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Patents for Sharing

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PATENTS FOR SHARING

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Spurred by the Internet, emerging technologies have changed the way commercial firms innovate and have made it possible for individuals to play an important role in that innovation. Producers in the Information Communication Technologies (ICT), and other sectors dealing with complex technologies with many separately patentable components, find it increasingly difficult to make products without infringing on patents held by others. Numerous overlapping patents often cover such products. Producers have developed a new way to use patents: as inclusive rights for sharing their technologies with others through cross-licensing and other private ordering arrangements in order to ensure the freedom to operate and innovate. Individual innovators, and open source software ("OSS") programmers in particular, have also developed a new use of copyrights: using them to share their technologies through OSS licenses. Producers of complex technologies use patents for sharing their technologies with OSS programmers and for protecting themselves from patent assertion. In light of these recent uses, this article proposes a new utilitarian theory for patents: patents as the incentive to share, with the reward of increasing the freedom to operate and innovate. It argues that both the ex ante and ex post incentive to invent theories are outdated because they fail to take into account the patent owners' lack of control over their products in complex technology sectors. This article urges Congress to reevaluate U.S. patent rights in light of this new patent use. It reviews U.S. patents as property rights from the comparative law perspective and proposes the revitalization of the inclusive side of U.S. patents by introducing a compulsory license for blocking patents. It also proposes that the exclusive side of patent rights should be limited to private and experimental use exceptions to ensure the freedom to operate and innovate by sharing.

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TABLE OF CONTENTS

INTRODUCTION

On January 31, 2019, Elon Musk, the co-founder and CEO at Tesla Inc., announced that he had released all the carmaker's patents and intended to share their patented inventions with anyone who wants to utilize the technologies to fight climate change.[1] This is not the first time that Tesla has pledged to use patents for sharing their technologies: Tesla embraced an open source philosophy and made a public patent non-enforcement pledge in 2014.[2] Tesla made this recent announcement to encourage more carmakers to join their effort in electric car innovation by adding legal effect to their previously made pledge for those who are wary of liability.[3] In the view of some observers, Tesla's pledge has, in effect, destroyed the ra-

1. "*No Patent Suit Against People Who Use Our Tech in Good Faith": Elon Musk*, NDTV (Feb. 2, 2019, 9:36 AM), https://www.ndtv.com/world-news/elon-musk-releases-all-tesla-patents-to-help-save-the-earth-1986450.

2. Elon Musk, *All Our Patent are Belong to You*, TESLA (June 12, 2014), https://www.tesla.com/blog/all-our-patent-are-belong-you. For a general discussion on Tesla's pledge, see Serguei Netessine & Karan Girotra, *Tesla Goes Big, Not Home*, HARV. BUS. REV. (June 17, 2014), https://hbr.org/2014/06/tesla-goes-big-not-home.

3. *See* Fred Lambert, *A Number of Companies Are Now Using Tesla's Open Source Patents and It Has Some Interesting Implications*, ELECTREK (Nov. 10, 2015, 7:07 AM), https://electrek.co/2015/11/10/a-number-of-companies-are-now-using-teslas-open-source-patents-and-it-has-some-interesting-implications/.

tionale for patents.[4] This view is correct in the sense that Tesla's actions destroyed the outdated rationale for patents in the pre-Internet era. However, the pledge also demonstrates the need for a new rationale in the post-Internet era—patents for sharing. It is unlikely that Tesla will stop obtaining patents because the company still needs patents in order to share their technologies and engage in open innovation. It will use patents defensively to avoid patent infringement litigation as well as proactively to advertise its technological expertise to prospective business partners and licensees through patent disclosures.

Tesla is just one example of the current trend in high-tech industries to use intellectual property for sharing technologies. Microsoft has also announced its innovation initiative and shifted their innovation strategies toward open source software ("OSS") to take advantage of individual user innovators—in particular, programmers in the OSS community.[5] The software giant also released its 60,000 patents to the OSS community by joining a defensive patent pool for protecting the OSS community from aggressive patent assertion.[6]

Industrialized economies across the globe are working together to benefit from advanced manufacturing technologies made possible by machines, humans, and big data linked through the Internet. The revolution currently underway within the manufacturing industry in the post-Internet era is commonly referred to as "Industry 4.0." Industry leaders and policymakers in Europe and Asia have adopted a number of initiatives under the moniker "Industry 4.0" to enhance the marriage between the physical and digital worlds, transforming the way products and processes are developed and commercialized. Emerging technologies in the post-Internet era have increased the value of non-physical objects such as software and data compared with physical objects such as machines and equipment.[7] Firms and individuals no longer need to purchase and own tangible objects because intangible digital objects are easily shared. Thus, many of them prefer to obtain a license to use the objects on a pay-by-time basis because doing so is cost-efficient. In the United States, this transformation of society resulting

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4. Mike Masnick, *Elon Musk Destroys the Rationale for Patents, Opens Up All of Tesla's*, TECHDIRT (June 12, 2014, 11:58 AM), https://www.techdirt.com/articles/20140612/11253427557/elon-musk-destroys-rationale-patents-opens-up-all-teslas.shtml.

5. Brad Smith, *A New IP Strategy for a New Era of Shared Innovation*, MICROSOFT (Apr. 4, 2018), https://blogs.microsoft.com/blog/2018/04/04/a-new-ip-strategy-for-a-new-era-of-shared-innovation/; *see also* Kurt Mackie, *Microsoft Outlines Its Open Source Software Shift*, REDMOND MAG. (Sept. 17, 2018), https://redmondmag.com/articles/2018/09/17/microsoft-outlines-open-source-shift.aspx.

6. Klint Finley, *Microsoft Calls a Truce in the LINUX Patent Wars,* WIRED (Oct. 11, 2018, 7:33 PM)), https://www.wired.com/story/microsoft-calls-truce-in-linux-patent-wars/.

7. *See Intangible Assets Increase to 84% of S&P 500's Value in 2015 Report*, BUS. INTANGIBLES LLC (Mar. 11, 2015), https://www.businessintangibles.com/single-post/2015/03/11/Intangible-Assets-Increase-to-84-of-the-SP-500s-Value-in-2015-Report.

from emerging technologies is frequently referred as the "information society" or the "sharing economy."

The societal transformation brought on by emerging technologies in the post-Internet era has also removed the physical limitations of manufacturing plants and has significantly changed the way patents function. The majority of valuable goods in the post-Internet era are made up of complex technologies that include a large number of components and functions such as Information and Communication Technologies ("ICT").[8] Such technologies result from open and highly distributed innovation networks including firms, universities, government agencies, and individual users. Each component and function of a product in complex technologies is the result of cumulative innovation: the process of refinement and improvement of an existing idea by different innovators who obtain separate patents on their inventions throughout the process. The complex and cumulative nature of products in the post-Internet era leads to various overlapping patents being held by multiple patent owners. These phenomena are often referred as patent thickets.[9] Firms in complex technologies are no longer able to manufacture a product or provide a service without infringing patents held by others. Consequently, innovators such as Tesla have developed a new way to use the traditional patent framework—using patent rights to share technologies through no-enforcement pledges, cross-licenses, and other private ordering arrangements—to ensure the freedom to operate and innovate on their own inventions.[10]

Moreover, large producer firms that make profits by selling products and services are no longer the sole influential players in the innovation landscape. Through access to emerging technologies such as the Internet of Things ("IoT") and Artificial Intelligence ("AI"), non-traditional innovators such as individual users can now assume a more important role in the development and improvement of products and services. Individual users—in particular, programmers and members of the OSS community who embrace the open source philosophy—often promote innovation by sharing technologies. In the copyright context, the OSS community has retooled the existing copyright framework by developing open source licenses to stimulate collaboration. Large firms in complex technologies have reinforced this new use of the patent framework by sharing technology and collaborating with individual users to take advantage of their innovations. Even Microsoft,

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8. Robert W. Rycroft & Don E. Kash, *Innovation Policy for Complex Technologies*, 16 ISSUES SCI. & TECH. 73, 73 (1999). In 1995, complex technologies made up 82% of the most valuable world goods exports and the portion is expected to rise.

9. Carl Shapiro, *Navigating the Patent Thicket: Cross Licenses, Patent Pools, and Standard-Setting*, 1 INNOVATION POL'Y & ECON. 119, 119 (2001).

10. *Cf.* James Bessen, *Patent Thickets: Strategic Patenting of Complex Technologies* 2 (Research on Innovation, Boston University School of Law, Working Paper No. 0401, 2004), https://ideas.repec.org/p/roi/wpaper/0401.html.

once the greatest enemy of the OSS community, has called a truce by adopting the shared innovation initiative.[11]

Despite dramatic changes in the innovation landscape, the rationale for the patent system is still based on several assumptions rooted in the eighteenth century when the system was developed. Producer firms were the key players in the innovation process. These firms did not invent without any incentive and patents were used to exclude others and profits were made by selling products or services with supracompetitive prices. These firms dealt with products in the discrete technologies, *i.e.,* technological sectors dealing with products that consist of few components and are covered by patents held by one patent owner who engages in the closed-innovation model. Patent scholars modernized this incentive theory as the prospect theory in an effort to give pioneer inventors the ability to control follow-on innovation through a broader scope of exclusivity on pioneer inventions. Neither the traditional nor modern incentive theories apply to many producer firms dealing in complex technologies. These firms inclusively use their patents to share technologies with others. Today, many inventors often prefer the freedom to operate over supracompetitive profit margins.

Moreover, these incentive theories do not apply to individual user innovators because individual users are satisfied with contributing to improvements of products. Like firms in complex technologies, they are willing to invent and share their inventions with others without any additional profit motive.

This article discusses impacts of the innovation landscape transformation on innovative players and processes ushered in by the technological progress of the post-Internet era. It proposes a new utilitarian theory for patents in light of the new ways that patents are being used by firms in complex technologies and OSS communities. Part I discusses the origin of the "Industry 4.0" concept, how technologies in the Industry 4.0 era have affected society and innovation processes, and how the growing role of individual user innovators has changed the way producer firms use patents and engage innovation.

Part II reviews the traditional utilitarian theory for rationalizing the patent system. It further argues that the incentive to invent has become obsolete for many commercial firms in complex technologies because these firms engage in open innovation and need to share technologies with multiple innovators in a more cumulative innovation process. Patents seldom provide the power to control such markets and no longer provide firms with profits through supracompetitive pricing.

Part II also reviews modern theories focusing on incentives for commercialization after invention—*ex post* incentive theories. Many *ex post* incentive theories are based on the prospect theory, which assumes a scope for

11. *See* Finley, *supra* note 6; Smith, *supra* note 5.

commercialization and use of the patent beyond the original idea of the inventor. The prospect theory has also become obsolete under current case law. Without coordination, multiple inventors engaged in cumulative innovation are forced to develop ad-hoc collaboration mechanisms by using patents to share technologies.

Part III proposes a new utilitarian theory: the incentive to share. In the post-Internet era, the patent system provides innovators with incentives to share their technology that rewards them with the freedom to operate and innovate. The current patent system fails to take into account the new use of patents in complex technologies and the unique motivation of individual user innovators, in particular programmers in the OSS communities. Current patent policies are too producer-centric and largely apply to firms that engage in closed innovation in the discrete technologies. Such firms are in the minority in the post-Internet era.

Part IV reevaluates patent rights in light of the proposed new incentive to share theory. The Supreme Court recently gave Congress more flexibility to decide the content of patent rights, *i.e.*, the exclusive and inclusive sides of patents as property rights.[12] A review of U.S. history and other comparative studies on the concept of property rights reveals that patent rights are two-sided rights: an exclusive side for excluding others and an inclusive side to ensure that patent owners can both practice and share their own inventions. In the United States, the legal and political revolution at the turn of last century marginalized the inclusive side. In contrast, the inclusive side of patent rights under the German and Japanese Patent Acts guarantee patent owners the right to practice through compulsory licenses and share their patented inventions with others. The U.S. patent system can learn from these models to revitalize the inclusive side. Although their compulsory licenses are seldom exercised, German and Japanese innovators can use such licenses as a last resort if voluntary license negotiations fail, thus rewarding them with the freedom to operate and innovate. U.S. innovators cannot find such a resort even if patent owners who do not practice their patents and are not interested in sharing technologies make an unreasonable offer. Thus, this article argues for revitalizing the inclusive side of U.S. patent rights to provide innovators with an incentive to share. It proposes reform of the current patent system by introducing a compulsory license for blocking patents, or limitations on infringement remedies as well as statutory exceptions for experimental and private uses.

12. 35 U.S.C. § 261 (2012); Oil States Energy Servs., LLC v. Greene's Energy Grp., LLC, 138 S. Ct. 1365, 1375 (2018).

I. Industry 4.0 and Its Impact on Innovation

A. *Industry 4.0*

In 2011, the German government launched an initiative called "Industry 4.0" to promote and support digital manufacturing, research, intra-industry networking, and standardization.[13] The German government defines "Industry 4.0" as the intelligent networking of machines and processes for industry with the help of information and communication technologies.[14] Three visionary German engineers organized a press conference to promote the notion "Industry 4.0" in 2011.[15] The campaign accelerated when a top executive at Siemens used the term Industry 4.0 to describe the Internet's impact on manufacturing technology and products at the 2013 Hannover Messe.[16] This led to the World Economic Forum's adoption of the term as the main theme for the 2016 annual meeting.[17] Now, under the concept of Industry 4.0, many EU member states sponsor national initiatives to encourage high-tech manufacturing.[18]

The "industry" in Industry 4.0 stems from the industrial revolution. The notion of "industrial revolution" was born in France to describe the technological breakthrough in manufacturing processes in England, marked by the proliferation of machines powered by water and steam.[19] Since that seminal press conference in 2011, images showing the historical progress of the manufacturing industry—in four phases from the first industrial revolution

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13. Demetrius Klitou et al., *E.U. Commission, Germany: Industry 4.0*, 3 (Jan. 2017), https://ec.europa.eu/growth/tools-databases/dem/monitor/sites/default/files/DTM_Industrie 4.0.pdf.

