contribution to the public domain. This open source concept has spread to other realms normally protected by copyright through systems like the Creative Commons. The Creative Commons is a non-profit organization devoted to expanding the breadth of creative works available in the public domain for others to legally build upon and share.[2] The organization has released several copyright licenses (known as Creative Commons licenses) that authors can choose from and use to protect their works in lieu of traditional copyright. These licenses allow creators to communicate which rights they reserve, and which they waive for the benefit of recipients and/or other creators.

Although it does not provide the same commercial gains to creators as traditional copyrights, the widespread use of the Creative Commons licenses in the digital creative world and subsequent increase of material in the public domain suggest that the open source movement may be useful to spur innovation in other areas. Biotechnology, such as genetic and molecular biology research that leads to the development of useful therapeutics, is one area where open source was postulated to be useful to counter the over-proliferation of patents hypothesized to suppress innovation.[3] As such, the Boston-based Science Commons was developed in 2005 to bring the open source movement to biotechnology through various projects designed to increase the amount of scientific data available in the public domain. The implicit goal of the Science Commons project is to replace traditional intellectual property systems, such as patents, and to promote innovation by increasing access to knowledge conferred through open access approaches. This

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1. *See* RICHARD M. STALLMAN, *The GNU Project, in* FREE SOFTWARE FREE SOCIETY: SELECTED ESSAYS OF RICHARD M. STALLMAN 15-31 (Joshua Gay ed., 2002).

2. CREATIVE COMMONS, http://creativecommons.org/ (last visited Oct. 19, 2010).

3. Michael A. Heller & Rebecca S. Eisenberg, *Can Patents Deter Innovation? The Anticommons in Biomedical Research*, 280 SCIENCE 698, 698 (1998).

Comment provides the first substantive analysis of whether the Science Commons is succeeding in its attempts to promote innovation. Because there are challenges inherent in the practice of biotechnology, such as the large financial costs associated with research and development of pharmaceuticals and the absence of an appropriate community, this Comment suggests that open source biotechnology as envisioned and implemented by the Science Commons is not successful in promoting innovation because the Science Commons attempts to promote innovation only by increasing the amount of material in the public domain, ignoring the incentive effects of rewarding inventors with patent rights and the related commercial benefits.

This Comment postulates a compromise where premarket or "upstream" knowledge such as unknown gene sequences is shared through open source systems like the Science Commons, but downstream developments such as pharmaceuticals that act on the gene to treat a particular disease are patentable according to intellectual property norms. However, this Comment also suggests modifying the traditional patent system to be stricter, thereby resulting in fewer patents. This proposed system maximizes shared knowledge by publicizing information that is generally not patentable to begin with, potentially making further development easier. This system will also likely encourage innovation at all levels, from individual users to large pharmaceutical companies.

In Part II, this Comment explores the historical background and traditional legal practice of copyrights and patents, both of which were developed to increase the amount of material in the commons and reward inventors and creators for their work with a temporary monopoly. Part III follows the ideological change suggesting that traditional intellectual property norms do not actually promote innovation and reveals how an over-proliferation of proprietary rights is now considered to stifle innovation. The open source movement and its attempts to solve these problems by increasing the amount of material in the public domain are addressed in Part IV of this Comment, with particular attention paid to the development of the Creative Commons as an alternative means to copyright to promote innovation. Part V follows the expansion of the Creative Commons model to the world of biotechnology and details the three main projects of the Science Commons: the Biological Materials Transfer Project, the Scholar's Copyright Project, and the Neurocommons. In Part VI, these three projects are compared to existing practices and critiqued for their effectiveness in promoting innovation, with this Comment illustrating that none of the projects are ultimately successful. Several theories underlying the failure of the Science Commons are discussed in Part VII, one based on the realization that these approaches attempt to promote innovation by increasing the amount of material in the public domain without invoking the incentive or reward system for inventors and creators. Based on this discussion, an alternative solution is proposed in Part VIII. In Part IX, this Comment concludes that a combination of traditional intellectual property protection and open source approaches is the most effective way to promote innovation in the field of biotechnology.

II. HISTORICAL DEVELOPMENT OF COPYRIGHT AND PATENT PRACTICE

The United States Constitution specifies that Congress is authorized "[t]o promote the [p]rogress of [s]cience and useful [a]rts, by securing for limited [t]imes to [a]uthors and [i]nventors the exclusive [r]ight to their respective [w]ritings and [d]iscoveries . . . ."[4] Related to the "useful arts" phrase, one of the first acts of Congress was to pass the Copyright Act of 1790,[5] which has subsequently undergone several reformations broadening the scope of protection and expanding the terms of protection to arrive at its current form.[6] Although the Copyright Act undoubtedly confers valuable rights upon authors without requiring much, or even any, effort on their part to secure protection,[7] judicial decisions have emphasized that the primary purpose of this grant of power is to provide an incentive for innovation by increasing the amount of material in the public domain, noting that reward to the owner of the patent or copyright is a "secondary consideration."[8]

Copyright law covers the broad range of literary and artistic expression, including such varied works as books, public performances, songs, movies, and computer programs.[9] Ideas themselves are not copyrighted; it is the author's expression of the work in a tangible medium that is protected.[10] The copyright owner (who may be someone other than the author if the author assigns the copyright to another person or entity) has the exclusive right to carry out or authorize reproductions, preparation of derivatives, distribution of copies, and public performance or display of the copyrighted work.[11] If a third party infringes

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4. U.S. CONST. art. I, § 8, cl. 8.

5. Copyright Act of 1790, ch. 15, 1 Stat. 124 (1790) (repealed) (current version codified at 17 U.S.C. §§ 101-205 (2006)).

6. 17 U.S.C. §§ 101-205 (2006). Section 102 outlines copyrightable subject matter broadly to include literary, musical, dramatic, and choreographic works, pantomime, pictorial, graphic, and sculptural works, motion pictures, sound recordings, and other audiovisual works, and architectural works. 17 U.S.C. § 102 (2006). Section 302 sets the standard term for copyright protection as the life of the author plus seventy years after the author's death, with various exceptions in subsequent sections for anonymous or institutional authors, etc. 17 U.S.C. § 302 (2006).

7. Section 102 makes it clear that a copyright automatically exists in any original work of authorship fixed in a tangible medium. 17 U.S.C. § 102 (2006). Formality requirements such as registration, notice, or marking have largely been abandoned by the United States' ratification of the Berne Convention, which states that copyright shall "not be subject to any formality." Berne Convention for the Protection of Literary and Artistic Works, art. 5(2), Sept. 29, 1886, 25 U.S.T. 1341.

8. United States v. Paramount Pictures, 334 U.S. 131, 158 (1948). *See also* Sony Corp. of Am. v. Universal City Studios, Inc., 464 U.S. 417, 429 (1984) (emphasizing that the limited monopoly privileges granted by copyright are the means by which the "important public purpose" of motivating creative activity and allowing the public access to such activity may be assured).

9. 17 U.S.C. § 102 (2006).

10. *Id.*

11. 17 U.S.C. § 106 (2006). If a third party infringes on any of these rights, the copyright owner may sue for an injunction and/or damages. However, there are limitations to these exclusive rights, such as the fair use doctrine. 17 U.S.C. § 107 (2006). Certain uses of copyrighted material that would otherwise be considered to be infringing are allowable if they meet the requirements of the fair use doctrine. *Id.* Classic examples of uses that are permitted under the doctrine include using the copyrighted work for criticism, comment, teaching, or research. For application of the criteria set forth in section 107, *see* Am. Geophysical Union v. Texaco, Inc., 60 F.3d 913 (2d Cir. 1994) (holding that research scientists' photocopying of individual articles from scientific journals for archiving purposes to make later research easier was not fair use). *But see* Campbell v. Acuff-Rose Music, Inc., 510 U.S. 569

upon any of these rights, the copyright owner may sue for an injunction and/or damages.[12]

Parallel to protecting the useful arts through copyright, scientific improvements were protected by the first patent statute passed in 1790,[13] although a system including a board of examiners responsible for determining whether to grant a patent resembling that of today was not put in place until 1836.[14] In contemporary practice, examiners from the Patent and Trademark Office review each utility patent[15] application for patentability based on five criteria:[16] (1) utility and subject matter; (2) novelty (the invention is not published or known to the public prior to filing the application); (3) non-obviousness (inventiveness); (4) whether it is described fully in the application; and (5) whether the description would allow one skilled in the art to carry out the invention.[17] The current term for patents is twenty years from the date of filing the application, with limited extensions available under some circumstances.[18] As with copyright, the Supreme Court has reiterated that the primary purpose of patent law is the promotion of innovation, rather than the reward of individual effort.[19] Promoting innovation is achieved by the two-fold approach of (i) increasing the amount of material in the public domain after the patent expires and (ii) providing material incentives to inventors with the monopoly conferred through the patent rights during the life of the patent.[20]

Patent law covers new and useful processes, machines, manufacture, compositions of matter, and improvements thereof to which a patent has been granted,[21] and the scope of subject matter protectable under patent law has long

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(1994) (applying the fair use doctrine and finding that a parody rap version of Roy Orbison's well-known song "Pretty Woman" constituted fair use and, therefore, did not infringe the copyright). In order to use a copyrighted work for purposes that are not considered fair use, it is necessary to obtain the consent and authorization of the copyright owner.

12. 17 U.S.C. §§ 501-05 (2006).

13. Patent Act of 1790, ch. 7, 1 Stat. 109-12 (1790) (repealed) (current version codified at 35 U.S.C. §§ 1-376 (2006)).

14. DONALD S. CHISUM, 1 CHISUM ON PATENTS 5-6 (2009). The 1836 Act established the Patent Office and an examination system where applications were evaluated with respect to novelty over the prior art. Additional requirements such as non-obviousness were not included until the revisions in the 1956 Act were made. *Id.* at 12.

15. There are three types of patents: plant patents, design patents, and utility patents. They all vary in terms of requirements for patentability and granted terms of protection. Since utility patents are the most common form of patent and are most pertinent to the following discussion, all later uses of the word "patent" should be understood to refer to utility patents only.

16. *See generally* Graham v. John Deere Co. of Kansas City, 383 U.S. 1 (1966) (applying these criteria).

17. 35 U.S.C. §§ 101-103, 112 (2006).

18. 35 U.S.C. §§ 154-155 (2006).

19. Sinclair & Carroll Co. v. Interchemical Corp., 325 U.S. 327, 330 (1945). Later cases have reiterated this principle, emphasizing that the primary goals of patent law are fostering and rewarding invention and promoting disclosure of inventions in order to stimulate further innovation. *See, e.g.*, Thomas & Betts Corp. v. Panduit Corp., 138 F.3d 277, 284 (7th Cir. 1998).

20. *See Sinclair*, 325 U.S. at 330.

21. 35 U.S.C. § 101.

been considered to be "anything under the sun that is made by man."[22] Abstract ideas, laws of nature, and physical phenomena such as naturally occurring products are excluded from patent protection.[23] Once a patent is obtained, the patent confers upon the patent owner the right to exclude others from making, using, selling, or importing the invention.[24] If a third party infringes upon any of these rights, the patent owner may sue for an injunction and/or damages.[25] Therefore, in order to make or use a protected invention, a third party must obtain permission from the patent owner, usually in the form of a license whereby the patent owner is compensated.

III. COPYRIGHT AND PATENT LAWS ACTUALLY STIFLE INNOVATION

A. Problems with Copyright Overprotection: Loss of Innovation and Access to Culture

Despite reiteration by the Supreme Court that promoting innovation is the primary goal of the Copyright and Patent Acts, cultural theorists suggest that the extensive property rights conferred by patents and copyrights may have precisely the opposite effect. One of the first to voice this position was Richard Stallman, who premises his concerns on changes in copyright law that dramatically increased the scope and number of proprietary rights of copyright holders, thereby decreasing the opportunity of the public to work with and use copyrighted works.[26] Numerous copyrights can work to prevent access to history and culture, as poignantly illustrated by law professor Michael Heller with the example of a documentary featuring Martin Luther King, Jr.[27] Most of the public is aware of Dr. King's legacy through indirect means such as recorded speeches or collected information as presented in the Emmy Award-winning documentary *Eyes on the Prize*.[28] This culturally important documentary draws on interviews with hundreds of Dr. King's acquaintances and tremendous numbers of media sources including video footage, photographs, and music.[29] In order to make the documentary without the threat of

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22. Diamond v. Chakrabarty, 447 U.S. 303, 309 (1980) (quoting the Committee Reports accompanying the 1952 Patent Act, S. REP. NO. 1979, at 5 (1952); H. R. REP. NO. 1923, at 6 (1952)).

23. *Diamond*, 447 U.S. at 309.

24. 35 U.S.C. § 271(a) (2006). There are some exceptions that are not considered to be infringement. *See supra*, text accompanying note 11. For example, medical practitioners carrying out a patented method of treatment on a patient are free from liability. 35 U.S.C. § 287(c) (2006). In addition, research performed for the purposes of fulfilling requirements for registration with a federal agency, such as the Federal Drug Administration agency, does not constitute infringement. 35 U.S.C. § 271(e) (2006).

25. *See* 35 U.S.C. §§ 283-84 (2006).

26. *See* RICHARD M. STALLMAN, *Misinterpreting Copyright—A Series of Errors, in* FREE SOFTWARE FREE SOCIETY: SELECTED ESSAYS OF RICHARD M. STALLMAN 77-86 (Joshua Gay ed., 2002). Another example is the Audio Home Recording Rights Act of 1992, 17 U.S.C. §§ 1001 *et seq.*, which imposed technological design constraints on the manufacture of copying devices. 17 U.S.C. § 1002 (2006).

27. MICHAEL HELLER, THE GRIDLOCK ECONOMY 9 (2008).

28. *Id.*

29. *Id.* at 10.

lawsuits, the filmmakers had to secure licenses from each copyright owner.[30] Clearly, even if copyright owners negotiate in good faith, the cost of finding and bargaining with each one can be challenging. In some instances the cost of "clearing rights" for each copyright may be prohibitive, as evidenced by the twenty years spent in jumping through legal hoops to re-release the film.[31] Challenges were greater for the re-release than the original version because of the increase in the number of copyrights involved. This increase was due to the expansion in the number of partial owners of or heirs to the copyrights and the overall increase in the cost of copyright licenses, especially those for music.[32] Attempts to re-release the film were nearly thwarted, and in some cases the filmmakers could not obtain licenses for certain materials, requiring replacement of these materials before the film could be shown.[33]

In addition to dealing with myriads of copyright holders and the associated licensing challenges, changes to copyright law have created additional complexity. Stallman asserts that extending copyright terms and preventing digital workarounds by implementing the Digital Millennium Copyright Act (DMCA) shifts the focus of copyright law from spurring innovation and aiding the public to assisting large publishing and recording companies.[34] Expanded proprietary rights can now be used as a weapon by publishers to maintain their monopoly by imposing restrictions on the general public. These restrictions are arguably necessary because the public now threatens their monopoly in ways as never before by having the means to easily produce their own copies inexpensively.[35]

Advances in digital technologies and the Internet, and with them the commensurate ability of individuals to easily copy, modify, and redistribute content, are the underlying premises of Stanford Law School Professor Lawrence Lessig's criticisms of how copyright is stifling, rather than spurring, innovation.[36] Lessig postulates that standard copyright law cannot coexist with the digital technologies of today for several reasons. As it stands now, copyright law confers the right to make copies to the copyright owner alone. However, in this digital age, "[e]very act on the Internet is a copy."[37] When surfing the Internet each website or image that appears on the computer screen is translated from the code of the original website publisher's site and necessarily conveyed in the form of a digital copy. As such, acts that were unregulated and legal, such as reading a book, are

30. *Id.* The bulk of the licenses expired after the broadcast of the film in 1987, and did not include distribution rights for use in new media like DVDs. *Id.* This hampered the filmmakers' attempts to re-release the documentary. *Id.*

31. HELLER, *supra* note 27, at 11.

32. *See* Katie Dean, *Cash Rescues Eyes on the Prize*, WIRED (Aug. 30, 2005), http://www.wired.com/entertainment/music/news/2005/08/68664 (last visited Oct. 19, 2010).

33. HELLER, *supra* note 27, at 11.

34. *See* RICHARD M. STALLMAN, *Copyright and Globalization in the Age of Computer Networks, in* FREE SOFTWARE FREE SOCIETY: SELECTED ESSAYS OF RICHARD M. STALLMAN 133-44 (Joshua Gay ed., 2002).

35. *Id.* Examples of improvements to the ease of copying include the transitions from photocopiers to scanners, from VCRs to TiVos, and music production technology, such as CD/DVD burners, samplers, etc.

36. Lawrence Lessig, *The Creative Commons*, 65 MONT. L. REV. 1, 2-3 (2004).

37. *Id.* at 6-7.

now regulated within the scope of copyright law when carried out in the digital environment.[38]

Lessig also points out that digital advances and the laws that authorize them[39] are dramatically altering the way that copyright is enforced.[40] For instance, before the use of the Internet became widespread, copyright violations were regulated through the courts, and a judge was ultimately responsible for determining whether a violation existed or whether a user's conduct was permissible.[41] Now, programming code written into digital technologies dictates what access a user is entitled to, and the anti-circumvention provisions of the DMCA ensure that a user cannot get around such code.[42] In this sense, the copyright holders are enforcing copyrights themselves, rather than through the traditional court system.

Legal activists are responding to the change in regulation and enforcement of copyright law and potential abuse thereof through undertakings such as the Chilling Effects Clearinghouse, a group dedicated to protecting online activity from copyright-based legal threats that may be impermissible violations of free speech.[43] Concerned Internet activists founded the group in 2001 based on the observation that the unregulated private practice of sending cease-and-desist letters under the auspices of the DMCA was increasing and potentially having a "chilling effect" on speech and fair use of copyrighted material.[44] Specifically, although fair use of copyrighted material is permitted,[45] it is necessary for a user of software protected by the DMCA to break the provisions of the DMCA in order to carry out a fair use. As such, the DMCA can be viewed as preventing access to materials that would otherwise be in the public domain. Although Stallman, Lessig, and Heller base their positions on different aspects of copyright practice, they all reach the same conclusion, and in light of this, it appears that the Supreme Court's long-standing assertion that copyrights promote innovation[46] may not be accurate.

B. Problems with Patent Overprotection: Tragedy of the Anticommons

Concern that changes in the implementation, scope, and enforcement of copyright law are stifling innovation has been echoed in the world of patents.

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38. *Id.*

39. For example, the Digital Millennium Copyright Act of 1998, Pub. L. No. 105-304, 112 Stat. 2860 (1998) (adding 17 U.S.C. §§ 512, 1201–1205 and 28 U.S.C. § 4001, and substantially amending 17 U.S.C. §§ 101, 104, 104A, 108, 112, 114, 117, 701).