14. *What is Industrie 4.0*, Platform Industrie 4.0, https://www.plattform-i40.de/PI40/Navigation/EN/Industrie40/WhatIsIndustrie40/what-is-industrie40.html#:~:text=Industrie%204.0%20refers%20to%20the,companies%20to%20use%20intelligent%20networking (last visited Oct. 7, 2019).

15. Sabine Pfeiffer, *The Vision of "Industrie 4.0" in the Making – a Case of Future Told, Tamed and Traded*, 11 NanoEthics 107 (2017).

16. Siegfried Russwurm, Member, Managing Board of Siemens AG, Press Conference Presentation at the Hannover Messe: Shaping the Future of Production with Siemens: On the Way to Industry 4.0 (Apr. 8, 2013), https://www.siemens.com/press/pool/de/events/2013/industry/2013-04-hannovermesse/presentation-russwurm-e.pdf.

17. Pfeiffer, *supra* note 15, at 107. For additional discussion, see World Economic Forum, The Future of Jobs: Employment, Skills and Workforce Strategy for the Fourth Industrial Revolution, (2016), http://www3.weforum.org/docs/WEF_Future_of_Jobs.pdf.

18. Ron Davies, European Parliamentary Research Service, *Briefing on Industry 4.0: Digitalisation for Productivity and Growth*, 8, PE 568.337 (Sept. 2015), http://www.europarl.europa.eu/RegData/etudes/BRIE/2015/568337/EPRS_BRI(2015)568337_EN.pdf.

19. Emma A. Griffin, *The 'Industrial Revolution': Interpretations from 1830 to the Present*, *in* A Short History of the British Industrial Revolution (2010).

to the present—have become very popular among industry leaders and politicians to promote the motto "Industry 4.0."[20]

As depicted in these images, the initial industrial revolution, otherwise known as Industry 1.0, began with the inventions of water- and steam-powered manufacturing machines. Electrically powered manufacturing machinery enabled mass production and marked the start of Industry 2.0., or the second industrial revolution. With the development of the computer, many steps in the manufacturing process were automated by the use of programmable logic controllers and robots powered by electronics and ICT in the Industry 3.0 era. Consequently, machines replaced many human operators. Industry 4.0 is the era of Cyber Physical Systems ("CPS"), where hyperlinked manufacturing processes and related products are combined with AI and Big Data. Both Industry 3.0 and Industry 4.0 are based on the computer and ICT, but Industry 4.0 is distinguished from Industry 3.0 by the intensive use of networks connected through the Internet. Under Industry 4.0, computers and ICT enable autonomous manufacturing and optimum product performance without human intervention.[21]

In the United States, the notion of the "Information Society" has gained popularity to describe the phenomena resulting from digital information and communication technologies.[22] Thus, the term "Information Society" includes economic, political, and cultural activities, and is not limited to phenomena related to the industrial aspects of modern society.

Japan, too, recently adopted "Connected Industries," a concept similar to Industry 4.0. The "Connected Industries" initiative seeks to take advantage of technological innovations. It aims to add value and find solutions to societal problems by further connecting the various facets of modern life, including consumers, suppliers, companies, machines, and systems.[23] The Ministry of Economy, Trade and Industry ("METI") has adopted measures to stimulate technological development in five priority fields: automated driving and mobility services; biotechnology and materials; smart life; man-

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20. E.g. JOAQUÍN FUENTES-PILA ET AL., BEST PRACTICES FOR IMPROVING ENERGY EFFICIENCY (IN AGRO-INDUSTRIES) 58, Fig. 32 (2015), https://www.researchgate.net/publication/303767337_Best_Practices_for_Improving_Energy_Efficiency_in_agro-industries.

21. Industry 4.0 combines various concepts of current industrial development, such as the IoT and smart factories and products. *See* GIZEM ERBOZ, HOW TO DEFINE INDUSTRY 4.0: MAIN PILLARS OF INDUSTRY 4.0 (2017), https://www.researchgate.net/publication/326557388_How_To_Define_Industry_40_Main_Pillars_Of_Industry_40.

22. JAMES R. BENIGER, THE CONTROL REVOLUTION: TECHNOLOGICAL AND ECONOMIC ORIGINS OF THE INFORMATION SOCIETY 3 (1986).

23. *Connected Industries*, MINISTRY OF ECONOMY, TRADE AND INDUSTRY, http://www.meti.go.jp/english/policy/mono_info_service/connected_industries/index.html, (last updated Apr. 10, 2019).

ufacturing; and plan-infrastructure safety management.[24] The METI's concept is similar to Industry 4.0 in its focus on improving efficiencies and optimizing manufacturing processes. With the German government's campaign to develop international alliances, many of the ideas underlying Industry 4.0 have been adopted worldwide in China[25] and Canada.[26]

B. *Sharing Economy*

Industry 4.0 has had a significant impact not only on how products are produced, but also on how things are invented and innovated. In particular, the concept has changed the way in which companies deploy R&D resources in innovation.[27] Industry 4.0 connects both things and people through advanced high speed Internet; it enables different types of innovators to share resources for research, manufacturing, and conducting business.[28] In particular, both small and medium-sized enterprises ("SMEs") and individual innovators are able to share, exchange, and rent expensive R&D resources with the help of the Internet-supported technologies without the transfer of ownership.[29] These practices are often referred to as the "Sharing Economy."

Sharing has become increasingly popular and is viewed positively by economists because it increases business efficiencies by reducing transaction costs and maximizes the utilization of goods and services.[30] Even large commercial firms hope to take advantage of the flexibility brought by Industry 4.0 technologies. Many choose to rent R&D resources in an effort to avoid the large costs associated with purchasing and maintaining expensive equipment.

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24. "CONNECTED INDUSTRIES" TOKYO INITIATIVE 2017, MINISTRY OF ECONOMY, TRADE AND INDUSTRY (2017), http://www.meti.go.jp/english/press/2017/pdf/1002_004b.pdf.

25. Jost Wübbeke & Björn Conrad, *'Industrie 4.0': Will German Technology Help China Catch Up with the West?* CHINA MONITOR (Apr. 14, 2015), https://www.merics.org/sites/default/files/2017-09/China_Monitor_23_Industrie40_EN.pdf.

26. PIERRE-OLIVIER BÉDARD-MALTAIS, BUSINESS DEVELOPMENT CANADA, INDUSTRY 4.0: THE NEW INDUSTRIAL REVOLUTION – ARE CANADIAN MANUFACTURERS READY? 2 (2017), https://bridgr.co/wp-content/uploads/2017/06/bdc-etude-manufacturing-en.pdf.

27. In this article, a term "innovate" is used to include activities resulting in improvements, which could either be patentable or not patentable.

28. For more discussion, see *infra* Section I.C.2.

29. According to the Organisation for Economic Co-operation and Development ("OECD"), SMEs are "non-subsidiary, independent firms which employ fewer than a given number of employees. This number varies across countries. The most frequent upper limit designating an SME is 250 employees, as in the European Union. However, some countries set the limit at 200 employees, while the United States considers SMEs to include firms with fewer than 500 employees." OECD, SME AND ENTREPRENEURSHIP OUTLOOK: 2005 17, (Marian Murphy, ed., 2005).

30. *See* Araz Taeihagh, *Crowdsourcing, Sharing Economies and Development*, 33 J. DEVELOPING SOC'Y 191, 192 (2017).

This paradigm shift also fostered the emergence of cloud computing services.[31] Firms and businesses prefer the ease of pay-per-use flexibility, rather than large lump-sum payments for hardware—which often requires vast amounts of storage space—and the additional cost of employing engineers to support the ever-changing hardware and software needs of a dynamic firm. Now that they can rely on the resources and services provided by computer specialists, firms no longer need to worry about the once-necessary infrastructure required for the production of goods and services. Now, companies have access to a wide variety of software, as well as the ability to customize the software as needed. This flexibility and broad access to resources has had the effect of democratizing the innovation process; non-traditional innovators such as individual consumers and users may now participate in the improvement of products and services by themselves.[32]

Another sharing community that enables non-traditional innovators to engage in innovation is a mechanism called "distributed computing," which provides big R&D resources by utilizing multiple limited resources through Internet technologies.[33] Distributed computing works by combining the power of several ordinary computers on a network to solve a problem in one second that would otherwise require the use of a more advanced computer.[34] Individuals make their idle CPU time available to research projects for furthering knowledge and assisting academic research such as improving climate prediction[35] or protein structure predication.[36]

Universities and research institutions run many of these projects. By joining the projects, individuals have the ability to rival the computing capacity of large commercial firms such as Microsoft, Amazon and Google. They can participate in major research projects and contribute to the progress of science and the useful arts. In addition, with the birth of blockchain technologies that achieve consensus among participants, distributed compu-

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31. Cloud computing services give users access to a storage space in a high-speed computer and deliver various types of services via the Internet. For a general discussion on the social and economic impact of cloud computing, see generally Katsantonis Konstantinos et al., *Cloud Computing and Economic Growth*, *in* PROCEEDINGS OF THE 19TH PANHELLENIC CONFERENCE ON INFORMATICS 209 (2005).

32. For more discussion, see *infra* Section I.C.2; *see also infra* note 55.

33. For a general discussion of distributed computing system, see Krishna Nadiminti et al., *Distributed Systems and Recent Innovations: Challenges and Benefits*, 16 INFONET MAGAZINE 1, 1 (2006), http://www.cloudbus.org/papers/InfoNet-Article06.pdf.

34. *See* Yochai Benker, *"Sharing Nicely": On Shareable Goods and the Emergence of Sharing as a Modality of Economic Production*, 114 YALE L.J. 273, 289 (2004).

35. *About*, CLIMATEPREDICTION.NET, https://www.climateprediction.net/about/ (last updated May 20, 2019).

36. ROSSETTA@HOME, https://boinc.bakerlab.org/ (last visited Sept. 25, 2019) ("By simply running a free program, you can help advance research in medicine, clean energy, and materials science.").

ting has been implemented in a wide variety of areas, not only in financial services like Bitcoin, but also anything that is believed to have some value.[37]

C. *Distributed Innovation*

1. Open Innovation

Through cloud computing and distributed computing, nontraditional innovators such as individual consumers and users can now participate in R&D projects that were previously limited to large firms in the pre-Industry 4.0 era. These technologies enhance the innovation capacity of SMEs—which are often the source of radical innovations—by providing access to resources that SMEs lack.[38] A system involving various types of innovators who collaborate toward a common goal is defined as a distributed model of innovation and constitutes an advanced model of open innovation.[39] The concept of "open innovation" comes from a book authored by a UC Berkeley's business school professor, Henry Chesbrough.[40] According to Professor Chesbrough's own definition, open innovation is "the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively."[41] He describes the activities as "a distributed innovation process based on purposively managed knowledge flows across organizational boundaries, using pecuniary and non-pecuniary mechanisms in line with the organization's

37. Bender Marr, *30+ Real Examples of Block Chain Technology in Practice*, FORBES (May 14, 2018, 1:39 AM), https://www.forbes.com/sites/bernardmarr/2018/05/14/30-real-examples-of-blockchain-technology-in-practice/#17a4d1e3740d; Alex Pazaitis et al., *Blockchain and Value Systems in the Sharing Economy: The Illustrative Case of Backfeed*, 125 TECH. FORECASTING & SOC. CHANGE 105, 105-06 (2017) .

38. Antoine Pierre & Fernandez Anne-Sophie, *Going Deeper into SMEs' Innovation Capacity: An Empirical Exploration of Innovation Capacity Factors*, 25 J. INNOVATION ECON. & MGMT. 139, 156 (2018). SMES are considered an important source of radical innovations, particularly in science-driven sectors. OECD, PROMOTING INNOVATION IN ESTABLISHED SMES 3-6 (2018), https://www.oecd.org/cfe/smes/ministerial/documents/2018-SME-Ministerial-Conference-Parallel-Session-4.pdf.

39. *See* GARRY GABISON & ANNAROSA PESOLE, AN OVERVIEW OF MODELS OF DISTRIBUTED INNOVATION (2014), http://publications.jrc.ec.europa.eu/repository/bitstream/JRC93533/jrc93533_ap.pdf.

40. HENRY WILLIAM CHESBROUGH, OPEN INNOVATION: THE NEW IMPERATIVE FOR CREATING AND PROFITING FROM TECHNOLOGY (Harvard Univ. Press 2003). Systems of distributed innovation are coined with the concept of "business ecosystem." Carliss Y. Baldwin, *Organization Design for Distributed Innovation* 1-3 (Harvard Bus. Sch., Working Paper No. 12-100, 2012), https://www.hbs.edu/research/pdf/12-100.pdf.

41. Henry William Chesbrough, *Everything You Need to Know About Open Innovation*, FORBES (March 21, 2011, 1:10 PM), https://www.forbes.com/sites/henrychesbrough/2011/03/21/everything-you-need-to-know-about-open-innovation/#313b99d775f4.

business model."[42] Chesbrough's paradigm challenges the traditional vertically integrated innovation model and instead calls on traditional innovators and commercial producer firms to share both knowledge and technology in a more distributed model.[43]

In the early twentieth century, closed innovation prevailed as the development model. Closed innovation embraces exclusive control over all steps in the process of delivering an invention to market because all steps are performed within each commercial producer firm that vertically integrates upstream through downstream stages of the value chain.[44] In the closed innovation model, a producers' R&D investment is recouped through the sale of products and services with supracompetitive prices that are enabled by the patent monopoly.[45]

Chesbrough's paradigm predates the publication of his book. One example of the paradigm is the relationship between U.S. universities and commercial producer firms. For years, commercial producer firms received innovative technologies freely from universities. Prior to the enactment of the Bayh Dole Act in 1980, universities rarely sought patent protection for their inventions due to the lack of incentive to apply for patents because the federal government took ownership of patents issued to the universities.[46] The Bayh Dole Act encourages universities to obtain patents for their inventions and to engage in open innovation with commercial producer firms through technology transfer, thus increasing the incentive for commercialization.[47] Commercial technology firms that received exclusive licenses for inventions developed by university researchers began to engage in cumulative R&D in an effort to rapidly commercialize technologies.[48] Such collaborative efforts with commercial firms led to a shift in universities' attitudes towards patents, from passive observers to commercially aggressive patent assertion entities seeking to exclude others.[49] Nevertheless, the custom of

42. Henry Chesbrough & Marcel Bogers, *Explicating Open Innovation: Clarifying an Emerging Paradigm for Understanding Innovation*, *in* NEW FRONTIERS IN OPEN INNOVATION 3, 17 (H. Chesbrough et al., eds., 2014).