40. Lessig, *supra* note 36, at 7-8.

41. *Id.*

42. *Id.*

43. CHILLING EFFECTS CLEARINGHOUSE, http://www.chillingeffects.org/ (last visited Oct. 19, 2010) (with contributors from the Harvard, Stanford, Berkeley, University of San Francisco, University of Maine School of Law, George Washington School of Law, and Santa Clara University School of Law clinics).

44. *Id.* In some instances, overly aggressive tactics or misrepresentations by copyright owners to suppress legal activities have even led to law suits. *See, e.g.*, Rossi v. Motion Picture Ass'n of Am., 391 F.3d 1000 (9th Cir. 2004) (tortuous interference, libel, and intentional infliction of emotional distress); Online Policy Grp. v. Diebold, Inc., 337 F. Supp. 2d 1195 (N.D. Cal. 2004) (misrepresentation of copyright infringement and tortuous interference).

45. *See supra* note 11.

46. *See* cases cited, *supra* note 8.

Michael Heller, a professor at the Michigan Law School, has postulated that the existence of numerous patent proprietary rights can preclude achieving a socially desirable outcome, a situation he termed the "tragedy of the anticommons."[47] Heller describes this situation as occurring in the field of biomedical research, where the proliferation of fragmented and overlapping intellectual property rights creates an *anticommons* that stifles scientific research.[48] Supporters of this position point to increased privatization encouraged by laws that have promoted patenting biotechnology inventions in universities, such as the Bayh-Dole Act.[49] The trend of increased university patenting has snowballed as institutions become dependent on licensing revenues from commercially successful patented technologies and the associated prestige.[50] However, because only a small number of patents lead to commercial success, patenting is a bit of a lottery system,[51] although the risks of obtaining a patent are not just un-recouped expenses for the university, but also lost opportunities for other researchers who are blocked from carrying out downstream research without obtaining a license.

The problem with an increased number of upstream patents or patents generally related to research tools (rather than to marketable products such as pharmaceuticals) has been succinctly summarized by law professor Mark Lemley: "[W]hile in theory patents spur innovation, they can also interfere with it. Broad patents granted to initial inventors can lock up or retard improvements needed to take a new field from interesting lab results to commercial viability."[52] A recent survey indicates that scientists attribute problems of delayed or blocked access to necessary materials and knowledge to poor management of intellectual property rights, with no correlative benefits in spurring innovation.[53]

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47. *See generally* Michael A. Heller, *The Tragedy of the Anticommons: Property in the Transition from Marx to Markets*, 111 HARV. L. REV. 622 (1998). In this article Heller notes that after the fall of Communism, there were many open air kiosks in front of empty stores in cities, and concludes that, since many agencies and private parties had proprietary rights governing the use of store space, it was extremely challenging for a new retailer to negotiate the use of that space. This prevented the effective use of store front property, and became the classic example of the tragedy of the anticommons. *Id.* at 622-24.

48. Heller & Eisenberg, *supra* note 3, at 701.

49. Universities and Small Business Patent Procedures Act, Pub. L. No. 96-517, 94 Stat. 3015 (1980) (codified at 35 U.S.C. §§ 200-212 (2000)); Lorelei Ritchie de Larena, *The Price of Progress: Are Universities Adding to the Cost?*, 43 HOUS. L. REV. 1373, 1378-84 (2007). Professor de Larena notes that, although the stated intention of the Bayh-Dole Act was to standardize the rules of ownership regarding inventions created using federal research funds, the impact has been much wider, and Bayh-Dole is commonly perceived as the impetus behind a dramatic increase in the number of patents obtained by universities. *Id.* The Bayh-Dole Act provides strong incentives to apply for patents because patent rights are granted to the inventors, rather than to the government funding agency. Megan Ristau Baca, *Barriers to Innovation: Intellectual Property Transaction Costs in Scientific Collaboration*, 2006 DUKE L. & TECH. REV. 4, ¶ 14, http://www.law.duke.edu/ journals/dltr/articles/pdf/2006dltr0004.pdf (last visited Oct. 19, 2010).

50. Ritchie de Larena, *supra* note 49, at 1381.

51. *Id.* at 1381-82.

52. Mark A. Lemley, *Patenting Nanotechnology*, 58 STAN. L. REV. 601, 618-19 (2005).

53. Zhen Lei et al., *Patents Versus Patenting: Implications of Intellectual Property Protection for Biological Research*, 27 NATURE BIOTECHNOLOGY 36, 37-38 (2009). However, a dissenting group of scholars suggest that the rise in the level of biotechnology patenting has no adverse effect on innovation.

A more nuanced view is that while innovation is proceeding, at least in some areas, there are also problematic areas where a proliferation of patents is hampering the progression of crucial research. For example, negotiating licenses and transfer of material for even a single patented product may be prohibitively costly and time-consuming for legally unsophisticated scientists or those researching diseases unlikely to be commercially successful.[54] The number of patents involved multiplies these prohibitive costs, and obtaining licenses, necessary to avoid the even more costly problem of infringement litigation, becomes an extremely daunting task.

The consequences of high transaction costs are stifled innovation and less research. Such stifling may prevent drug development in any area, but it is particularly notable in relation to diseases prevalent in developing countries because pharmaceutical companies are not interested in investing in areas where they believe they will not be able to make the large returns needed to justify their initial legal investment. In addition, the smaller companies and university research labs that do work on these projects are stymied by their inability to gain sufficient and timely access to needed patented subject matter.[55]

The tragedy of the anticommons in preventing crucial drug development has been articulated by Bennett Shapiro, former vice president of Merck & Co., Inc. (Merck), in relation to schizophrenia.[56] Shapiro states:

> [People taking] compounds for schizophrenia, a disorder of the dopamine system, often develop other disorders some of which resemble Parkinson's disease, another disease involving the dopamine system. A rational approach to discovery of improved schizophrenia drugs would be to target specific dopamine receptors. But if different companies hold patents on different receptors, the first step on the path to an important and much needed therapeutic advance can be blocked.[57]

The implications of patent over-proliferation are underscored by examining the whole process a company such as Merck must go through to bring a potential drug to the market. For example, Merck must uncover any potential side effects of a compound before spending millions of dollars on clinical tests and development. However, if the materials necessary for undergoing research to determine side effects (such as new or improved assays,[58] crucial proteins such as dopamine receptors, etc.) are patented, the research phase becomes prohibitively expensive.[59] Specifically, before Merck can test the compound with a particular receptor using the correct assay, Merck must obtain a license from every patent owner involved. This onerous task is necessary because in order to be approved for use, the

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David E. Adelman & Kathryn L. DeAngelis, *Patent Metrics: The Mismeasure of Innovation in the Biotech Patent Debate*, 85 TEX. L. REV. 1677, 1679-80 (2007).

54. Lee Petherbridge, *Road Map to Revolution? Patent-Based Open Science*, 59 ME. L. REV. 339, 355 (2007).

55. Ann Weilbaecher, Comment, *Diseases Endemic in Developing Countries: How to Incentivize Innovation*, 18 ANNALS HEALTH L. 281, 285 (2009).

56. HELLER, *supra* note 27, at 53.

57. *Id.*

58. An assay is a biological or immunological test carried out in a laboratory, often to detect the presence or absence of a substance in a sample or the activity level of a drug or the like.

59. HELLER, *supra* note 27, at 54.

compound must be demonstrably safe and effective. Therefore, every patent involved becomes a "tollbooth" where Merck must pay money to the patent owner, and if it is determined that the entire field of research will be too costly, Merck will simply abandon the project and move on to an area of research that is less challenging both legally and financially.[60] Unfortunately, the real loser in this scenario is the public, which is denied access to a potential cure to a devastating disease. Therefore, as with copyrights, it appears that the Supreme Court's assertion[61] that patents promote innovation may not be accurate.

IV. CURING STIFLED INNOVATION: DEVELOPMENT OF THE OPEN SOURCE MOVEMENT

The first allegation that proprietary laws such as the Copyright Act of 1976 were *not* stimulating innovation came from the computer programming industry. In the early days of computer programming, proprietary restrictions on the source code of software were rare and hackers shared their code widely.[62] However, one consequence of the Copyright Act of 1976 was that many manufacturers stopped distributing source code and began using copyright and restrictive software licenses to limit or prohibit copying and redistribution to prevent software from being appropriated by their competitors.[63] These increased copyright restrictions have been suggested to be counterproductive to the innovation and knowledge generation that copyright was intended to encourage.[64] Although the hacker community resented this change, most of them were able to work within the system.[65] However, Richard Stallman, a computer hacker working at MIT, was not

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60. *Id.* However, there may be some relief for companies like Merck in sight. The research exception for activities carried out in relation to FDA approval has recently been expanded to include a broader range of activities, including preclinical research. *See* Merck KGaA v. Integra Lifesciences I, Ltd., 545 U.S. 193 (2005). In light of this broadened exception, fewer patents would have a "tollbooth" effect. However, interpreting whether a particular use would be exempt or not could involve costly litigation (at least currently) and thus it may be simpler or easier to obtain a license or move on to different research.

61. *See supra* note 19.

62. Brewster Kahle, a hacker at MIT in the 1970s and 1980s, discusses the effect of the Copyright Act of 1976, emphasizing that before the Act copyrights had to be affirmatively asserted, so many works were not copyrighted. Transcript of Interview with Brewster Kahle, *NerdTV #4: Brewster Kahle*, PBS, http://www.pbs.org/cringely/nerdtv/transcripts/004.html (last visited Oct. 19, 2010). However, after the Act was passed, the formality requirements for copyrights were largely dropped, and works became automatically copyrighted. *Id.* Institutions like MIT and various companies immediately capitalized on this change for commercial profit. *Id.*

63. *Id.*

64. *See generally* LAWRENCE LESSIG, THE FUTURE OF IDEAS (2001) [hereinafter THE FUTURE OF IDEAS] (postulating that aspects of the internet that are part of the commons promoted the tremendous innovation that resulted in the Internet as we know it, and warning that changes in copyright and patent laws will stifle further creativity and progress unless users fight back). Lessig states:

> The argument of this book is that always and everywhere, free resources have been crucial to innovation and creativity; that without them, creativity is crippled. Thus, and especially in the digital age, the central question becomes not whether government or the market should control a resource, but whether a resource should be controlled at all.