43. GABISON & PESOLE, *supra* note 39, at 14.

44. CHESBROUGH, *supra* note 40, at 29; *see also* Natalie Rodet-Kroichvili et al., *New Insights into Innovation: The Business Model Approach and Chesbrough's Seminal Contribution to Open Innovation*, 15 J. INNOVATION, ECON. & MGMT. 79, 82 (2014).

45. VON HIPPEL, FREE, *infra* note 55, at 7, 53.

46. 35 U.S.C. §§ 200–212 (1980).

47. Joel West, *Does Appropriability Enable or Retard Open Innovation?*, *in* OPEN INNOVATION: RESEARCHING A NEW PARADIGM 109, 120 (Henry Chesbrough et al. eds., 2006).

48. *See* Suzanne Scotchmer, *Standing on the Shoulders of Giants: Cumulative Research & the Patent Law*, 5 J. ECON. PERSP. 29, 31, 34 (1991).

49. Peter Lee, *Patents and University,* 63 DUKE L.J. 1, 77-78 (2013).

sharing among academic research scientists still prevails, and universities seldom enforce patent exclusivity against other academic institutions.[50]

Oftentimes, highly distributed open innovation results in a component or function being covered by a number of patents held by different patentees; this is because pioneer inventions are improved and commercialized successively by the cumulative process of multiple innovators.[51] Such components are typically combined with numerous other components in order to make products in complex technologies such as smartphones.[52] As the complexity of products increases, firms need to intensify their collaboration by learning, integrating, and applying knowledge from other firms.[53] As will be discussed in Part II, firms that engage in open innovation use patents differently from those that practice closed innovation. This is especially true for firms in complex technologies.[54] Patents provide such firms with an incentive to share technologies, further promoting open innovation.

2. User and Free Innovation

In contrast to Chesbrough's producer-focused innovation model, Eric von Hippel advanced the importance of roles played by non-traditional innovators. Specifically, he identified the part that users and individuals play in the innovation process.[55] Von Hippel categorized firms and individual innovators in terms of the functional relationship with a given product: how innovators benefit from it.[56] Innovators are considered users if they benefit from using products or services and are distinguishable from producers, whose benefit arises from making and selling products or services.[57] He

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50. Maria Teresita Barker, Patent Litigation Involving Colleges and Universities: An Analysis of Cases From 1980 – 2009 (Summer 2011) (unpublished Ph.D. thesis, University of Iowa) (on file with the University of Iowa), https://doi.org/10.17077/etd.z1290gi7. For a discussion of the academic research science norm, see Rebecca S. Eisenberg, *Proprietary Rights and the Norms of Science in Biotechnology Research*, 97 YALE L.J. 177 (1987).

51. For a discussion of cumulative innovation, see Kevin J. Boudreau & Karim R. Lakhani, *"Open" Disclosure of Innovations, Incentives and Follow-On Reuse: Theory on Processes of Cumulative Innovation and a Field Experiment in Computational Biology*, 44 RES. POL'Y 4 (2015).

52. For a discussion of complex technologies, see Wesley M. Cohen et al., *Protecting Their Intellectual Assets: Appropriability Conditions and Why U.S. Manufacturing Firms Patent (or Not)* 19 (Nat'l Bureau of Econ. Research, Working Paper No. 7552, 2000), https://www.nber.org/papers/w7552.

53. *See* Rycroft & Kash, *supra* note 8, at 2.

54. Justus Baron & Henry Delcamp, *The Private and Social Value of Patents in Discrete and Cumulative Innovation*, 90 SCIENTOMETRICS 581, 583 (2011). For the discussion of a new use of patents for promoting open innovation, see *infra* Section II.C.

55. *See* ERIC VON HIPPEL, THE SOURCES OF INNOVATION 102-105 (1988) [hereinafter VON HIPPEL, SOURCES]; ERIC VON HIPPEL, DEMOCRATIZING INNOVATION 19-31 (2005) [hereinafter VON HIPPEL, DEMOCRATIZING]; ERIC VON HIPPEL, FREE INNOVATION 65-76 (2017) [hereinafter VON HIPPEL, FREE].

56. VON HIPPEL, SOURCES, *supra* note 55, at 3.

57. VON HIPPEL, DEMOCRATIZING, *supra* note 55, at 3.

found that commercial and individual users, and not producers, account for much of the major product innovation in certain fields including complex technologies, such as semiconductor and printed board circuits.[58] In particular, individual users have made significant improvements to products in the software and household sectors and are more willing to freely disclose them without patent protection.[59]

Von Hippel's paradigm of user innovation predates recent developments in computer technology and the Internet. Long before the Internet, user firms were engaging in collaborative innovation and they continue to do so now.[60] For example, as early as the mid-nineteenth century, firms in the iron industry in England's Cleveland district were found to engage in "collective invention" to incrementally improve furnace technology.[61]

However, the advent of modern computers and the Internet in the Industry 3.0 and 4.0 eras has underscored the importance of user innovation by enabling non-traditional innovators such as individual computer programmers to participate in the development of the OSS innovation model. The idea underlying the OSS innovation model was born in the 1980s led by a programmer at MIT's AI Lab, Mr. Richard Stallman, who created a free operating system called "GNU."[62] Mr. Stallman created the concept of copyleft—an idea to use copyright licenses to keep the source code for his software open, thereby securing the freedom of any user to copy or modify the software.[63] His copyleft idea also took into account any derivative works that were developed based on his original software; the license required that any derivative works should be redistributed under the same conditions that governed the sharing of his original software.[64] In 1989, Mr. Stallman drafted and released the first version of the General Public License ("GNU GPL"), with provisions implementing the copyleft concept that effectively prevent derivative works from making their way into proprietary software. Many programmers shared Mr. Stallman's philosophy, represented by the copyleft concept, and joined his efforts to improve the GNU software, leading to the creation of the Free Software Foundation.

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58. *See* VON HIPPEL, SOURCES, *supra* note 55, at 3-4, 43-57.

59. VON HIPPEL, FREE, *supra* note 55, at 4-5, 19-35.

60. *See* VON HIPPEL, SOURCES, *supra* note 55, at 84.

61. Robert C. Allen, *Collective Invention*, 4 J. ECON. BEHAV. & ORG. 1, 3-11 (1983).

62. David Bretthauer, *Open Source Software: A History*, PUBLISHED WORKS, 7, at 3-8 (Dec. 16, 2001), http://digitalcommons.uconn.edu/libr_pubs/7.

63. *See, e.g.*, Christopher S. Brown, *Copyleft, the Disguised Copyright: Why Legislative Reform is Superior to Copyleft Licenses*, 78 UMKC L. REV. 749, 761 (2010).

64. The Copyleft idea can spread in proprietary software because any software combined with copyleft licensed software is transformed to be distributed under a copyleft license. This extension of copyleft license to other software is called contamination. *See generally Copyleft and the GNU General Public License: A Comprehensive Tutorial and Guide*, COPYLEFT.ORG (2018), https://copyleft.org/guide/monolithic/.

Open source software is one of the best examples of an innovation model that is run by and for users without the involvement of commercial producer firms.[65] Different groups of programmers from the OSS community engage in transaction-free interaction, often bound by GPL or GPL-inspired copyright licenses.[66] One of the most successful examples is Linux. In 1991, Finnish student Linus Torvalds integrated GNU and released his original Linux software under GPL.[67] Today, Linux is a family of operating systems based on the core computer program "Linux Kernel" and is bundled with a set of programs, tools, and services to provide necessary functionality.[68] Not all the Linux-related programs are distributed under the GPL: some programs are distributed under BSD, Apache, and/or other GPL-inspired licenses that do not prevent programmers from creating proprietary software.[69] This inclusion of programs with less restrictive licenses makes the Linux system attractive to for-profit firms. Many large multinational companies have joined the community and both sponsor the project financially and hire contributors to improve the Linux system.[70]

Many programmers who participate in OSS projects are individual users spread across the horizontal innovation network; they are connected through the Internet so that they can take advantage of innovations developed by others and, in turn, share their own innovations with others.[71] Although many technologies were developed by users in the pre-Industry 4.0 eras,[72] those users were mainly commercial firms with access to vast R&D resources.[73] Due largely to the growing number of resources available via the Internet in the Industry 4.0 era, both individual users and consumers can independently or collaboratively participate in innovative processes across technological fields.[74] Economists emphasize the importance of user innova-

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65. *See* Eric von Hippel, *Innovation by User Communities: Learning from Open-Source Software*, 42 MASS. INST. TECH. SLOAN MGMT. REV. 82, 82 (2001); Eric von Hippel, *Horizontal Innovation Networks - By and For Users,* 16 INDUS. CORP. CHANGE 293, 293 (2006) [hereinafter von Hippel, *Horizontal*].

66. *See* Carliss Y. Baldwin, *Where Do Transactions Come From? Modularity, Transactions and the Boundaries of Firms*, 17 INDUS. CORP. CHANGE 155, 182 (2008).

67. *What is Linux?*, OPENSOURCE.COM, https://opensource.com/resources/linux (last visited Sept. 25, 2019).

68. *Id.*; JONATHAN CORBET & GREG KROAH, 2017 LINUX KERNEL DEVELOPMENT REPORT 2 (2017), https://www.linuxfoundation.org/2017-linux-kernel-report-landing-page/.

69. Bretthauer, *supra* note 62, at 12. For BSD, Apache and other GNU inspired licenses, see ANDREW M. ST. LAURENT, UNDERSTANDING OPEN SOURCE AND FREE SOFTWARE LICENSING 14 (2004),.

70. CORBET & KROAH, *supra* note 68, at 14-15.

71. von Hippel, *Horizontal, supra* note 65, at 293-94.

72. *See* VON HIPPEL, SOURCES, *supra* note 55, at 19-25.

73. *See* David J. Teece, *Firm Organization, Industrial Structure, and Technological Innovation*, 31 J. ECON. BEHAV. ORG. 193, 210 (1996).

74. *See generally* Carliss Baldwin & Eric von Hippel, *Modeling a Paradigm Shift: From Producer Innovation to User and Open Collaborative Innovation*, 22 ORG. SCI. 1399 (2011); Eric von Hippel et al., *Comparing Business and Household Sector Innovation in Con-*

tion, which increases social welfare by complementing producer innovation and removing inefficiencies.[75] Traditional innovators, such as commercial producer firms, need two types of information: (1) a technical problem; and (2) a solution of the problem.[76] The former is frequently held by users, while the latter is held by producers. This discrepancy often leads to high information transfer costs.[77] User innovation is effective at reducing information transfer costs, and consequently increases social welfare.[78]

User innovation also promotes commercial producer innovation because producers can take advantage of innovations disclosed by users without payment of R&D cost for innovation.[79] When producers are interested in open innovation, they start working with the users, leading to more open and collaborative innovation.[80] SMEs and individual user innovators often disclose their innovations without any attempt to obtain patents because the cost of disclosing their innovation is less than the cost of enforcing the potential benefit from either keeping it secret or obtaining patents and licensing them.[81] SMEs and individual user innovators can rarely afford to hire lawyers to manage confidential agreements or prosecute patents for their inventions. In fact, licensing inventions can often generate less profit than the cost of securing and licensing patents and other types of intellectual property.[82]

By making their innovated source code publicly available, individual programmers in the OSS community enjoy non-commercial benefits, such

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sumer Products: Findings from a Representative Survey in the United Kingdom, 58 MGMT. SCI. 1669 (2012); Ruth Stock et al., *Impacts of Hedonic and Utilitarian User Motives on the Innovativeness of User-Developed Solutions*, 32 J. PRODUCT INNOVATION MGMT. 389 (2014); Ruth Stock et al., *Impacts of Personality Traits on Consumer Innovation Success* (2014), 45 RES. POL'Y 757 (2016).

75. *See, e.g.*, Joachim Henkel & Eric von Hippel, *Welfare Implications of User Innovation,* 30 J. TECH. TRANSFER 73, 73 (2005).

76. *See* Eric von Hippel, *"Sticky Information" and the Locus of Problem Solving: Implications for Innovation*, 40 MGMT. SCI. 429, 431-32 (1994).

77. *See* VON HIPPEL, SOURCES, *supra* note 55, at 7.

78. *See* Henkel & von Hippel, *supra* note 75 at 79.

79. *See* Dietmar Harhoff et al., *Profiting from Voluntary Information Spillovers: How Users Benefit by Freely Revealing Their Innovations*, 32 RES. POL'Y 1753 (2003); VON HIPPEL, FREE, *supra* note 55, at 19-35.

80. *See* Baldwin & von Hippel, *supra* note 74 at 1411. LEGO is one example of user-producer open innovation. *See* Christoph Hienerth et al, *Synergies Among Producer Firms, Lead Users, and User Communities: The Case of the LEGO Producer–User Ecosystem*, 31 J. PRODUCT INNOVATION MGMT. 848 (2013).

81. *See* Baldwin & von Hippel, *supra* note 74, at 1400-01. For empirical evidence on relative low licensing returns, see Charles W. L. Hill, *Strategies for Exploiting Technological Innovations – When and When Not to License*, 3 ORG. SCI., 428, 428-41 (1992); C. T. TAYLOR & Z. A. SILBERSTON, THE ECONOMIC IMPACT OF THE PATENT SYSTEM: A STUDY OF THE BRITISH PATENT SYSTEM (1973).

82. *See* Baldwin & von Hippel, *supra* note 74, at 1401.

as improved reputation among peers[83] and enhanced value as well as desirability in the job market.[84] Likewise, they are motivated by their own enjoyment of learning and feeling creative, and often feel the need to give back to the communities because they, too, have received source code for free.[85] It is unlikely that such programmers would suffer as a result of a free rider's copying of source code.[86] Even if a programmer were the first to develop source code and attempted to keep it secret, that disadvantage is unavoidable, as another may develop and disclose the same or similar source code freely.[87] Instead, individual programmers can increase the above benefits by distributing source code through free disclosure, rather than enforcing royalty-bearing licenses.[88]

Even for large producer firms, the cost of securing and licensing patents is often significantly higher than the resulting benefit.[89] Many large firms publish their inventions and innovations, foregoing any attempt for patent protection, in an effort to create prior art against future patent assertions.[90] U.S. firms, the government, and individuals have widely adopted this defensive publication practice, and submitted their inventions to the United States Patent and Trademark Office ("USPTO") for publication through the statutory invention registration program.[91] When the America Invents Act[92] was

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83. *See generally* ERIC S. RAYMOND, THE CATHEDRAL & THE BAZAAR: MUSINGS ON LINUX AND OPEN SOURCE BY AN ACCIDENTAL REVOLUTIONARY (1999).

84. Josh Lerner & Jean Tirole, *Some Simple Economics of Open Source*, 50 J. INDUS. ECON. 197, 213 (2003).

85. K. Lakhani & R. Wolf, *Why Hackers do What They Do: Understanding Motivation and Effort in Free/Open Source Software Projects*, *in* PERSPECTIVES ON FREE AND OPEN SOURCE SOFTWARE 11 (J. Feller et al. eds., 2005); FREE SOFTWARE FOUNDATION, *Motives for Writing Free Software*, https://www.gnu.org/philosophy/fs-motives.en.html (last updated June 24, 2014).

86. *See* Lakhani & Wolf, *supra* note 85, at 15-16.

87. Karim R. Lakhani & Eric von Hippel, *How Open Source Software Works: "Free" User-To-User Assistance*, 32 RES. POL'Y 923, 923-24 (2003).

88. Harhoff et al., *supra* note 79, at 1759.

89. *See* Jason Schultz & Jennifer M. Urban, *Protecting Open Innovation: The Defensive Patent License as a New Approach to Patent Threats, Transaction Costs, and Tactical Disarmament*, 26 HARV. J.L. & TECH. 1, 16-20, (2012). However, large firms may view prosecution costs as insignificant when subsumed into the huge operation cost. *See* VON HIPPEL, SOURCES, *supra* note 55, at 84.

90. Schultz & Urban, *supra* note 89, at 27. IBM used to run its own publication system, IBM Technical Disclosure Bulletin, but later joined other commercial firms and OSS foundations to run a web site for defensive publications. *Defensive Publications*, OPEN INVENTION NETWORK LLC, http://www.defensivepublications.org/defensive-pubs-aboutus (last visited Oct. 6, 2019).

91. 35 U.S.C. § 157 (2006), *repealed by* Leahy-Smith America Invents Act, Pub. L. No. 112-29, § 103(e)(1), 125 Stat. 284, 287 (2011); Wendell Ray Guffey, *Statutory Invention Registration: Defensive Patentability*, 16 GOLDEN GATE U.L. REV. 291 (1986). For statistics on the number of statutory invention registrations, see *Number of Statutory Invention Registrations and Defensive Publications Granted in the U.S. as of 2015, by Ownership*, STATISTA

enacted, the USPTO abolished the program on the assumption that the overwhelming majority of applications are published eighteen months from the effective filing date anyway.[93]

Even if patent protection is secured, many firms no longer use patents to bully competitors through injunctions and forced royalties.[94] In complex technologies, firms use patents to share technology. Through cross-licensing, companies obtain patents to increase opportunities to exchange technologies with competitors who might otherwise allege infringement against them.[95]

Another form of patent sharing is the (fair) reasonable and nondiscriminatory ("(F)RAND") license, an arrangement that producer firms in the telecommunication industry have developed. These firms pledge to license their standard essential patents under (F)RAND licenses when standard setting organizations ("SSOs") adopt standards.[96] These pledges prevent standard essential patent owners from excluding not only SSO members, but also anyone who wishes to manufacture a product that is compatible with the standards.[97] Some firms have developed a business model based on a patent sharing arrangement to protect customers from patent assertion entities ("PAEs"), *i.e.,* firms that primarily acquire patents and seek to generate revenue by asserting them against accused infringers,[98] by developing a patent portfolio, licensing patents to customers, and procuring patents to prevent PAEs from obtaining patents.[99] In these private ordering arrangements, pa-

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(Mar. 31, 2016), https://www.statista.com/statistics/256647/statutory-invention-registrations-defensive-publication-grants-by-the-uspto-by-ownership/.

92. Leahy-Smith America Invents Act, Pub. L. No. 112-29, 125 Stat. 284 (2011) (codified in scattered sections of 35 U.S.C.).

93. *See* USPTO, STUDY AND REPORT ON THE IMPLEMENTATION OF THE LEAHY-SMITH AMERICA INVENTS ACT 32 (2015).

94. *See* Schultz & Urban, *supra* note 89, at 6. For patent bullies, see Colleen V. Chien, *Of Trolls, Davids, Goliaths, and Kings: Narratives and Evidence in the Litigation of High-Tech Patents*, 87 N.C. L. REV. 1571, 1588 (2009).

95. *See, e.g.*, Bessen, *supra* note 10, at 1; Bronwyn H. Hall & Rosemarie Ham Ziedonis, *The Patent Paradox Revisited: An Empirical Study of Patenting in the U.S. Semiconductor Industry, 1979-1995*, 32 RAND. J. ECON. 101, 107 (2001) .For more discussion on the new use, see *infra* Section III.

96. Marc Rysman & Timothy Simcoe, *Patents and the Performance of Voluntary Standard-Setting Organizations* 8 (June 2007), http://people.bu.edu/tsimcoe/documents/published/ssopatents5.pdf.

97. Microsoft Corp. v. Motorola Inc., 696 F.3d 872, 876 (9th Cir. 2012). For a discussion of this case, see Jorge L. Contreras, *From Private Ordering to Public Law: The Legal Frameworks Governing Standards Essential Patents,* 30 HARV. J.L. & TECH. 211 (2017); Kassandra Maldonado, *Breaching RAND and Reaching for Reasonable*: Microsoft v. Motorola *and Standard-Essential Patent Litigation*, 29 BERKELEY TECH. L.J. 419, 422 (2014).

98. *See* FTC, PATENT ASSERTION ENTITY ACTIVITY: AN FTC STUDY 1 (2016).

99. *See, e.g.*, James M. Rice, *The Defensive Patent Playbook*, 30 BERKELEY TECH. L.J. 725, 752 (2015).

tent rights are used inclusively to provide access to patent technologies to other firms, patent owners, and licensees. As a result, patent owners, other firms, and licensees are rewarded with the freedom to operate should they themselves or their customers be charged with patent infringement.

Even for firms that are willing to assert patent infringement to exclude others, recent changes in U.S. patent case law have significantly reduced the benefits of patent exclusivity. After the decision *in eBay*,[100] the likelihood of obtaining an injunction is only 53% when the technology at issue in the litigation relates to software.[101] When such patents are owned by PAEs, the likelihood of success falls to 16%.[102] Even for practicing entities, an injunction is not available unless the prevailing patentee can establish that meaningful competition exists.[103] Historically, various surveys have indicated that the value of patent rights to technology companies has typically not been very high, except for in the pharmaceutical industry, where patents remain a valuable asset.[104] What is more, the falling success rate of injunctions since *eBay* has significantly reduced patent owners' power to negotiate favorable royalty rates.

Under the entire market value rule, courts may calculate a reasonable royalty based on the value of the entire product if a patentee can establish that the patented feature is the basis for customer demand.[105] However, recent case law has made clear that the entire market value rule is a narrow exception to the general rule that requires patent owners to calculate a reasonable royalty based on the smallest saleable patent practicing unit.[106] Case law has further clarified that a reasonable royalty must be based on the incremental value that the patented feature adds to the entire product.[107] The burden lies with the prevailing patent owner to apportion damages between the patented improvement and any conventional components when the infringed patent covers only a part of a multicomponent product.[108]

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100. eBay Inc. v. MercExchange, L.L.C., 547 U.S. 388, 394 (2006).

101. Christopher B. Seaman, *Permanent Injunctions in Patent Litigation After eBay: An Empirical Study*, 101 IOWA L. REV. 1949, 1985 (2016).

102. *Id.* at 1988.

103. *See, e.g.*, Nichia Corp. v. Everlight Ams., Inc., 855 F.3d 1328, 1342 (Fed. Cir. 2017).

104. *See* Harhoff et al., *supra* note 79, at 1755; Alvin K. Klevorick et al., *Appropriating the Returns from Industrial Research and Development*, 3 BROOKINGS PAPERS ECON. ACTIVITY 783, 796 (1987).

105. *See, e.g.*, LaserDynamics, Inc. v. Quanta Comput., Inc., 694 F.3d 51, 68-69 (Fed. Cir. 2012); Rite-Hite Corp. v. Kelley Co., 56 F.3d 1538, 1549 (Fed. Cir. 1995).

106. *LaserDynamics*, 694 F.3d at 67.

107. Exmark Mfg. Co. v. Briggs & Stratton Power Prods. Grp., LLC, 879 F.3d 1332, 1348 (Fed. Cir. 2018).

108. *Id.*; Commonwealth Sci. & Indus. Research Org. v. Cisco Sys., Inc., 809 F.3d 1295, 1301 (Fed. Cir. 2015). A study also shows a significant decrease of the median 2016 award from 2015's median award. PWC, 2017 PATENT LITIGATION STUDY: CHANGE ON THE

In contrast to the considerable reduction of the financial benefit of patent exclusivity, the cost of securing patents has soared since the Supreme Court's adoption of a rather uncertain standard for patent eligibility in *Alice v. CLS Bank*.[109] Applications claiming software-related inventions are frequently rejected for lack of eligibility and attorneys are spending an increasing amount of time challenging USPTO decisions.[110] The scope of claims in applications that manage to overcome USPTO rejections will likely be limited to a product or process including the algorithm disclosed in the specification. Such claims are frequently found to describe the invention in functional terms: An element of a claim for combination that is expressed in functional language without sufficient structural limitation will be construed to cover only the structure disclosed in the specification to perform the function recited in the claim and its equivalents.[111] For software patents where the recited function is performed by a special purpose computer, the structure is an algorithm.[112] When the scope is so narrow, competitors can easily circumvent the patent by creating a different algorithm that performs the same function.[113]

Some producer firms—SMEs that were founded by individual programmers, in particular—disclose their innovations free of patent exclusivity because they aspire to the same idealistic goal as the open source philosophy: spreading free software and promoting cooperation in the OSS community through copyleft software development.[114] It often makes sense for SMEs to join the OSS community in order to take advantage of the col-

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HORIZON 9 (2017), https://www.pwc.com/us/en/forensic-services/publications/assets/2017-patent-litigation-study.pdf.

109. Alice Corp. Pty. Ltd. v. CLS Bank Int'l, 573 U.S. 208, 215 (2014) (citing CLS Bank Int'l v. Alice Corp. Pty. Ltd., 717 F.3d 1269, 1286 (Lourie, J., concurring) (2013)) (requiring something more or significantly more than a patent upon the ineligible subject matter or an inventive concept sufficient to make patent ineligible subject matter eligible).

110. Samuel Hayim & Kate Gaudry, *Eligibility Rejections Are Appearing in Greater Frequency Across All Computer Related Technology Centers,* IPWATCHDOG (May 24, 2018), http://www.ipwatchdog.com/2018/05/24/eligibility-rejections-greater-frequency-uspto/id=97615/; Mark Summerfield, *New USPTO Data Set Reveals Extent of Patent-Eligibility Confusion and Carnage*, PATENTOLOGY (Dec. 4, 2017, 5:21 PM), https://blog.patentology.com.au/2017/12/new-uspto-data-set-reveals-extent-of.html.

111. 35 U.S.C. § 112(f) (2012); Williamson v. Citrix Online LLC, 792 F.3d 1339, 1357 (Fed. Cir. 2015) (en banc) (quoting 35 U.S.C. § 112(f) (2012)).

112. *Williamson*, 792 F.3d at 1352; Aristocrat Techs. Austl. PTY Ltd. v. Int'l Game Tech., 521 F.3d 1328, 1333 (Fed. Cir. 2008); WMS Gaming, Inc. v. Int'l Game Tech., 184 F.3d 1339, 1349 (Fed. Cir. 1999).

113. *See, e.g.*, Enfish, LLC v. Microsoft Corp., 822 F.3d 1327 (Fed. Cir. 2016) (patent owner's claims survived defendant's eligibility-based validity challenge but were found not infringing because defendant adopted an algorithm different from the algorithm disclosed in the specification of the asserted patent).