Id. at 14.

65. JANET HOPE, BIOBAZAAR 7-8 (2008).

among them.[66]

Stallman fought back by developing a "free" software project (where "free" refers to the liberty of others to use source code for any purpose rather than price) based on an operating system he developed called GNU.[67] Stallman launched the GNU project in 1984 together with the GNU Manifesto, which explained the purpose of the project to hackers and requested their participation and support.[68] The GNU project works together with the Free Software Foundation to ensure free software remains a part of the public domain, promoting innovation by ensuring that software remains accessible to all to build on and change as they please.[69]

In order to achieve this goal, Stallman created a license that focuses on "the rights of software *users* instead of software owners," called a "copyleft" license, now referred to as the General Public License (GPL).[70] The GPL elegantly guarantees that further innovations belong to the public: under its terms the owner of the work grants users broad rights to use, modify, or distribute the work in any way they like, free of charge.[71] If a user builds on the work and develops a new product or a modified version, the user must make the new work freely available to the public under the same terms.[72] In other words, the license grants users access to a continually growing commons from which they cannot withdraw.

Hackers embraced the GPL, thereby ensuring its success and the thriving development of a large computer programming public commons. The most well known example is Linux: an operating system developed communally by hackers based on the terms of the GPL.[73] Although Linux is an operating system generally favored by computer programmers rather than by the public for use on personal computers, the Internet as we know it would not exist except for open source software.[74] For example, the 100,000 servers at Google all run on Linux and are widely used by the public.[75]

The development of Linux, the crowning success of Stallman's free software movement, marked the birth of a closely related, but philosophically different branch-off: open source software.[76] The Open Source Initiative (OSI), recognizing the successes of the Free Software Foundation and the GPL, hopes to improve upon them by combining the free software concept with the standard proprietary model to reach a broader community.[77] The OSI acknowledges the superiority of free software, noting:

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66. *Id.* at 4-5, 8.

67. *Id.* at 8-9. GNU is a recursive acronym standing for "'*G*nu's *N*ot *U*NIX.'" *Id.* at 9.

68. *Id.* at 9. For a copy of the GNU Manifesto, see *The GNU Manifesto*, GNU OPERATING SYSTEM, http://www.gnu.org/gnu/manifesto.html (last visited Oct. 19, 2010).

69. FREE SOFTWARE FOUNDATION, http://www.fsf.org/ (last visited Oct. 19, 2010).

70. HOPE, *supra* note 65, at 11.

71. *See GNU General Public License*, GNU.ORG, http://www.gnu.org/licenses/gpl.html (last visited Oct. 19, 2010).

72. *Id.*

73. HOPE, *supra* note 65, at 11-13.

74. *Id.* at 16 (stating that "the Internet is built, overwhelmingly, on open source software").

75. *Id.*

76. David W. Opderbeck, *The Penguin's Genome, or Coase and Open Source Biotechnology*, 18 HARV. J.L. & TECH. 167, 180 (2004).

77. *Id.*

> When programmers can read, redistribute, and modify the source code for a piece of software, the software evolves. People improve it, people adapt it, people fix bugs and this can happen at a speed that, if one is used to the slow pace of conventional software development, seems astonishing. We in the open source community have learned that this rapid evolutionary process produces better software than the traditional closed source model, in which only a very few programmers can see the source and everybody else must blindly use an opaque block of bits.[78]

The OSI created the open source movement based on this superiority, expanding the reaches of the free software movement from the hacker community to commercial users. The open source movement merges the key concept of free software, providing the source code, with the more traditional proprietary norms of copyrights, maintaining that some intellectual property law needs to exist to protect cultural producers.[79] Under the open source movement, the rights to be retained by the copyright holder are self-determined by the copyright holder's choice of license.[80] For example, the Artistic License 2.0 (one among many licenses selectable) is designed such that the copyright holder maintains some artistic control over the development of the work by allowing users to freely copy and distribute the work, but not to change and then distribute changed versions of the work.[81] This approach attempts to promote innovation by increasing the amount of material in the public domain in combination with conferring rights to the creator. However, the rights retained by the creator tend to be along the lines of artistic control rather than rights that may be exploited for commercial gain.

The success of the open source software movement sparked interest in other areas, and projects expanding the concept of open source to other domains traditionally protected by copyright were born. The most prevalent of these is Creative Commons, founded in 2001 by cultural activist Lawrence Lessig.[82] Lessig's concerns regarding accessibility to creative cultural works and the dramatic expansion of copyright terms and coverage[83] guides Creative Commons' attempts to promote innovation by increasing access to creative works in the public domain and providing a series of licenses users can choose from, communicating which rights they reserve and which rights they waive for the benefit of recipients or other creators.[84] As with the OSI, the approach Creative Commons adopts

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78. OPEN SOURCE INITIATIVE (Nov. 28, 2006, 2:04 AM), http://web.archive.org/web/20061128020422/http://www.opensource.org/ (last accessed by searching for www.opensource.org in the Internet Archive Index, Oct. 19, 2010).

79. HOPE, *supra* note 65, at 15.

80. *Licensing*, OPEN SOURCE INITIATIVE (Sept. 24, 2006, 1:21 PM), http://web.archive.org/web/20060924132143/http://www.opensource.org/licenses/index.php (last accessed by searching for www.opensource.org/licenses/index.php in the Internet Archive Index, Oct. 19, 2010).

81. *Artistic License 2.0*, OPEN SOURCE INITIATIVE, http://www.opensource.org/licenses/artistic-license-2.0.php (last visited Oct. 19, 2010).

82. *History*, CREATIVE COMMONS, http://creativecommons.org/about/history/ (last visited Oct. 19, 2010) [hereinafter *History*].

83. *See* THE FUTURE OF IDEAS, *supra* note 64, at 106-07 (describing the expanded scope of current copyright protection); *see also id.* at 250-57 (describing changes Lessig would like to see in copyright law).

84. *See History*, *supra* note 82 (detailing the exponential growth of Creative Commons around the world). As of 2009, Creative Commons has provided licenses for over 130 million works. *Id.*

confers rights to the creator generally related to artistic control rather than rights which can be exploited for commercial gain, unlike those associated with traditional copyright.

V. OPEN SOURCE PARADIGMS AND BIOTECHNOLOGY: THE SCIENCE COMMONS

Based on the presumption that excessive patenting stifles innovation in fields such as biotechnology, Creative Commons launched a new project in 2005 called Science Commons.[85] Although not explicitly put forth by Science Commons, the implicit goal appears to be promoting innovation by using open source strategies to replace traditional intellectual property systems such as patents. The stated goal of Science Commons is to promote "faster, more efficient web-enabled scientific research" by identifying and lowering "unnecessary barriers to research" and thereby "unlocking the value of research so more people can benefit from the work scientists are doing."[86] In other words, the goal of Science Commons is to promote innovation for the benefit of the public, just as the goal of the Intellectual Property clause in the Constitution and subsequent patent legislation is to promote innovation for the benefit of the public.[87] Therefore, in order to be successful, Science Commons must promote innovation at least as much as the systems currently in place.

Science Commons is designed to build on Creative Commons' approach, and is based on the belief that innovation carried out by scientific enterprises is impossible without easy access to materials, publications, and data.[88] Therefore, Science Commons launched projects to improve access in these three areas by increasing the volume of, and accessibility to, materials in the public domain.[89] The following discussion describes how three of these projects are intended to work. The success of the projects is addressed separately.

A. The Biological Materials Transfer Project

Biological materials are essential to biotechnology research. Cell lines,[90] DNA probes,[91] and animal models[92] are examples of biological materials that are crucial for testing and validating hypotheses. Conducting research with specific materials provides key information that cannot be replicated without access to that specific material. However, despite the importance of biological materials for scientific research, material transfer remains overly complex, which significantly impacts the quantity and quality of research.

Biological materials are routinely transferred between labs subject to the terms

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85. SCIENCE COMMONS, http://sciencecommons.org/ (last visited Oct. 19, 2010).

86. *Id.*

87. *See supra* notes 8, 19 and accompanying text.

88. *See* SCIENCE COMMONS, *supra* note 85.

89. *Id.*

90. Cell lines are a single type of cell adapted to grow continuously when cultured in a laboratory.

91. A DNA probe is a single-stranded DNA molecule used in laboratory experiments to detect the presence of a complementary sequence among a mixture of DNA fragments, which can indicate presence or absence of a particular gene or mutation.