114. *See, e.g.*, RICHARD STALLMAN, *Copyleft: Pragmatic Idealism*, *in* FREE SOFTWARE, FREE SOCIETY: SELECTED ESSAYS OF RICHARD M. STALLMAN 188 (Joshua Gay ed., 2002).

lective innovation power that would otherwise be unattainable with their limited resources.[115]

The number of large producer firms who have joined the OSS community is increasing. Such firms share source code and allow programmers to use their software for motives that differ from those of individual programmers and SMEs: monetizing OSS projects by developing business models for profit while remaining in compliance with restrictions set out by GPL and GPL-inspired licenses.[116] Like SMEs, large producer firms also harness the power of the OSS community in order to expand their R&D resources and develop better products more quickly.[117] Both SMEs and large firms can profit from innovations developed through OSS projects by selling complimentary services such as training, technical support, etc.[118] All types of firms can maximize their R&D capability by engaging in open-sourcing,[119] using the OSS community as a platform for engaging users and improving products by removing user-reported bugs and modifying software to meet users' general and unique needs.[120] For firms that face the constant challenge of cost reduction and seek to be competitive in the global market, open-sourcing is a better way of reducing R&D cost than outsourcing because it allows producer firms to retain and increase their R&D capability, while outsourcing research activities to other institutions may reduce such capabilities in the long run.[121] They also donate patents to the OSS community to minimize maintenance costs and trigger innovations that create new business.[122]

In addition to these business-oriented motives, studies have shown that the idealistic goals of collective innovation and giving back to the OSS community also play a role in motivating producer firms to join the OSS community.[123] A wide variety of types of commercial firms are particularly keen on participating in non-commercial patent pools that are developed to promote social welfare, such as improving global health and diffusing eco-

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115. *See* Andrea Bonaccorsi et al., *Entry Strategies Under Competing Standards: Hybrid Business Models in the Open Source Software Industry*, 52 MGMT. SCI. 1085 (2006).

116. *See* Morten Andersen-Gott et al., *Why Do Commercial Companies Contribute to Open Source Software?*, 32 INT'L J. INFO. MGMT. 106 (2012).

117. MICHAEL L. GEORGE ET AL., FAST INNOVATION: ACHIEVING SUPERIOR DIFFERENTIATION, SPEED TO MARKET, AND INCREASED PROFITABILITY 93, 98 (2005).

118. Andersen-Gott et al., *supra* note 116, at 113; Brian Fitzgerald, *The Transformation of Open Source Software,* 30 MIS Q. 587, 592-93 (2006).

119. Par J. Ågerfalk & Brian Fitzgerald, *Outsourcing to an Unknown Workforce: Exploring Opensourcing as a Global Sourcing Strategy*, 32 MIS Q. 385, 401-03 (2008); Andersen-Gott et al., *supra* note 116, at 108.

120. Andersen-Gott et al., *supra* note 116, at 108-09.

121. *Id.* at 114. Regarding the drawback of outsourcing, see Gary P. Pisano & Willy C. Shih, *Restoring American Competitiveness*, 87 HARV. BUS. REV. at 116-20 (July-Aug. 2009).

122. Nicole Ziegler et al., *Why Do Firms Give Away Their Patents for Free?*, 37 WORLD PAT. INFO. 2, 5 (2014).

123. Andersen-Gott et al., *supra* note 116, at 113.

friendly technologies.[124] These firms also leverage indirect benefits such as improving their reputation by making copyrights and patents publicly available free of charge.[125]

II. REVIEW OF PATENT THEORIES

Although technological developments in the Industry 4.0 era have significantly changed the way commercial firms engage in innovation and increased the role of individual users in innovation processes, U.S. courts continue to apply antiquated theories for rationalizing the patent system that were developed in the pre-Industry 4.0 era. In particular, the predominant rationale was developed in the Industry 1.0 era when individual inventor-entrepreneurs, such as Thomas Edison and the Wright Brothers, invented the first electric light bulb and powered aircraft.[126] Even in the Industry 2.0 and 3.0 eras, large commercial firms played central roles in innovation because SMEs and individual user innovators had no or limited access to machinery, computers, and R&D resources.[127] Many of these commercial firms were highly vertically integrated to maintain exclusive control over innovation processes and the resulting products.[128] Technological change encouraged commercial firms' fragmentation, which led to more collaboration with SMEs and individual user innovators that implemented a highly distributed innovation process in complex technologies. These firms use cross-licensing and other private ordering mechanisms to use patents for including others and sharing technologies instead of excluding others.

A. *Traditional Utilitarian Theory*

In the United States, utilitarianism is the dominant economic theory for justifying exclusive patent rights.[129] The Copyright and Patent Clause of the

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124. Ziegler et al., *supra* note 122 at 3.

125. Ågerfalk & Fitzgerald, *supra* note 119, at 592 (reporting that Apple's reputation in the open source community has improved by starting its Darwin open source project); *cf.* Tim Smedley, *Big Pharma Attempts to Cast Off Bad Reputation by Targeting the Poor*, GUARDIAN (June 25, 2015 8:07 AM), https://www.theguardian.com/sustainable-business/2015/jun/25/big-pharma-attempts-to-cast-off-bad-reputation-by-targeting-the-poor.

126. Teece, *supra* note 73, at 210.

127. *Id.* ("[S]ince the last quarter of the 19th century and the emergence of R&D labs, and more recently venture capital, innovation has become more the domain of organizations, not individuals").

128. Henry Chesbrough, *A Better Way to Innovate*, 87 HARV. BUS. REV. 12, 12 (2003).

129. There are philosophical justifications based on natural rights theories, including the labor theory by John Locke, the personhood theory by George Hegel, and the functional theory by Immanuel Kant. *See generally* ROBERT P. MERGES, JUSTIFYING INTELLECTUAL PROPERTY (2011) [hereinafter MERGES, JUSTIFYING]; Robert P. MERGES ET AL., INTELLECTUAL PROPERTY IN THE NEW TECHNOLOGICAL AGE 2-3 (6th ed. 2012) [hereinafter MERGES, NEW TECHNOLOGICAL AGE]; Justin Hughes, *The Philosophy of Intellectual Property*, 77 GEO. L.J. 287 (1988); Tom G. Palmer, *Are Patents and Copyrights Morally Justified?*

U.S. Constitution supports the theory by granting exclusive rights "to promote the progress of science and the useful arts."[130] U.S. courts and legal scholars have interpreted the clause to mean that Congress adopted the utilitarian theory to reward inventors with an exclusive right that will, in turn, provide incentives to invent.[131] This inventor-centric reward theory was developed in the early stages of the industrial economy. This theory, however, has largely been rendered irrelevant by the information economy with the development of computing technologies in Industry 3.0 and the network information society in Industry 4.0.[132] In the industrial economies of Industry 1.0 and 2.0, inventors of pioneer inventions were awarded with the broad scope of patent protections covering their entire product and could start firms and exercise significant market power by being the exclusive seller of a product.[133]

As was intended by the founders of the U.S. patent system,[134] inventor-entrepreneurs could enjoy profits by selling their products or services with supracompetitive pricing during the temporary period of exclusivity to re-

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The Philosophy of Property Rights and Ideal Objects, 13 HARV. J.L. & PUB. POL'Y 817 (1990); *see also* Edwin C. Hettinger, *Justifying Intellectual Property*, 18 PHIL. PUB. AFF., 31, 31 (1989).

130. U.S. CONST., art. I, § 8, cl. 8. Literature on the incentive theory published by U.S. economics and legal scholars is profuse. *E.g.*, WILLIAM M. LANDES & RICHARD A. POSNER, THE ECONOMIC STRUCTURE OF INTELLECTUAL PROPERTY LAW 305 (2003); Jeanne C. Fromer, *Expressive Incentives in Intellectual Property*, 98 VA. L. REV. 1745, 1750–52 (2012); Mark A. Lemley, *Ex Ante Versus Ex Post Justifications for Intellectual Property*, 71 U. CHI. L. REV. 129, 129–30 (2004).

131. *E.g.*, Diamond v. Chakrabarty, 447 U.S. 303, 307 (1980) ("The patent laws promote this progress by offering inventors exclusive rights for a limited period as an incentive for their inventiveness and research efforts. The authority of Congress is exercised in the hope that '[the] productive effort thereby fostered will have a positive effect on society through the introduction of new products and processes of manufacture into the economy, and the emanations by way of increased employment and better lives for our citizens.'") (citations omitted); Mazer v. Stein, 347 U.S. 201, 219 (1954) ("The economic philosophy behind the clause empowering Congress to grant patents and copyrights is the conviction that encouragement of individual effort by personal gain is the best way to advance public welfare through the talents of authors and inventors in 'Science and useful Arts.' Sacrificial days devoted to such creative activities deserve rewards commensurate with the services rendered.").

132. YOCHAI BENKLER, THE WEALTH OF NETWORKS 3 (2006), http://www.benkler.org/Benkler_Wealth_Of_Networks.pdf. ("[W]e are seeing the emergence of a new stage in the information economy, which I call the 'networked information economy.' It is displacing the industrial information economy that typified information production from about the second half of the nineteenth century and throughout the twentieth century.").

133. For example, the Wright brothers obtained patent claims that covered the entire aircraft, thus granting the firm monopoly power. Carl Zollmann, *Patent Rights in Aircraft*, 11 MARQ. L. REV. 216, 218-20 (1927).

134. Jefferson's letter to his daughter reveals his intent to encourage U.S. inventors to invent and commercialize those inventions through the patent system. *See* DAVID KLINE, THE INTANGIBLE ADVANTAGE: UNDERSTANDING INTELLECTUAL PROPERTY IN THE NEW ECONOMY 15 (2016); HENRY NOTHHAFT & DAVID KLINE, GREAT AGAIN: REVITALIZING AMERICA'S ENTREPRENEURIAL LEADERSHIP 71 (2011).

coup their investment in developing the products.[135] This reward theory also presumes a closed innovation model; in the model, entrepreneurs invent, commercialize and market a new product during every stage of the value chain.[136]

Yet, this presumption no longer applies to the majority of commercial firms in the era of Industry 4.0. The ICT sector—at the very core of Industry 4.0 technology—is classified as a complex technology because its products contain numerous components.[137] Such technologies are characterized by overlapping, and thus mutually blocking, patents that cover each component and are held by different innovators, the result of highly distributed open innovation.[138] Even if a piece of technology consists of one or very few components and is discrete, each component may have been covered by overlapping patents because it is likely that such components were the result of the cumulative innovation process based on generations of prior inventions and were contributed by different innovators.[139] The cumulative innovation process is a dominant feature of technologies developed in the Industry 3.0 and 4.0 eras, such as ICT, biotechnology, and other modern innovations.[140] Through Germany's Industry 4.0 initiative, the complex and cumulative nature of ICT has been spread through industry sectors of discrete technologies where patent owners were once able to control their products.

In complex technologies, firms do not enjoy exclusive control over their products. Because the technologies necessary to manufacture a product are frequently covered by a number of patents held by different parties, a patent owner can no longer produce a product without infringing patents held by others, making it impossible to develop products in the closed model without the involvement of other firms.[141] Standardized telecommunication technologies, which are essential for the enhancement of Industry 4.0, are good examples; 250,000 patents, declared essential for 2G, 3G, and 4G technolo-

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135. For the basic economics of patent protection and reward, see FRANÇOIS LÉVÊQUE & YANN MÉNIÈRE, THE ECONOMICS OF PATENTS AND COPYRIGHT 20-42 (2004), https://ssrn.com/abstract=642622.

136. Teece, *supra* note 73, at 198 ("The 'Schumpeterian' view of the innovation processes appears to be one that involves full integration, from research, development, manufacturing and marketing.") For the Schumpeterian view, see JOSEPH A. SCHUMPETER, THE THEORY OF ECONOMIC DEVELOPMENT: AN INQUIRY INTO PROFITS, CAPITAL, CREDIT, INTEREST, AND THE BUSINESS CYCLE (1934).

137. Baron & Delcamp, *supra* note 54, at 583.

138. For more discussions on open innovation, see *supra* Section I.C.1.

139. *See generally* Arti K. Rai, *Fostering Cumulative Innovation in the Biopharmaceutical Industry: The Role of Patents and Antitrust*, 16 BERKELEY TECH. L.J. 813 (2001).

140. Alberto Galasso & Mark Schankerman, *Patents and Cumulative Innovation: Causal Evidence from the Courts,* 130 Q.J. ECON. 317-18 (2015).

141. Peter C. Grindley & David J. Teece*, Managing Intellectual Capital: Licensing and Cross-Licensing in Semiconductors and Electronics*, 39 CAL. MGMT REV. 8, 9 (1997).

gies, were held by different patent owners.[142] Components of such technologies are interdependent to ensure compatibility.[143] As discussed in Part I, patent owners developed (F)RAND licenses to prevent others from excluding them and to share interdependent technologies with all prospective users to ensure sector-wide compatibility and the freedom to operate the technologies.[144] Like multinational firms that protect programmers in the OSS communities,[145] many firms in the field of complex technologies use patents defensively to develop a strong patent portfolio for cross-licensing with competitors and maintaining their own freedom of operation.[146] In other words, these firms use their own patents as currency for cross-licensing in order to gain access to technologies that would otherwise be blocked by competitors' patents. By obtaining access to the technology, firms are free to implement their own innovations into multi-component products.[147]

A study on patenting motivations also confirms the relatively high priority that commercial firms have for using patents defensively to ensure the freedom to operate. However, preventing imitation and hampering the competition's access to technologies are motives that ranked even higher.[148] One recent study of German firms supports the proposition that imitation prevention and defensive patenting are the leading reasons for firms in all sectors to seek patent protection.[149] Even in chemical engineering, once classified as a discrete technology,[150] the defensive motive is now ranked on par with the imitation prevention motive.[151] This is further evidence of the impact of

142. TIM POHLMANN & KNUT BLIND, IPLYTICS FOR THE EUROPEAN COMMISSION, LANDSCAPING STUDY ON STANDARD-ESSENTIAL PATENTS 17 (2016), https://ec.europa.eu/growth/content/landscaping-study-standard-essential-patents-europe-0_en; Tim Pohlmann, *Industry Report – How To Count and Valuate Standard –Essential Patents*, IAM (Nov. 15, 2017), https://www.iam-media.com/how-count-and-valuate-standard-essential-patents.