92. An animal model is a laboratory animal useful for research because it has specific characteristics that resemble a human disease or disorder.

of material transfer agreements (MTAs).[93] These agreements, drafted by individual institutions, are often complex documents, requiring coordination between lawyers and technology transfer offices of the respective institutions rather than allowing for a simple exchange of material between scientists.[94] MTAs formalize the relationship between the provider and the recipient of the material, and set forth rules regarding commercial exploitation or publication of research based on the material.[95] Using such licenses generally involves significant transaction costs and delays, which can be crucial in research, particularly for small researchers. In worst-case scenarios, negotiations for a material transfer can be so protracted and painful that a scientist may find it easier to re-make the material, often at taxpayer expense.[96]

The Biological Materials Transfer Project is dedicated to improving access to biological materials required by researchers, and draws heavily on the success of the Creative Commons licenses. This project provides standard modular contracts that researchers can access on the Science Commons website and then employ to lower the costs of transferring biological materials such as DNA, cell lines, and model animals.[97]

B. The Scholar's Copyright Project

Scientific research has long been recorded in paper form to allow research to be critiqued and built upon by others. Furthermore, scientific success is often evaluated based on the number of publications a researcher has and the prestige of the journals in which the research is published.[98] Digital technologies replicate paper technology and permit instantaneous publishing and copying of research. However, the legal aspects of copyright associated with sharing research through paper have not been adapted appropriately to the digital world.[99]

A unique aspect of copyright law in relation to publishing scientific research is that, traditionally, the author of an article was required to transfer his or her rights in the copyright to the journal publisher, allegedly necessary to protect the copyright and coordinate reprints and the like. This is a practice that has continued into the digital age—as owners of the copyright, online publishers can prevent authors and people who purchase licenses to view articles from making archival copies of the articles.[100]

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93. Wendy D. Streitz & Alan B. Bennett, *Material Transfer Agreements: A University Perspective*, 133 PLANT PHYSIOLOGY 10, 10 (2003).

94. *Id.* at 10-13.

95. *See* Victor Rodriguez et al., *On Material Transfer Agreements and Visibility of Researchers in Biotechnology*, 2 J. INFORMETRICS 89 (2008).

96. BIOLOGICAL MATERIALS TRANSFER PROJECT, http://sciencecommons.org/projects/licensing/ (last visited Oct. 19, 2010).

97. *Id.*

98. *Publish or Perish*, WIKIPEDIA, http://en.wikipedia.org/wiki/Publish_or_perish (last visited Jan. 26, 2010). "Publish or perish" refers to the notion that researchers must publish frequently in well-respected journals in order to obtain funding. *Id.*

99. *See supra* Part III.

100. *License to Publish*, OXFORD JOURNALS, http://www.oxfordjournals.org/our_journals/hmg/for_authors/licence.pdf (last visited Oct. 19, 2010) [hereinafter *License to Publish*] (indicating that if the

Many authors and readers have found this approach to be unsatisfactory, spawning the Open Access (OA) movement.[101] Under this approach, the publisher obtains a license to publish and the author retains the copyright in exchange for paying a fee.[102] However, as with MTAs discussed above, the solution to the problem can be complex and legally sophisticated and may require a lawyer to carry out the transaction. The Scholar's Copyright Project attempts to lower the barriers to OA by reducing transaction costs and eliminating contract proliferation.[103] Through the Scholar's Copyright Project, Science Commons offers a spectrum of tools and resources catering to authors who wish to publish their work and retain copyright ownership. The Scholar's Copyright Project does this either by helping authors publish in an OA journal, or by negotiating a license where the author may archive a copy of his or her article and make it freely available on the Internet if they wish.[104]

C. The Neurocommons

In addition to gleaning information from empirical studies, biotechnology researchers have access to myriad knowledge sources that must be reviewed and incorporated into their experimental design and analysis. Some of the knowledge sources available are peer reviewed journals, patent applications, and online databases of genetic or protein sequences. As a result, many scientists spend as much time on Google and PubMed[105] as they do at the laboratory bench. The founders of Science Commons posit that the explosion of available information in biotechnology research overwhelms any one individual's ability to store and model all the relevant science in his or her head.[106] The result is problematic: methods for generating information have gone digital and quasi infinite, while methods for processing and using that information remain neurological.[107]

The goal of the Neurocommons project is to assuage the aforementioned issue and maximize the availability and the usability of scientific research materials such as research articles, knowledge bases, research data, and physical materials.[108] In order to achieve this goal, the Neurocommons project attempts to render existing databases and search engines interoperable through the "Semantic Web." The Semantic Web uses the current World Wide Web as we know it, but adopts

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article is published in paper form or in standard online form, the author must transfer the copyright to the publisher).

101. *See Open Access Movement*, WIKIPEDIA, http://en.wikipedia.org/wiki/Open_Access_movement (last visited Oct. 19, 2010).

102. *See License to Publish*, *supra* note 100 (illustrating an example of an Open Access publishing license).

103. *See Scholar's Copyright Project*, SCIENCE COMMONS, http://sciencecommons.org/projects/publishing/ (last visited Oct. 19, 2010).

104. *Id.*

105. PubMed, a service of the United States National Library of Medicine, is a free search engine for accessing a bibliographic database of citations, abstracts, and full text articles on life science and biomedical topics. PUBMED, http://www.ncbi.nlm.nih.gov/pubmed/ (last visited Oct. 19, 2010).

106. *The Neurocommons*, SCIENCE COMMONS, http://sciencecommons.org/projects/data/ (last visited Oct. 19, 2010).

107. *See id.*

108. *Id.*

common formats and uses the same language and nomenclature so that existing data may be integrated and combined, thus becoming more accessible to researchers.[109] John Wilbanks, Executive Director of Science Commons, describes his image of the Neurocommons:

> With this system, scientists will be able to load in lists of genes that come off the lab robots, and get back those lists of genes with relevant information around them based on the public knowledge. They'll be able to find the papers and pieces of data where that information came from, much faster and more relevant than Google or a full text literature search, because for all the content in our system, we've got links back to the underlying sources. And they've each got an incentive to put their own papers into the system, or to make their corner of the system more accurate for the better the system models their research, the better results they'll get. We'll be inviting the bioinformatics community to work on both the content and the analytic software. Neither one can easily reach potential in a single organization.[110]

As a test model, the Neurocommons project focuses on sources specific to neuroscience and neuromedicine, rather than all biotechnology research fields. Neuroscience is a particularly apt focus area because of the tremendous amount of public data available from the use of computer-implemented research techniques such as high throughput screening and gene chips.[111]

VI. CRITICISMS OF THE SCIENCE COMMONS PROJECTS

Despite their laudable aims of increasing the availability and amount of material in the public domain for researchers to use, the Biological Materials Transfer, the Scholar's Copyright, and the Neurocommons projects are ineffective at promoting innovation. The Biological Materials Transfer Project largely mirrors an existing system, and is therefore redundant. Similarly, the complications that the Scholar's Copyright Project attempts to address are not severe enough to actually prevent authors from utilizing currently available forms of open access publishing, thus rendering the project unnecessary. Finally, as will be elaborated below, the Neurocommons is unusable for researchers who lack significant computer programming knowledge. Even if this project is imagined to be user-friendly and fully functional, it is unlikely that providing access to more data will promote innovation, as discussed below.

A. The Biological Materials Transfer Project is Redundant

The Biological Materials Transfer Project does not contribute anything substantial to the world of scientific research because public and universal material transfer agreements already exist and are widely used. In the hope of "alleviating some of the paperwork associated with MTAs," the National Institute of Health established the Uniform Biological Material Transfer Agreement (UBMTA) for use

109. *Id.*
110. *Id.*
111. *Id.*

by non-profit organizations.[112] Institutions that sign the master agreement are able to transfer materials under the agreement with other institutions through the use of a simple implementing letter.[113] As of 2007, there were 320 institutions signed onto the UBMTA master agreement.[114]

Critics might point out that the UBMTA does not solve the problems the Biological Materials Transfer Project attempts to address because it is only for use by non-profits and cannot serve as a model for a profit-minded company because of different policies, procedures, valuations, and objectives that must be written into the contract. However, non-profit organizations are the entities likely to have the most difficulty navigating the legal and financial hurdles of obtaining an MTA. In contrast to an independent researcher affiliated with a university, even a small biotechnology or pharmaceutical company is likely able to afford legal assistance to draft an appropriate MTA when necessary. As such, the Biological Materials Transfer Project is largely superfluous in light of the availability of, and advances made by, the UBMTA.

Furthermore, the biotechnology research community often functions like the hacker community, lamented by Richard Stallman as being lost,[115] where members cooperate with each other without involving institutions and their associated formalities. For example, a student researcher may come across an article describing a cell line that would be particularly suitable for use in her experiments. Under the formal process, the student would go to the university's technology transfer office and request them to draft a request to the institution where the research regarding the cell line was initiated. The other institution would then prepare an MTA based on their desired terms, and the student's technology office would agree, disagree, or modify the MTA. However, much more commonly, the student will simply contact the author directly and request a small sample of the cell line. The author often chooses to respond to the informal request positively and sends a sample to the student. Although there are situations where a request for informal transfer is unsuccessful,[116] in my experience they are relatively rare.[117]

B. The Scholar's Copyright Project is Unnecessary

Open access publishing had already successfully taken off before the Scholar's

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112. Katharine Ku, Commentary, *Point: MTAs are the Bane of our Existence!*, 25 NATURE BIOTECHNOLOGY 721, 722 (2007).

113. *Id.*

114. *Id.* This relatively widespread use supports the notion that the Biological Materials Transfer Project may not be necessary.

115. *See supra* Part IV.

116. Legitimate reasons for denying transfer of material are easy to imagine, such as a particularly laborious production method or protecting the ability of a student or research associate to publish related results using the material.

117. In my three years of carrying out laboratory research on a Spinobulbar Muscular Atrophy (a rare human genetic disease), I was never denied a request for materials from another lab. Materials provided from other labs varied from DNA fragments to tissue from genetically modified mice. However, some denials are reported by other scientists. In a survey conducted in 2000, forty-seven percent of geneticists asking for information, data, or materials "reported that at least [one] of their requests had been denied in the preceding [three] years." Eric G. Campbell et al., *Data Withholding in Academic Genetics*, 287 JAMA 473, 473 (2002).

Copyright Project was established, making this tool unnecessary. As such, the Scholar's Copyright Project does little to promote innovation by increasing access to research data. The Public Library of Science (PLS), a nonprofit organization of scientists and physicians and a pioneer in open access publishing, launched its first journal in 2003[118] and has since expanded to seven well-regarded, broad-topic journals.[119] PLS has been joined in the field by other prolific open access publishers such as BioMed Central, with 206 journals,[120] and the Directory of Open Access Journals, which includes free, full text, quality controlled scientific and scholarly journals of all subjects and languages, currently boasting 5,358 journals.[121]

Furthermore, some open access scientific journals currently use a Creative Commons license.[122] Suggesting that authors may need additional assistance to navigate such licenses actually undermines the purpose of the Creative Commons program[123] and underscores this Comment's assertion that the Scholar's Copyright Project is not actually required or relevant.

A potential problem with open access publishing that the Scholar's Copyright Project fails to address is that authors may be less concerned with increasing accessibility to their work and more concerned with the impact factor[124] of the journal in which they publish. Many authors eschewed publishing in or even subscribing to open access journals in the early days of open access publishing for just these reasons.[125] In the past, the prestige of open access journals had been considered lower than that of traditional journals for various reasons;[126] however, this may no longer be the case. Standard measures of the prestige of scientific journals such as impact factor or the number of citations now rank open access journals on the same levels as traditional journals.[127]

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118. *See* Saeed Shah, *US Public Library of Science Launches Rival to 'The Lancet'*, THE INDEPENDENT (Oct. 19, 2004), http://www.independent.co.uk/news/media/us-public-library-of-science-launches-rival-to-the-lancet-544205.html (last visited Oct. 19, 2010).

119. For the seven PLoS journals, see *The PLoS Journals*, PUBLIC LIBRARY OF SCIENCE, http://www.plos.org/journals/index.php (last visited Oct. 19, 2010).

120. BIOMED CENTRAL, http://www.biomedcentral.com/ (last visited Oct. 19, 2010).

121. DIRECTORY OF OPEN ACCESS JOURNALS, http://www.doaj.org/ (last visited Oct. 19, 2010).

122. The PLoS journals use the Creative Commons Attribution License. *See License*, PUBLIC LIBRARY OF SCIENCE, http://www.plos.org/journals/license.php (last visited Oct. 19, 2010).

123. *See supra* Part IV.

124. Impact factor is a measure reflecting the average number of citations to articles published in science and social science journals. It is indicative of the relative importance of a journal within its field; journals with higher impact factors are deemed to be more important than those with lower ones. Impact factors are calculated yearly by Thompson Reuters. *See The Thompson Reuters Impact Factor*, THOMPSON REUTERS, http://thomsonreuters.com/products_services/science/free/essays/impact_factor/ (last visited Oct. 19, 2010).

125. *See generally* Sara Schroter et al*., Perceptions of Open Access Publishing: Interviews with Journal Authors*, 330 B.M.J. 756 (2005).

126. Gabe Bloch, *Transformation in Publishing: Modeling the Effect of New Media*, 20 BERKELEY TECH L.J. 647, 669-70 (2005).

127. SCIENCE and NATURE are generally regarded as the most prestigious scientific research journals and are routinely awarded impact factors of approximately thirty. *See Impact Factor*, WIKIPEDIA, http://en.wikipedia.org/wiki/Impact_factor (last visited Oct. 19, 2010). Well-renowned specialty journals such as GENOMICS generally rate around 3. GENOMICS, http://www.elsevier.com/wps/find/journaldescription.cws_home/622838/description#description (last visited Oct. 19, 2010). In

C. The Neurocommons is Unusable

Unfortunately, the Neurocommons is largely unusable to researchers who are not also computer programmers, as acknowledged by the Science Commons group.[128] In its simplest form, the Neurocommons integrates a number of existing public databases and allows a researcher to search them all simultaneously. However, at this time, searches can only be run if they are written in a rare computer code called SPARQL.[129] It can be assumed that the average researcher working in a laboratory would be unable to access these grouped databases and would therefore resort to the current method of searching databases one at a time.

Even assuming the Neurocommons has a successful, user-friendly interface, the concept is flawed: preventing access to data cannot logically be seen as the problem in innovation caused by an over-proliferation in patents.[130] Researchers are never at a loss for experiments to run because they cannot read enough journals or find related gene sequences or interacting proteins. Even in the digital world, scientific innovation still proceeds based on the analog time frame of the individual cogitations required to interpret data and design experiments. Therefore, high tech solutions, such as the Neurocommons, that aim to increase access to data will not be useful in speeding up research because each new piece of information must be analyzed by the researcher for relevance and the appropriate hypotheses must be adopted and tested.

As such, the Neurocommons, like the Biotechnology Materials Transfer Project and the Scholar's Copyright Project, is unlikely to promote innovation in biotechnology. By understanding the reasons underlying the failure of Science Commons, a potential workable solution may become evident.

VII. ANALYZING THE SHORTCOMINGS OF THE SCIENCE COMMONS CONCEPT

A. Biotechnology is Not a Suitable Candidate for Open Source Approaches

As detailed in Parts IV and V of this Comment, Science Commons is modeled on Creative Commons and the Open Source Movement. In the open source software model, users of the software are assumed to contribute widely to the improvement of the projects, and the project grows and expands as a result. However, law professor Yochai Benkler has postulated that this model cannot be extrapolated easily to biotechnology research.

Benkler established criteria for determining whether open source production

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2006, PLOS BIOLOGY was awarded an impact factor of 14.7 and PLOS MEDICINE of 13.8. PLOS, http://www.plos.org/cms/node/233 (last visited Oct. 19, 2010).

128. *See The Neurocommons*, SCIENCE COMMONS, http://sciencecommons.org/projects/data/ (last visited Oct. 19, 2010) (stating that in the "short term this is most valuable to people who already know how to use it. The skill set is rare and still considered a specialty. But over time the use of machine-annotation should evolve into a mainstream part of biology, just as the use of machine-generated data has evolved").

129. *See The NeuroCommons Project*, SCIENCE COMMONS, http://neurocommons.org/page/Main_Page (last visited Oct. 19, 2010).

130. Scientists may publish findings less frequently or not at all in order to preserve the novelty of their invention, a requirement to obtain a patent. *See supra* text accompanying notes 16-17.

methods can extend to new fields such as biotechnology.[131] According to Benkler, the technology must first be divided into layers.[132] Using the Internet as an example, the layers are the hardware layer (the machines running the network), the software or code layer (the information traveling over the network), and the content layer (the information being communicated).[133] The next step is determining whether open source paradigms would be feasible and efficient with respect to any layer.[134] For Benkler, feasibility generally requires that a layer be divisible into small components that can be worked on by many users.[135]

Benkler's analysis can be applied to biotechnology to determine whether it is a suitable candidate for open source. Law professor David Opderbeck carried out this analysis, splitting a biological system, such as an organism, into hardware (cells and tissues), software (genetic code), and content (protein interaction and chemical pathways) layers.[136] Opderbeck concludes that the code layer of biotechnology, gene sequence data, is a possible candidate for use in an open source system, but determines that the robust competition in this field would prevent development of an open source system.[137]

There are additional theoretical complications suggesting that biotechnology may not be a suitable field for implementation of open source systems. For instance, innovation in biotechnology involves significantly higher costs than areas such as software development. Complex reagents and equipment are prohibitively expensive, and as a result, there are few, if any, individual researchers: most research is carried out on behalf of an institution.[138] For this reason, the material incentives of exclusive patent rights are likely key in order to promote innovation and are even required to provide a rich public domain. The artistic control conferred to creators by the rights awarded through systems like Creative Commons would be an insufficient incentive for biotechnology researchers and/or their backers.

The involvement of deep-pocketed institutions in biotechnology research leads to the next potential problem: there is no "user" community in biotechnology collaborating on the same project akin to the hacker community underlying the open source software movement.[139] Opderdeck postulates that the social-psychological rewards inherent in the hacker community were the driving force of open source development therein, and an equivalent community/reward system would be necessary for open source to be successful in other areas.[140] In fact, users

131. *See* Yochai Benkler, *Coase's Penguin, or, Linux and* The Nature of the Firm, 112 YALE L.J. 369 (2002).

132. *Id.* at 378-79.

133. FUTURE OF IDEAS, *supra* note 64, at 23-25.

134. Benkler, *supra* note 131, at 379.

135. *Id.*

136. Opderbeck, *supra* note 76, at 183-85.

137. *See id.* at 226.

138. Petherbridge, *supra* note 54, at 364.

139. Although this Comment analogizes researchers to hackers in terms of sharing materials in *supra* Part VI, hackers as "users" of a single large scale programming project such as Linux where commercial reward is unlikely to occur are distinguishable. Scientific researchers all work on different projects; collaborations, as among hackers, are rare.

140. Opderdeck, *supra* note 76, at 192.

in other fields (tending to be non-commercial) have also contributed discoveries to the public domain without requiring compensation,[141] supporting the notion that a community of individual users is requisite for an open source development and distribution system to function.