143. Baron & Delcamp, *supra* note 54, at 582.

144. For the discussion of (F)RAND license, see *supra* notes 96-97 and accompanying text.

145. *See infra* notes 210-12 and accompanying text. Regarding the open patent license used by these multinational firms, see *infra* notes 206-12 and accompanying text.

146. William Kingston, *Innovation Needs Patents Reform,* 30 RES. POL'Y 403, 408 (2001).

147. *Id.*

148. Gaétan de Rassenfosse et al., *Motivations to Patent: Empirical Evidence from an International Survey*, *in* 2008 PROC. 5TH INT'L CONF. INNOVATION & MGMT. 96, 98 tbl.1, https://www.researchgate.net/profile/Gaetan_De_Rassenfosse2/publication/237433666_Motivations_to_Patent_Empirical_Evidence_from_an_International_Survey24/links/54edcfc90cf2e2830863813f.pdf.

149. Knut Blind et al., *Motives to Patent: Empirical Evidence from Germany,* 35 RES. POL'Y 655, 663 (2006).

150. WORLD INTELLECTUAL PROPERTY ORGANIZATION, WORLD INTELLECTUAL PROPERTY INDICATORS 181 (2011) [hereinafter WIPO]; Georg von Graeventz et al., *Incidence and Growth of Patent Thickets: The Impact of Technological Opportunities and Complexity,* 61 J. INDUS. ECON. 521, 560 (2013).

151. Blind et al., *supra* note 149, at 664, 665 fig.4.

changes in the innovation process on motivation because imitation prevention was once the dominant motive in such technology sectors.[152] Pharmaceuticals, also once classified as discrete technologies,[153] have become more cumulative in nature due to the increased number of patents on large molecule drugs.[154] As large molecules begin to play an important role in drug development, drugs are no longer immune from the necessity to ensure access to patents held by biotechnology firms through defensive patenting strategies.[155]

In short, throughout the core technological sectors in the Industry 4.0 era, patents in practice do not give exclusive rights. It is essential that firms that deal with complex technologies engage in open innovation. Practically, such firms can no longer use patents for excluding others. Although commercial firms secure patents when motivated by the desire to prevent imitations by competitors, these patents frequently do not give firms sufficient power to prevent imitation if the firms are simultaneously infringing their competitors' patents. The only firms that can easily enforce exclusivity in such technological sectors are PAEs, who do not practice patents and thus are immune from counter patent infringement assertion. The incentive to invent theory does not apply to PAEs anyway because many PAEs do not invent their patented technologies themselves; therefore, many view their enforcement of patent exclusivity as contrary to patent policy by diminishing patent practicing firms' incentive to invent.[156]

In addition, the incentive to invent theory does not apply to individual user innovators, who play an important role in open innovation. Indeed, in many cases they do not need or even dislike rewards provided by patent exclusivity.[157] Unlike producer firms that benefit from selling products and services, user innovators are self-rewarded by the benefit of developing and improving products and services. These benefits encourage not only individual users but also commercial firms to disclose their inventions without

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152. *See* Dan L. Burk & Mark A. Lemley, *Policy Levers in Patent Law,* 89 VA. L. REV. 1575, 1590, 1684-87 (2003) (Describing chemical and pharmaceutical industries as being special by manufacturing a single product being covered by a single patent); Wesley M. Cohen et al., *R&D Spillovers, Patents and the Incentives to Innovate in Japan and the United States*, 31 RES. POL'Y 1349, 1358 (2002).

153. WIPO, *supra* note 150, at 181; *see also* Michael Meurer*, Patent Notice and Cumulative Innovation*, *in* COMPETITION POLICY AND PATENT LAW UNDER UNCERTAINTY: REGULATING INNOVATION 331, 332 (Geoffrey A. Manne & Joshua D. Wright eds., 2011).

154. *See generally* Lisa L. Ouellette, *How Many Patents Does It Take to Make a Drug? Follow-On Pharmaceutical Patents and University Licensing*, 17 MICH. TELECOMM. & TECH. L. REV. 299 (2010).

155. For the biotech firms' responses to overlapping patents, *see* Shapiro*, supra* note 9, at 122-24.

156. FTC, *supra* note 98, at 24-25; *see also* Lauren Cohen et al., *The Growing Problem of Patent Trolling*, 352 SCIENCE 521, 521–22 (2016).

157. *See* Katherine J. Strandburg, *Users as Innovators: Implications for Patent Doctrine*, 79 U. COLO. L. REV., 467, 485-87 (2008).

patent protection to allow others to use their inventions for which they have secured patents.[158] The sharing philosophy is particularly important for OSS programmers, who have already adapted the copyright framework as a sharing tool.[159] To conclude, the incentive-to-invent theory was rational for patents in the Industry 1.0 era, but remains practical only for firms that engage in the closed-innovation model in the discrete technologies.

B. *Modern Utilitarian Theories*

Finding the traditional incentive to invent theory insufficient to support the current patent system, both legal and economics scholars have proposed numerous theories to explain how patents promote innovation following a break-through pioneer invention (follow-on innovation). However, these modified theories presume a reward from profits through exclusive control over their products and services. As discussed in connection with the incentive-to-invent theory,[160] this presumption does not apply to firms in complex technologies sectors. Complex technology firms have developed a new use—the defensive use of patents for sharing technologies. This new use is different from the use by firms in the sectors of discrete technologies that are the typical technological sectors of Industry 1.0.[161]

These modified theories are outdated in their failure to take account of the defensive use of patents. Moreover, these theories still focus on traditional innovators such as commercial producer firms and do not take into account the changes enabled by the technological advancement in Industry 4.0: highly distributed open innovation in which commercial firms and individual user innovators collaboratively engage.

Economics scholars have long attempted to show the elasticity between patent grants and R&D investments, yet no empirical study has resulted in clear evidence supporting the connection.[162] Similarly, no clear empirical evidence exists to show any positive impact on R&D investment from the change of patent policy through patent law revisions.[163]

Acknowledging the opportunity to develop a commercially viable technology as a prospect, one leading patent scholar, Edmund Kitch, developed

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158. *See supra* notes 55-60 and accompanying text.

159. *See supra* notes 62-64 and accompanying text.

160. *See supra* notes 137-40 and accompanying text.

161. *See* Luigi Orsenigo & Valerio Sterzi, *Comparative Study of the Use of Patents in Different Industries*, (Knowledge, Internationalization & Tech. Stud., Universita' Bocconi Working Paper No. 033, 2010), https://ideas.repec.org/p/cri/cespri/kites33_wp.html.

162. *See* Heidi L. Williams, *How Do Patents Affect Research Investments?*, 28 (Nat'l Bureau of Econ. Res., Working Paper No. 23088, 2017), http://www.nber.org/papers/w23088.

163. *See* Josh Lerner, *The Empirical Impact of Intellectual Property Rights on Innovation: Puzzles and Clues*, 99 AM. ECON. REV. 343 (2009); Mariko Sakakibara & Lee Branstetter, *Do Stronger Patents Induce More Innovation? Evidence from the 1998 Japanese Patent Law Reforms,* 32 RAND J. ECON., 77 (2001).

the prospect theory, arguing that a patent grant with a broad exclusive scope on a pioneering invention results in positive impacts on downstream inventions; the pioneer patent owner can coordinate investments in follow-on innovation that falls within the broad scope.[164] The prospect theory is more in line with innovation by commercial firms in the Industry 4.0 era than the incentive-to-invent theory in that it acknowledges the cumulative nature of innovation and the necessity for managing resources among follow-on innovators.[165]

A number of economics scholars have also examined the impact of pioneer patents on follow-on innovation, but none of their studies has been able to clearly support a significant link between the two. In response to criticisms of Kitch's prospect theory,[166] Green and Scotchmer have used a theoretical model that showed no negative impact on follow-on innovation resulting from patents on pioneer inventions, so long as the exclusive rights on pioneer inventions encourage the execution of correct licensing between the pioneer patent owner and follow-on innovators.[167] Other scholars have challenged Green and Scotchmer's conclusion by showing negative impacts from patenting pioneer inventions when pioneer patent owners block follow-on innovation and proper licensing fails to occur.[168] Another recent study has shown that the negative impacts of blocking patents are limited to very specific circumstances.[169] Other empirical studies confirm that there is no impact or only a marginal one on follow-on innovations.[170] However, whether patent grants affect pioneer inventions is still unclear because other studies show significant impacts on follow-on innovation.[171]

These studies have influenced patent scholars who have attempted to refine the prospect theory to explain the role of the patent system in light of its constitutional goal—the promotion of the useful arts. For some economics scholars, an invention leads to technical innovation only if the invention is

164. Edmund W. Kitch, *The Nature and Function of the Patent System*, 20 J.L. & ECON. 265, 266 (1977).

165. *Id.* at 276.

166. Robert P. Merges & Richard R. Nelson*, On the Complex Economics of Patent Scope,* 90 COLUM. L. REV. 839, 842 (1990) (arguing pioneer patenting's negative impact on follow-on innovation by taxing or impeding their activities).

167. *See* Jerry R. Green & Suzanne Scotchmer, *On the Division of Profit In Sequential Innovation*, 26 RAND J. ECON. 20, 22 (1995).

168. *See* James Bessen & Eric Maskin, *Sequential Innovation, Patents, and Imitation,* 40 RAND J. ECON. 611, 612-613 (2009; Albert Galasso & Mark Schankerman, *Patent Thickets, Courts and the Market for Innovation*, 41 RAND J. ECON. 472 (2010).

169. *See* Galasso & Schankerman, *supra* note 168, at 18.

170. Jean-Noel Barrot & David Colino, *Patent Duration and Cumulative Innovation: Evidence from a Quasi-Natural Experiment* 22-23 (2017), https://economics.mit.edu/files/12937.

171. Fabian Gaessler et al., *Patents and Cumulative Innovation – Evidence from Post-Grant Patent Oppositions*, 2017 ACAD. MGMT. PROC. 4.

commercialized.[172] Commercialization is "the process of moving a technology or innovative concept from the idea state to the market place;" such a process involves a great deal of challenges that firms must overcome in order to deliver a product that meets the needs of a particular market at an affordable price.[173] A variety of studies have demonstrated the advantages of the open innovation model for overcoming these challenges.[174] The prospect theory assumes that these challenges arise *after* invention and is distinguished from the traditional incentive to invent theory in focusing on *ex post* improvement and commercialization activities instead of *ex ante* invention activities.[175] The prospect theory also takes into account the fact that *ex post* activities—also known as follow-on innovations—are more likely to be engaged by innovators other than the innovators of pioneer inventions. The theory is thus more in line with the idea of open innovation than the incentive to invent theory, which assumes that *ex post* activities are engaged in by innovators of pioneer inventions in the closed innovation model.

The prospect theory attracted a lot of attention from patent scholars, which has led to various proposed modifications that revise the traditional *ex ante* incentive theory to extend to *ex post* incentive for commercialization.[176] Some of the *ex post* incentive theorists enhanced the prospect theory by proposing that patents be granted earlier,[177] while others proposed the extension of patent terms in order to encourage commercialization activities.[178] Others proposed a variety of reforms on the current patent system for increasing the *ex post* incentive including reform proposals that reward commercialization separately from inventions.[179] Several critiques were made to

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172. CHRIS FREEMAN & LUC SOETE, THE ECONOMICS OF INDUSTRIAL INNOVATION 6 (3rd ed. 1997).

173. Reza Bandarian, *Evaluation of Commercial Potential of a New Technology at the Early State of Development with Fuzzy Logic*, 2 J. TECH. MGMT. & INNOVATION 73, 74 (2007).

174. Joel West & Marcel Bogers, *Leveraging External Sources of Innovation: A Review of Research on Open Innovation,* 31 J. PROD. INNOVATION MGMT. 814, 814-15 (2014).

175. Lemley*, supra* note 130, at 138-39.

176. F. Scott Kieff, *Property Rights and Property Rules for Commercializing Inventions*, 85 MINN. L. Rev. 697, 707-08 (2001) (property right is necessary for facilitating investment for commercialization of nascent inventions); Ted M. Sichelman, *Commercializing Patents*, 62 STAN. L. REV. 341, 374-75 (2010) ("In sum, economic rationale for patent protection for *ex ante* inventive efforts arguably applies with similar force for *ex post* commercialization efforts.").

177. John F. Duffy, *Rethinking the Prospect Theory of Patents,* 71 U. CHI. L. REV. 439, 471-72 (2004).

178. *See* Michael Abramowicz, *The Danger of Underdeveloped Patent Prospects*, 92 CORNELL L. REV. 1065, 1068 (2007).

179. Christopher A. Cotropia, *The Folly of Early Filing in Patent Law*, 61 HASTINGS L.J. 65, 120 (2009) (analogizing patents to real options and arguing to require applicants to reduce their inventions to practice before or after filing a patent application); Camilla Alexandra Hrdy, *Commercialization Awards*, 2015 WIS. L. REV. 13, 13 (2015); Sichelman, *supra* note 176, at 396; *see also* Abramowicz, *supra* note 178, at 1106; Michael Abramowicz &

such reform proposals that sought to add a reward for commercialization. For example, one patent scholar argued that no separate incentive for commercialization is necessary. This is because the rewards from selling products are assumed to include all justification for patenting. This assumption does not apply to the university technology transfer context, where patent exclusivity was not an incentive to invent or disclose for inventors in the academic setting.[180]

Although the *ex post* incentive theory modernized the *ex ante* theory by taking account of the ideas of cumulative and open innovation, the current U.S. patent system seldom provides a prospect function because current case law has eliminated one important feature of the patent system: the patent scope beyond what is entitled as reward for a disclosed invention.[181] The Federal Circuit limited the scope of patent claims to what the inventor actually invented and intended to envelop in the claims.[182] For the overwhelming majority of patents, their scope is limited to what the inventor disclosed as his or her invention and thus does not extend to follow-on innovation as literal infringement. A patent's scope may reach to follow-on innovation as infringement under the doctrine of equivalents, because courts may find equivalence even if an element is replaced with an after-arising technology.[183] However, recent Federal Circuit case law has made the doctrine of equivalents a narrow exception.[184] Patent scholars view the doctrine as a dead letter.[185] Moreover, even if courts find that follow-on innovations infringe the original patent, post-*eBay* case law prevents a patent owner from excluding follow-on infringers if the infringers are not the patent owner's own competitors or if the owners broadly and extensively license their inventions for commercialization.[186] In short, patent owners seldom have the

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John Duffy, *Intellectual Property for Market Experimentation*, 83 N.Y.U. L. REV. 337, 344 (2008); Christopher A. Cotropia, *Describing Patents as Real Options,* 34 J. CORP. L. 1127, 1128 (2009).