B. Problems Underlying Open Source Approaches

Even if biotechnology was a suitable candidate for implementation of open source approaches, there are problems underlying these approaches that prevent their success in promoting innovation. One potential problem with Creative Commons and open source licenses is that it may be difficult to enforce such licenses. To date, there has been no litigation concerning the validity of Creative Commons licenses. Most disputes involving the open source General Public License (GPL) have been settled through negotiation, and although two court cases that have considered the GPL have held it to be valid, enforcement questions still exist.[142] In fact, it has not been clearly determined whether these licenses are enforceable contracts or bare licenses.[143] If open source licenses are considered to be enforceable contracts, licensors will benefit from stronger enforcement of the specific terms within the license.[144] However, if the license is a bare license permitting one to exercise rights that would otherwise be prohibited (such as a driver's license), there is no mutual obligation created between the parties.[145] Without clarity as to the validity and enforcement of such licenses, users may be justifiably hesitant to employ these strategies in light of the substantial legal uncertainties about the validity of open source licenses in general and specific license provisions in particular. Given current practices and the financial investment inherent in most biotechnology research and development, it makes perfect sense that a biotechnology company would be unwilling to adopt an open source strategy for sharing knowledge or resources if the terms of such a license may ultimately prove to be unenforceable.

Another reason that the Science Commons may not be successful at promoting innovation is that it is based on the assumption that the Creative Commons and Open Source Movement are themselves successful in promoting innovation. However, it may be that these movements are not as successful as proponents claim. In the creative utopia envisioned by Stallman, each user of a piece of open source software would use the software for their own individual purposes, improving and altering the code as appropriate, and releasing the improved code back into the public domain. The system does not actually work in this manner. For most open source projects, there are many users, but only a few developers

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141. Katherine J. Strandburg, *Users as Innovators: Implications for Patent Doctrine*, 79 U. COLO. L. REV. 467, 475-81 (2008).

142. Adrienne K. Goss, *Codifying a Commons: Copyright, Copyleft, and the Creative Commons Project*, 82 CHI.-KENT L. REV. 963, 984 (2007) (citing Computer Assocs. Int'l v. Quest Software, Inc., 333 F. Supp. 2d 688 (N.D. Ill. 2004), Progress Software Corp. v. MySQL AB, 195 F. Supp. 2d 328 (D. Mass. 2002), and Planetary Motion, Inc. v. Techsplosion, Inc., 261 F.3d 1188 (11th Cir. 2001)).

143. Matthew D. Stein, *Rethinking UCITA: Lessons from the Open Source Movement*, 58 ME. L. REV. 157, 193 (2006).

144. *Id.*

145. *Id.*

who actually work to change and improve the code or to develop new projects. The remaining users ride the coattails of the developers for free.[146] This is the archetypal tragedy of the commons situation, where people "overuse" or fail to take care of resources owned in common, and suggests that some aspect of private ownership may be necessary to balance open source and optimize attempts to promote innovation.

VIII. SUGGESTIONS FOR OPTIMIZING BIOTECHNOLOGY INNOVATION

The discussion above, together with the realization that open source approaches fail to address both aspects of the two-prong policy objectives behind the Constitution's goal of promoting innovation, suggest a solution to the Science Commons' failure to promote innovation. Specifically, the traditional modes of intellectual property protection were created to promote innovation through the dual approach of (1) increasing the amount of material in the commons, and (2) rewarding inventors and creators for their work with a temporary monopoly.[147] The Science Commons is exclusively directed to increasing the amount of material in the commons and does not address the second approach.[148] However, as indicated in Part VII.B of this Comment, a rich public domain alone, without providing material incentive for inventors and creators, may fail to stimulate innovation. This is particularly true in a field such as biotechnology, which requires heavy investment, and where, as a result, financial rewards for innovation may be necessary. Biotechnology innovation would be stimulated most by both increasing the amount of material in the commons *and* by rewarding inventors and creators for their work with a limited time monopoly such as that conferred by patent rights.

This is not to imply that the traditional patenting approach is the best alternative. As suggested by Opderbeck, the genetic code may be a candidate well-suited for open source approaches because this "layer" is most similar to computer programming code.[149] As such, the ideal system for promoting innovation in biotechnology would be a combination of open source and traditional patenting. This dual approach would prevent both the tragedy of the commons[150] *and* the tragedy of the anticommons.

Combinations of traditional approaches and open source have been proposed

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146. Two friends who are computer programmers employed by Microsoft first suggested this point of view. They stated that most high quality programmers do not bother working with open source software because of the large number of bugs that do not get fixed, because no one "owns" the software and takes responsibility for fixing errors that arise. Problems with users that do not contribute to the code have been suggested in various other places as well. *See 5 Ways to Contribute Open Source Projects Without Coding*, NONGEEK PERSPECTIVE, http://nongeeksight.blogspot.com/2006/09/5-ways-to-contribute-to-open-source.html (last visited Oct. 19, 2010).

147. *See supra* note 20 and accompanying text.

148. As noted in *supra* Part IV, the Creative Commons provides some incentive to creators in the form of rights such as maintaining artistic control. However, limited rights that do not offer material rewards are unlikely to be useful in the field of biotechnology, as discussed in *supra* Part VII.A.

149. *See supra* Part VII.A. For the purposes of this Comment, Benkler's theory and Opderbeck's application thereof are adopted as correct.

150. The tragedy of the commons in an open source system is suggested in *supra* Part VII where many users rely on a piece of software, but few contribute to its maintenance and improvement.

as replacements for the current system. Law professor Peter Lee suggests that publicly funded scientific research promotes commercial innovation by creating massive amounts of basic scientific knowledge such as gene sequences,[151] which is an example of the upstream knowledge where excessive patenting can have the most damaging blocking effects. As such, Lee suggests that the key to maximizing biotechnology innovation is creating a "distributive commons" where institutions conducting research with the benefit of public funds should distribute the results of their research under quid pro quo licenses, leveraging the power of their upstream developments (such as research tools) in order to maximize access to downstream health technologies (such as pharmaceuticals) to the largest possible user base.[152]

Professor Lee's approach, although correct in focusing on increasing the availability of upstream knowledge such as gene sequences or other research tools,[153] fails to appreciate the role of commercial players in adopting open source approaches. Given that most biotechnology research requires significant private expenditure, which may be funded by the licenses associated with exclusive patent rights, it is counterintuitive that a company would be willing to forego patent rights and "donate" data or research to the public domain. However, sharing of upstream knowledge by commercial entities has already happened. Although such sharing is not born out of generosity but out of worry for competing ownership claims,[154] the results are the same: preventing anticommons concerns.

In some specific areas, such as expressed sequence tags or ESTs,[155] big pharmaceutical companies took initiative even before the patent office had an opportunity to evaluate whether patents should be granted for ESTs.[156] Companies decided they were better off donating gene-fragment data to the public rather than seeking patents.[157] These companies hoped that donating their EST data to the public domain would prevent patents on these sequences from delaying downstream research that depended on access to this data.[158] As an example of this approach, in 1995, Merck created the Gene Index (a public database of gene sequences). By 1998, Merck had published almost a million gene sequences on this database, which were entirely in the public domain.[159] Similar results were

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151. Peter Lee, *Toward a Distributive Commons in Patent Law*, 2009 WIS. L. REV. 917, 941 (2009).

152. *Id.* at 1015. As an example of a public institution that provides access to its research conditionally, Lee points to the National Institute of Health (NIH), which encourages recipients of NIH funding to disseminate results widely. *Id.* at 953.

153. Based on the application of Yochai Benkler's formula, the genetic code and other upstream technologies are those most appropriate for open source approaches. *See supra* Part VII.A.

154. For decades, IBM published the "IBM Technical Disclosure Bulletin" with the explicit goal of preventing competitors from obtaining patents on the particular developments disclosed therein, because once the subject matter is published, it is no longer novel and thus not patentable. *See supra* notes 16-17; *IBM Technical Disclosure Bulletin*, WIKIPEDIA, http://en.wikipedia.org/wiki/IBM_Technical_Disclosure_Bulletin (last visited Oct. 19, 2010).

155. An expressed sequence tag or EST is a short sub-sequence of a transcribed genetic sequence. They may be used to identify gene transcripts, and are instrumental in gene discovery and gene sequence determination.

156. HELLER, *supra* note 27, at 61.

157. *Id.*

158. *Id.*

159. *Id. See also* Robert P. Merges, *A New Dynamism in the Public Domain*, 71 U. CHI. L. REV. 183, 188-89 (2004) (discussing the Merck project).

achieved in the area of single nucleotide polymorphisms,[160] or SNPs, by the SNP Consortium, a group consisting of private firms and nonprofit research organizations intent on preempting an anticommons patent thicket from developing.[161] Law professor Robert Merges has coined the phrase "property-preempting investments" for instances such as these where a private firm spends significant sums of money to create assets in the public domain in order to preempt intellectual property rights.[162]

The fact that some institutions have taken matters into their own hands and are circumventing traditional patent practice in order to prevent stifling of innovation strongly suggests that patent practice *itself* should be changed in order to stimulate innovation rather than relying on solutions to come from the private sector. This is especially true given that the activities of Merck and the SNP Consortium are the exception rather than the rule. This notion is supported by three studies concerning the effect of over-proliferation of patents in technological innovation.[163] These three reports conclude that it should be harder to obtain patents in the first place. The first report by the Federal Trade Commission and the Department of Justice concluded that "biotechnology patents might harm follow-on innovation through the creation of an anticommons."[164] The solutions proposed included reforms that would make it more difficult to obtain patents initially and also more difficult to sustain them later on in the face of litigation.[165] The second report by the National Academy of Science investigated operations at the United States Patent Office (USPTO), and found that patent quality seems to be declining, and made similar recommendations.[166] The third report by the National Research Council focused specifically on biotechnology patents and also "concluded . . . that the standard for patenting should be strengthened."[167]

This Comment suggests a more nuanced approach to reforming the patent system that applies the lessons from the analysis of open source approaches above. Specifically, not all biotechnology patents should be more difficult to obtain: only those patents directed to upstream technologies such as gene sequences or other research tools. This strategy should work together with existing open source initiatives to promote easier access to such upstream technologies. Researchers working on downstream projects would be free to use upstream technologies in the public domain to develop valuable downstream inventions such as pharmaceuticals. Under this system, particularly deserving upstream technologies and downstream technologies would remain protectable by traditional patent property rights. This

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160. A single nucleotide polymorphism is a DNA sequence variation occurring when a single nucleotide—A, T, C, or G—in the genome (or other shared sequence) differs between members of a species. SNPs have a variety of uses, such as disease markers.

161. Merges, *supra* note 159, at 189-90.

162. *Id.* at 185.

163. HELLER, *supra* note 27, at 65.

164. *Id.* (referring to FED. TRADE COMM'N, TO PROMOTE INNOVATION: THE PROPER BALANCE OF COMPETITION AND PATENT LAW AND POLICY (2003)).

165. *Id.*

166. *Id.* (referring to NAT'L RESEARCH COUNCIL, A PATENT SYSTEM FOR THE 21ST CENTURY (Stephen A. Merrill et al. eds., 2004)).

167. *Id.* (referring to NAT'L RESEARCH COUNCIL, REAPING THE BENEFITS OF GENOMIC AND PROTEOMIC RESEARCH (Stephen A. Merrill & Anne-Marie Mazza eds., 2006)).

approach would work to stimulate innovation by both increasing the materials in the public domain and providing financial incentives where appropriate.

The number of upstream patents granted could be reduced in several ways. The first would be a return to the stricter statutory notion that abstract concepts and ideas cannot be patented.[168] The idea that basic facts and natural phenomena are not protectable under the utility requirement has softened considerably over the last century.[169] Patents for naturally occurring substances were traditionally rejected as being directed to non-patentable subject matter until *Parke-Davis & Co. v. H.K. Mulford Co.*, where a patent was granted directed to a purified form of adrenalin (a naturally occurring hormone).[170] Since this watershed moment, patents for genetically modified organisms[171] and mathematical algorithms for use in a particular manner have been granted.[172] Gene sequences of existing organisms or mutations associated with a particular disease have been heavily patented under these expansions. However, it is arguable that these "inventions" are merely naturally existing works that were discovered rather than invented and should not have been patented based on the subject matter requirement of section 101 of Title 35.[173] Therefore, a stricter interpretation by examiners at the USPTO as to what is patentable under the subject matter requirement could prevent such patents from being granted.[174] This precise position was recently put forth in an expansive decision by the United States District Court of the Southern District of New York, holding that patents to naturally occurring gene sequences were invalid because natural gene sequences were a product of nature and thus impermissible under the subject matter requirement of section 101.[175] Although this decision will certainly be appealed, it could mark a change in how the courts view the patentability (or un-patentability) of upstream biotechnology, such as gene sequences.

The number of patents granted should also be reduced through a stricter application of the obviousness standard.[176] A recent Supreme Court decision held

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168. Gottschalk v. Benson, 409 U.S. 63, 67 (1972).

169. Section 101 defines what subject matter may be suitable for patenting as "any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof." 35 U.S.C. § 101 (2006). *See* Megan Ristua Baca, Note, *Barriers to Innovation: Intellectual Property Transaction Costs in Scientific Collaboration*, 2006 DUKE L. & TECH. REV. 4, ¶ 8 (2006), http://www.law.duke.edu/journals/dltr/articles/pdf/2006dltr0004.pdf (last visited Oct. 19, 2010). Such expansions in the notion of what constitutes patentable subject matter go hand-in-hand with the pro-patenting position put forth by the federal government by passing the Bayh-Dole Act. *See supra* text accompanying note 44.

170. 189 F. 95, 104 (S.D.N.Y. 1911).

171. Diamond v. Chakrabarty, 447 U.S. 303, 310 (1980).

172. Diamond v. Diehr, 450 U.S. 175, 192-93 (1981).

173. 35 U.S.C. § 101 (2006).

174. The Supreme Court recently reiterated that abstract concepts and discoveries are not statutory subject matter in relation to method patents. *See generally* Bilski v. Kappos, _ U.S. _, 130 S. Ct. 3218 (2010). Although this case is related to business patents (mathematical algorithms), it is likely that the position the Court adopted will be reflected by the USPTO in other areas.

175. Ass'n for Molecular Pathology v. U.S. Patent and Trademark Office, No. 09 Civ. 4515, 2010 WL 1233416, at *51 (S.D.N.Y. Mar. 29, 2010).

176. *See supra* text accompanying notes 16-17.

that the obviousness standard should be more strictly applied.[177] With application of this stricter standard, it should become more challenging to patent inventions that were simply the result of routine work, such as sequencing a gene. As such, upstream discoveries, such as the discovery of a gene sequence, would not be patentable, whereas truly inventive downstream technologies would be.

Another possibility to reduce the number of patents granted would be to implement a third party observation or opposition system at the USPTO.[178] Patent offices in other countries around the world allow independent third parties to present references (journal articles, other patents, etc.) that pre-date the patent application for the Examiner to consider when evaluating an application.[179] This type of involvement should result in more relevant references being introduced to the Examiner at an earlier stage and result in fewer or narrower patents being granted. For example, although Examiners carry out searches, there are instances where relevant references do not come to light. If a third party brought these disclosures to the attention of the Examiner, it may be necessary to deny the patent application because the subject matter is known in the field or would have been obvious over what was already known in the field.[180]

Approaches such as these that result in fewer patents should appeal to researchers on a practical level. Patenting gene sequences or other research tools is extremely costly, and such patents generally show a poor return on investment in terms of the licensing potential.[181] Furthermore, upstream inventions like gene sequences are more often developed by researchers in nonprofit institutions than by those in companies, and it has been suggested that the developers of research tools are more akin to hackers than other researchers and are more interested in sharing results to further research than in patenting inventions for commercial gain.[182]

In addition to the patent-reducing measures discussed above, both nonprofit and commercial researchers should be encouraged to adopt open source approaches to sharing data where appropriate, such as by contributing gene sequences to online databases or by publishing research in an open access journal. This combination of

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177. *See* KSR Int'l Co. v. Teleflex, 550 U.S. 398 (2007) (holding that one skilled in the art of the invention in question is not an automaton but rather has ordinary creativity and thus does not necessarily require teaching, suggestion, or motivation to arrive at an invention).

178. The Patent Reform Act of 2005 included third party observations as one of its provisions, but was not passed. H. REP. NO. 2795 (2005). Third party observations of patents after they have been granted is one provision in the pending Patent Reform Act of 2009. H. REP. NO. 1260 (2009).

179. Japan uses a third party observation system where interested parties can submit relevant prior art to the Japanese Patent Office for the Examiner to consider during Examination of a patent application. Int'l Pat. Coop. Union, *Meeting of International Authorities under the Patent Cooperation Treaty (PCT): Third Party Observations*, at 10 (Jan. 13, 2009), *available at* http://www.wipo.int/edocs/mdocs/pct/en/pct_mia_17/pct_mia_17_2.pdf (last visited Oct. 19, 2010). The European Patent Convention (EPC) includes a third party opposition system for applications during the examination phase. Convention on the Grant of European Patents, art. 115, Oct. 5, 1973. It also includes an opposition procedure, through which third parties can challenge the validity of a patent with the European Patent Office, rather than through the court system. *Id.* at art. 99.

180. *See supra* text accompanying notes 16-17 (discussing the novelty and non-obviousness requirements).

181. Paul N. Schofield et al., *Post-Publication Sharing of Data and Tools*, 461 NATURE 171, 172 (2009).

182. *See* Strandburg *supra* note 141; *supra* Part VII.A (discussing the motivation of hackers).

open access to upstream materials and traditional protection for downstream inventions should stimulate innovation.

IX. CONCLUSION

Although the legislation underlying the protection of copyrights and patents was adopted in order to spur innovation, it appears that an over-proliferation of property rights may in fact stifle further creations and developments. The open source movement was spawned in an attempt to counter this over-proliferation and increase innovation by expanding the material available in the public domain. Open source approaches, such as Creative Commons, have been successful in replacing traditional copyright in some situations, leading to the notion of applying open source approaches to biotechnology to increase the amount of material in the public domain.

Unfortunately, the three main projects of Science Commons fail to promote innovation and are largely redundant, unnecessary, or unusable. However, the problem may not be with the approaches adopted by Science Commons but rather the nature of open source itself. Open source may not be as successful as its proponents claim, and even if it is functional, it may not be adaptable to the field of biotechnology where financial incentives and clear enforcement rules are crucial. As such, increasing material available in the public domain alone is insufficient to promote innovation: inventors may need commercial incentives such as the economic benefits conferred by traditional patent rights.

This Comment postulates a compromise where premarket or upstream knowledge, such as unknown gene sequences or other research tools, are shared through open source systems like Science Commons, but downstream, marketable developments, such as pharmaceuticals that act on the gene to treat a particular disease, are patentable according to intellectual property norms. These upstream materials would be included in the public domain through a combination of open source approaches and stricter patenting processes whereby it becomes very challenging to patent upstream inventions. This system maximizes shared knowledge by publicizing information that is generally not patentable anyway, potentially making further development easier. Downstream innovation relying on these upstream materials would be invigorated as a result, and these downstream inventions should be protected by traditional patent means when appropriate. A system of this sort should encourage innovation at all levels, from individual users to large pharmaceutical companies.