180. Katherine J. Strandburg*, Users, Patents and Innovation Policy*, *in* THE OXFORD HANDBOOK OF INTELLECTUAL PROPERTY LAW 725, 737 (Rochelle Dreyfuss & Justine Pila, eds., 2018).

181. Kitch, *supra* note 164, at 267.

182. *Phillips*, 415 F.3d at 1312.

183. Christopher A. Cotropia, *"After-Arising Technologies" and Tailoring Patent Scope*, 61 N.Y.U. ANN. SURV. AM. L. 151, 151 (2005); Chung-Lun Shen, *Patent Infringement and Reasonable Allowance of New Technologies in Claim Construction*, 25 DEPAUL J. ART, TECH. & INTELL. PROP. L. 293, 293-94 (2015).

184. John R. Allison & Mark A. Lemley, *The (Unnoticed) Demise of the Doctrine of Equivalents*, 59 STAN. L. REV. 955, 960 (2007); Joshua D. Sarnoff, *Abolishing the Doctrine of Equivalents and Claiming the Future After* Festo, 19 BERKELEY TECH. L.J. 1157, 1157 (2004); David L. Schwartz, *Explaining the Demise of the Doctrine of Equivalents*, 26 BERKELEY TECH. L.J. 1157, 1177 (2011).

185. Brian J. Love, *Interring the Pioneer Invention Doctrine*, 90 N.C. L. REV. 379, 379 (2012).

186. ActiveVideo Networks, Inc. v. Verizon Commc'ns., Inc., 694 F.3d 1312 (2012).

power to control follow-on innovation in order to coordinate improvements and commercialization activities.

In addition, patent owners of pioneer inventions have little power over follow-on innovation when follow-on innovators obtain separate patents on their improvements, because the exclusive rights of pioneer and improvement patents necessarily block patent owners from practicing their own inventions.[187] Critics of prospect theory have made the point that this aspect of the U.S. patent system is inconsistent with the theory.[188] The premise of the prospect theory does not apply to cases where separate, overlapping patents are granted on each component because such patents further diminish the ability of patent owners in complex technologies to control follow-on innovation.[189] Without any mechanism to control follow-on innovation, pioneer patent owners cannot make profits through follow-on patent owners' sales of products resulting from their commercialization. Thus, the lack of a control mechanism may discourage patent owners from obtaining patents early. However, patent owners in complex technologies continue to obtain patents early because they use patents for sharing technologies and promoting open innovation.

Ex post theories that focus on commercialization do not apply to most user innovators, especially OSS programmers, because these inventors innovate on products and services and deliver them directly to other users (peer-to-peer diffusion). Not only is the *ex post* incentive for IP rights unnecessary to invent, but the practices based on this incentive are frequently avoided due to the prohibitively high transactional cost of acquiring and licensing IP rights.[190] OSS programmers use IP rights for *ex post* activities only when a transaction-free mechanism to share technology is developed, similar to the mechanism developed as copyleft in the copyright context.[191] In sum, modern utilitarian theories are inadequate for rationalizing the patent system in the Industry 4.0 technological age because they fail to explain the role of the patent system in complex technologies.

III. NEW UTILITARIAN THEORY

In light of the new uses of patents in complex technologies, this article proposes a new utilitarian theory for rationalizing the patent system: the incentive to share. The patent system should reward inventors with the free-

187. For more discussions about blocking patents, see *infra* notes 229-30, 263 and accompanying text.

188. Roger L. Beck, *The Prospect Theory of the Patent System and Unproductive Competition*, 5 RES. L. & ECON. 193, 205 (1983); Mark A. Lemley, *The Economics of Improvement in Intellectual Property Law*, 75 TEX. L. REV. 989, 1047 (1997).

189. *See supra* note 137 and accompanying text.

190. VON HIPPEL, FREE, *supra* note 55, at 6.

191. *See supra* notes 63-64 and accompanying text.

dom to operate and innovate on their inventions by providing incentives to share technologies. In the ICT sector, such incentives are given by retooling patent rights through open patent licenses to share technologies and promote collaboration between producer firms and OSS programmers.[192] In other words, the patent system should promote innovation by the diffusion of technological ideas through different innovators.[193]

The *ex ante* and *ex post* incentive theories are flawed because of the current patent system's producer-centric Industry 1.0 era policy, which assumes that all innovators maintain a closed innovation model and receive incentives only through profits from exclusively selling products and services.[194] In other words, patent policy should be modernized to take into account the new use of patents in complex technologies so that the patent grant might give innovators who engage in open innovation an incentive to share their inventions with prospective innovators by revitalizing the inclusive side of patent rights.[195] The exclusive side of patent rights, too, should be reevaluated in an effort to give prospective innovators the ability to operate and innovate on already-patented inventions.[196]

Current patent policy has yet to reflect the modern uses of the patent monopoly because the new use and the expansion of open innovation are relatively recent phenomena. Large firms, including those in complex technologies such as ICT, have historically been vertically integrated and have engaged in a relatively closed innovation model until the end of last century.[197] The technological advances that occurred in Industry 3.0 and 4.0 enhanced open innovation because such advances have made it possible for smaller, more specialized firms to compete with large firms in innovation, which has led to large firms' disintegration and modulation and their collaboration with small firms to expand open innovation.[198]

With an incentive to share, patents can reduce high transaction and search costs, which are a major concern for Coasian economics scholars.[199] With complex technologies, where innovation is highly distributed, firms often need to use many patents held by others. The new use of patents, *i.e.*,

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192. For a discussion of open patent licenses, see *infra* notes 208-12 and accompanying text.

193. Collen V. Chien, *Opening the Patent System: Diffusionary Levers in Patent Law*, 89 S. CAL. L. REV. 793, 846 (2016).

194. VON HIPPEL, *Free*, *supra* note 55, at 14.

195. *See* discussions *infra* Section IV.B.

196. *See* discussions *infra* Section IV.C.

197. Jens Frøslev Christensen, *Withering Core Competency for the Large Corporation in an Open Innovation World?*, *in* OPEN INNOVATION: RESEARCHING A NEW PARADIGM 35-61 (H. Chesbrough, W. Vanhaverbeke & J. West eds., 2006).

198. *Id.* at 43.

199. Edward J. Egan & David J. Teece, *Untangling the Patent Thicket Literature* 13, 18 (Tusher Center for Management of Intellectual Capital, Working Paper No. 7, 2015), http://www.bakerinstitute.org/research/untangling-patent-thicket-literature/.

the defensive use of patents for sharing, can reduce such cost by cross-licensing with patents held by others.[200] Technological advancements in the modern era have intensified the complex nature of products and services in all technological sectors because the Internet connects things and people with AI and big data, thus rendering the operation of such products and services interdependent.[201] Because this interdependency makes the scope of a freedom to operate search unreasonably broad and expensive, firms must limit the scope to balance the cost and risk.[202] As a result, firms that conduct a thorough freedom to operate search may still infringe patents held by others if the patents are directed to a technology unrelated to the field of invention that they plan to practice. Instead of conducting an expensive search, firms in complex technologies use their patents as a trading currency to cross-license with patents held by a party that might otherwise assert patent infringement.[203] Such firms also develop a large patent portfolio to deter others from asserting patent infringement.[204]

Moreover, firms in complex technologies have enhanced the new use of patents by retooling patent rights for sharing technologies through a variety of open patent licenses.[205] These open patent licenses share two common features: (1) using patents to share technologies with other members and defend against patent infringement assertions; and (2) using standard public licenses to minimize transaction costs. Among such licenses, the defensive patent license ("DPL") was developed to address the needs of the OSS community and was strongly influenced by its philosophical underpinnings: openness and the freedom to operate and innovate.[206] By joining the DPL, a patent owner (including a potential patent owner) gives all other DPL members a worldwide, royalty-free, non-exclusive license to other members with respect to their technologies in the entire and future patent portfolio.[207] Another arrangement that uses patents to share technology is the license offer

200. *See id.* at 14.

201. For technology interdependence, see Diane E. Bailey et al., *Minding the Gaps: Understanding Technology Interdependence and Coordination in Knowledge Work,* 21 ORG. SCi. 713, 714 (2010).

202. Gillian Fenton, *Application of Enterprise Risk Management (ERM) Principles to Patent Freedom to Operate (FTO) Analysis: A Novel 'IP-RM' System,* 51 LES NOUVELLES – J. LICENSING EXEC. SOC'Y 246, 248 (2016).

203. Kingston, *supra* note 146, at 408.

204. Corbel & Le Bas, *infra* note 216, at 11.

205. Natacha Estèves, *Open Models for Patents: Giving Patents a New Lease on Life*, 21 J. WORLD INTELL. PROP. 2, 8 (2018).

206. Schultz & Urban, *supra* note 89, at 52; THE DEFENSIVE PATENT LICENSE, *Preface*, https://defensivepatentlicense.org/license (last accessed Nov. 21, 2018).

207. THE DEFENSIVE PACT LICENSE, *supra* note 206, at License Grant. According to the preface, anyone can join the DPL community by making a commitment to be bound by the license terms when she obtains a patent in the future. *Id.* at Preface.

made under the creative common public patent license.[208] Once an offer is publicized online, anyone can accept the offer on a non-discriminatory basis without any further negotiation, although the license may include a license fee or royalty.[209]

Producer firms developed several open patent licenses with the particular aim of collaboration with programmers in the OSS community. In the Linux context, for example, the Open Invention Network ("OIN") is a patent pool for sharing technologies owned by their members: Patent owners join OIN and let it grant royalty-free worldwide non-exclusive licenses to other members in exchange for licenses to use other members' patents. [210] Large commercial firms such as IBM, Google, Philips, Toyota, and most recently Microsoft have all joined the OIN and donated their patents.[211] Members of the OSS community also run an initiative to use patents for protecting programmers; the Mozilla Foundation—an OSS group that developed the web browser "Firefox"—obtains patents and gives a royalty-free worldwide non-exclusive license to programmers in exchange for a license with the same conditions for the programmers' own patents.[212]

Tesla and other producer firms in the complex technology fields have made pledges to limit the enforcement of their patents.[213] These firms usually list their patents and make public commitments to grant licenses either with or without a royalty payment, or pledge not to assert their patent rights.[214] These pledges are good examples of mechanisms for using patents to share technologies. One drawback is that the enforceability of these pledges depends on principles of equity and is thus uncertain.[215] Nevertheless, the ultimate effect of these pledges is the same as open patent licenses if they are enforced — sharing and giving access to patented technologies.

Patents play a proactive role in promoting open innovation by facilitating the sharing of technology by innovators.[216] At present, producer firms

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208. *See Model Patent License*, CREATIVE COMMONS, https://wiki.creativecommons.org/wiki/Model_Patent_License (last updated Oct. 19, 2010, 5:29 PM).

209. *Id.*

210. *OIN License Agreement, Section 1. License*, OPENINVENTIONNETWORK https://www.openinventionnetwork.com/joining-oin/oin-license-agreement/ (last visited Nov. 1, 2019).

211. *See id.* at *Members*, https://www.openinventionnetwork.com/about-us/members/ (last visited Nov. 1, 2019).

212. *Mozilla Open Software Patent License Agreement v1.1,* MOZILLA, https://www.mozilla.org/en-US/about/policy/patents/license/ (last visited Sept. 29, 2019).

213. Jorge L. Contreras*, The Evolving Patent Pledge Landscape*, at 1, 3 (Ctr. for Int'l Governance Innovation Papers No. 166, 2018).

214. Jorge L. Contreras, *Patent Pledges,* 47 ARIZ. ST. L.J. 543, 555-57 (2015).

215. Contreras, *supra* note 213, at 4.

216. Pascal Corbel & Christian Le Bas, *The Evolution of Patent Functions: New Trends, Main Challenges and Implications for Firm Strategy* 12 (Groupe D'Analyse et de Théorie

work with a variety of partners including customers, suppliers, competitors, and other complementary partners. Improvements are discovered through external sources or are outsourced, and commercialization is achieved through multiple innovation models.[217] Some firms actively seek out external information about their inventions so that they can effectively commercialize them.[218] Other firms may not have sufficient complementary assets for commercialization and need to find partners to supplement assets that the firm may lack and commercialize their inventions so they can enjoy large profits from products or services sold in the open marketplace.[219] Patents facilitate interactions between firms who want innovation sources and those who want to collaborate or outsource the commercialization of their own.[220]

Through patent disclosures, patent owners can advertise and demonstrate their technological information and expertise to prospective partners and licensees.[221] This signaling effect is particularly important for technology startups seeking to facilitate access to external funding.[222] Patents articulately describe technological information as a property right through the function of patent claims, which reduces transaction costs for both technology licensing contracts and joint venture contracts.[223] Patents also encourage innovators to engage in discussions about technological information with

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Économique, Working Paper No. 1106, 2011), https://halshs.archives-ouvertes.fr/halshs-00569239/document.

217. Marcel Bogers & Joel West, *Contrasting Innovation Creation and Commercialization within Open, User and Cumulative Innovation*, (July 13, 2010) (working paper), http://dx.doi.org/10.2139/ssrn.1751025.

218. Keld Laursen & Ammon Salter, *Open for Innovation: The Role of Openness in Explaining Innovation Performance Among U.K. Manufacturing Firms*, 27 STRATEGIC MGMT. J. 131, 131 (2006).

219. David J. Teece, *Profiting from Technological Innovation: Implications for Integration, Collaboration, Licensing and Public Policy*, 15 RES. POL'Y 285, 285 (1986) (demonstrating that for innovators to receive profits from commercialization, they must have complementary assets).

220. Patrick Cohendet & Jurien Pénin, *Patents to Exclude v. Include: Rethinking the Management of Intellectual Property Rights in a Knowledge Based Economy,* TECH. INNOVATION MGMT. REV. 12 (2011); Deepak Hegde & Hong Luo, *Patent Publication and the Market for Ideas*, 64 MGMT. SCI. 652, 652 (2018) (discussing the benefits of patent disclosure, including the reduction of information costs between sellers and buyers of technological information through the publication of an invention in a credible, standardized, and centralized repository).

221. Chien, *supra* note 193, at 805; Cohendet & Pénin, *supra* note 220, at 13; Jay P. Kesan, *Economic Rationales for the Patent System in Current Context*, 22 GEO. MASON L. REV. 897, 911-12 (2015).

222. Joan Farre-Mensa et al., *What Is a Patent Worth? Evidence from the U.S. Patent 'Lottery'* 5 (USPTO, Economic Working Paper No. 2015-5, 2017), https://ssrn.com/abstract=2704028.

223. *See* Ashishi Arora et al., *Markets for Technology and Their Implications for Corporate Strategy*, 10 INDUS. CORP. CHANGE, 419, 422-23 (2001).

potential partners by reducing the risk of free-riders appropriating the invention.[224]

In short, innovators of complex technologies use patents for including others and sharing technologies in open innovation instead of excluding others. They have developed cross-licensing, patent non-enforcement pledges, and other imaginative arrangements by using their patents as rights to practice and share a patented invention. However, these private ordering arrangements cannot work to give PAEs the incentive to share. As will be discussed in the next section, the current patent system should be reformed so that patents on follow-on inventions would effectively require blocking prior patent owners, giving a license to the patent owners of the follow-on inventions.

IV. REEVALUATION OF PATENT RIGHTS

A. *Patents as Property Rights*

Adapting the patent system based on the incentive to share theory for accommodating the needs of new innovators and innovation models in the era of Industry 4.0 will inevitably lead to the reevaluation of the fundamental concepts of the current patent system. Because the review of firms' innovation activities reveals that many patents on complex technologies are no longer used for excluding others, it also makes sense to question the well-established feature of patent rights as property rights.

Congress, in the U.S. Patent Act, and Courts, in interpretations of that Act as well as the Constitution, have both confirmed the nature of patents as property rights.[225] It is a well-established rule that patents primarily give the right to exclude others.[226] The Federal Circuit has emphasized this fundamental nature by stating that it is "elementary" that "a patent grants only the right to exclude others and confers no right on its holder to make, use, or

224. Kenneth J. Arrow, *Economic Welfare and the Allocation of Resources for Invention*, *in* THE RATE AND DIRECTION OF INVENTIVE ACTIVITY: ECONOMIC AND SOCIAL FACTORS (H. M. Groves ed., 1962), http://www.nber.org/chapters/c2144.pdf. *See generally* James J. Anton & Dennis A. Yao, *Expropriation and Inventions: Appropriable Rents in the Absence of Property Rights*, 84 AM. ECON. REV. 190 (1994); Bruno Biais & Enrico Perotti, *Entrepreneurs and New Ideas*, 39 RAND J. ECON. 1105 (2008); Chien, *supra* note 193, at 835.

225. 35 U.S.C. § 261 (2012); Oil States Energy Servs., LLC v. Greene's Energy Grp., LLC, 138 S. Ct. 1365, 1375 (2018) ("Patents convey only a specific form of property right—a public franchise.").

226. *See Oil States Energy Servs.*, 138 S.Ct. at 1369 (stating that the Court "recognize[s] patent rights as the 'private property of the patentee.'"); *see also* Burk & Lemley, *supra* note 152, at 1597-99 ("[C]ourts and commentators widely agree that the basic purpose of patent law is utilitarian . . . . Agreement on basic utilitarian goals has not, however, translated into agreement on how to implement them.").

sell" the invention.[227] U.S. legal scholars take it as true, citing blocking patents as an example.[228] The patent owner of a pioneer invention may block the patent owner of an improvement invention by refusing to give a license to practice the pioneer invention that covers the improvement literally or equivalently, while the same patent owner is prevented from practicing the improvement within the scope of the pioneer invention because of the exclusive right of the subsequent improvement patent.[229] For the patent owner of the improvement to practice the invention, the U.S. Patent Act relies on a voluntary patentee-infringer bargain between the patent owners, which occasionally fails to occur.[230]

In contrast, patent systems in many European and Asian countries, including Germany and Japan, give a patent owner not only the right to exclude others but also a right to practice her invention by including a provision for compulsory licenses in the case of blocking patents.[231] Both German and Japanese Patent Acts ("the Acts") clearly provide that the effect of a patent is to give the patent owner a right to practice the patented invention.[232] Both Acts also give the patent owner a right to exclude others from using the patented invention because the Acts make clear that the right to practice the invention is exclusive to the patent owner.[233]

The Japanese Patent Act expressly provides that a patent owner may grant an exclusive or non-exclusive license to practice the patented invention.[234] The German Patent Act provides that any rights deriving from the

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227. Bio-Tech. Gen. Corp. v. Genentech, Inc., 80 F.3d 1553, 1559 (Fed. Cir. 1996) (quoting Vaupel Textilmaschinen KG v. Meccanica Euro Italia S.P.A., 944 F.2d 870, 879 n.4 (Fed. Cir. 1991)).

228. *E.g.*, DONALD S. CHISUM, CHISUM ON PATENTS § 16.02[1] (explaining, under section heading "The Right to Exclude Others" that patents secure only the right to exclude and then discussing blocking patents by way of illustration); Kieff, *supra* note 176, at 719 n.102.

229. *See* Robert P. Merges, *One Hundred Years of Solicitude: Intellectual Property Law, 1900-2000*, 88 CAL. L. REV. 2187, 2222 (2000) [hereinafter Merges, *Solicitude*]; *see also* Robert Merges, *Intellectual Property Rights and Bargaining Breakdown: The Case of Blocking Patents*, 62 TENN. L. Rev. 75, 80 (1994) [hereinafter Merges, *Bargaining Breakdown*].

230. Merges, *Bargaining Breakdown*, *supra* note 229, at 78.

231. Patentgesetz [PatG] [Patent Act], Dec. 16, 1980, BUNDESGESETZBLATT, Teil I [BGBL I] at 1, § 24, as amended, Oct. 8, 2017, 3546, art. 4 (Ger.); Tokkyohō [Patent Act], Law No. 121 of 1959, art. 72, 92 (Japan); *see also* Merges, *Bargaining Breakdown*, *supra* note 229, at 104.

232. Patentgesetz [PatG] [Patent Act], at 1, § 9, (Ger.) ("The patent shall have the effect that the proprietor of the patent alone shall be entitled to use the patented invention within the scope of the law in force."). For the positive right to use a patented invention, see PATENT LAW: A HANDBOOK ON EUROPEAN AND GERMAN PATENT LAW 733 (M. W. Haedicke & H. Timmann eds., 2014); Tokkyohō [Patent Act], Law No. 121 of 1959, art. 68 (Japan) ("A patentee shall have the exclusive right to work the patented invention as a business.").

233. Patentgesetz [PatG] [Patent Act], at 1, § 9, (Ger.); Tokkyohō [Patent Act], Law No. 121 of 1959, art. 68 (Japan).

234. Tokkyohō [Patent Act], Law No. 121 of 1959, art. 77-78, *translated in* (Japanese Law Translation [JLT DS]), http://www.japaneselawtranslation.go.jp (Japan).

patent, such as a license, are transferable, and the Act presupposes the power to grant a license by allowing either a patent owner or her licensee to register their exclusive license.[235] In short, these countries define a patent right positively and affirmatively; patents are viewed as a two-sided right – one side is to exclude others (exclusive side) and the other side is to practice the patented invention and include others through a license (inclusive side) – because of their nature as property rights in parallel to all other types of property rights under the German and Japanese legal systems.[236] The U.S. Patent Act once inherited the two-sided right through the conceptual development based on property right doctrines; however, the legal and political revolution at the turn of the twentieth century eliminated the inclusive side of patent rights.[237]

European scholarship on property helpfully rethinks patents as property rights and could be used to revitalize the inclusive side of U.S. patents. European legal scholars have acknowledged the inclusive side of patent rights and some have proposed reinventing patent rights as inclusive rights by focusing on the incentive to share technologies through licenses.[238] For example, in her proposal of a second-tier patent system, Geertrui von Overwalle stripped the exclusive side of patent rights and enhanced the inclusive side by defining a patent as "a temporary permit to exploit monopoly rights under fair and reasonable conditions, investing technology owners with the authority to invent and share."[239] Under this definition, patents give patent owners a right to execute licenses to encourage sharing behaviors without the right to request injunction for infringement.[240] Her reinvention of patent

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235. Patentgesetz [PatG] [Patent Act], Dec. 16, 1980, BUNDESGESETZBLATT, Teil I [BGBL I] at 1, § 15, 31, as amended, Oct. 8, 2017, 3546, art. 4 (Ger.).

236. *See* Geertrui Van Overwalle, *Inventing Inclusive Patents: From Old to New Open*, *in* KRITIKA: ESSAYS ON INTELLECTUAL PROPERTY 250 (P. Drahos et al. eds., 2015).

237. Adam Mossoff, *Exclusion and Exclusive Use in Patent Law*, 22 HARV. J.L. & TECH. 8, 14 (2008) [hereinafter Mossoff, *Exclusion*]; Adam Mossoff, *Patents as Constitutional Private Property: The Historical Protection of Patents Under the Takings Clause*, 87 B.U. L. REV. 689, 715 (2007); *see also* Adam Mossoff, *Who Cares What Thomas Jefferson Thought about Patents - Reevaluating the Patent Privilege in Historical Context*, 92 CORNELL L. REV. 953 (2007) (discussing history of U.S. intellectual property law).

238. Séverine Dusollier, *The Commons As a Reverse Intellectual Property: From Exclusivity to Inclusivity, in* CONCEPTS OF PROPERTY IN INTELLECTUAL PROPERTY LAW 258, 281 (Helena Howe & Jonathan Griffiths eds., 2013) [hereinafter Dusollier, *Commons*]; Séverine Dusollier, *Inclusivity in Intellectual Property*, *in* INTELLECTUAL PROPERTY AND GENERAL LEGAL PRINCIPLES – IS IP A LEX SPECIALS? 101, 103 (Graeme Dinwoodie ed., 2015) [hereinafter Dusollier, *Inclusivity in Property I*]; Overwalle, *supra* note 236, at 29.

239. Overwalle, *supra* note 236, at 30; *see also* Geertrui Van Overwalle, *Smart Innovation and Inclusive Patents for Sustainable Food and Health Care: Redefining the Europe 2020 Objectives*, *in* CONSTRUCTING EUROPEAN INTELLECTUAL PROPERTY: ACHIEVEMENTS AND NEW PERSPECTIVES 231 (Cristophe Geiger ed., 2013); Geertrui Van Overwalle, *Turning Patent Swords into Shares*, 330 SCIENCE 1630, 1631 (2010).

240. Overwalle, *supra* note 236, at 251.

rights revitalizes the patent system by enhancing the inclusive side of patent rights while substantive patent examination is being eliminated. Her proposed regime addresses the needs of both commercial firms in complex technologies and individual users who engage in open innovation through a combination of property rights and contract, as has been done by the OSS community.[241]

Another European scholar, Séverine Dusollier, has proposed another interpretation of property rights focusing on the inclusive side of intellectual property rights such as copyrights and patents.[242] She identifies two distinctive features of using property inclusively: "(1) the absence of a power to exclude others, which leads to inclusion of others in the use ('me *and* others'); and (2) the collectiveness of uses ('me *with* others'), in contrast to the feature of exclusive use of property that is defined by exclusion ('only me and not you') and individuality ('solely')."[243] Her definition of the features of property rights encompasses the important concept of a property right even without exclusivity; it is in stark contrast to a definition focusing on the exclusive side that may result in a no-content or empty right once exclusivity is removed. The concept under Dusollier's definition is a right owned in common by multiple parties who can share the use the subject matter of the property right.[244] With respect to intellectual property rights, such sharing may result from: (1) an absence of exclusivity through falling into the public domain or through limitations/exceptions; (2) a reversion through a license or no enforcement pledge; or (3) a denial through courts' refusal to grant an injunction.[245] She has re-conceptualized intellectual property rights with an emphasis on the public domain and other mechanisms to encourage collective use and the sharing of property rights, and has urged policymakers to create regimes wherein both the exclusive and inclusive sides of property rights are used to promote new types of innovation.[246]

U.S. scholars have also acknowledged the inclusive side of patent rights: Robert Merges has described the post-grant stage of intellectual property rights as "bound up with various forms of inclusion" by citing examples of non-enforcement and waiver.[247] Further, he has observed the im-

241. *Id.* at 206, 277 (proposing a hybrid, public-private constructed, semi-codified regime and citing OSS licensing as an example).

242. *See* Dusollier, *Commons*, *supra* note 238, at 279-81; *see also* Séverine Dusollier, *Inclusivity in Property* 5 (Global and Emile Noel Fellow Forum, October 10, 2017), http://www.law.nyu.edu/sites/default/files/upload_documents/Severine%20Dusollier%20-%20Oct%2010%20forum.pdf [hereinafter Dusollier, *Inclusivity in Property II*].

243. Dusollier, *Inclusivity in Property I*, *supra* note 238, at 105.

244. *See* Dusollier, *Commons*, *supra* note 238, at 262.

245. Dusollier, *Inclusivity in Property I*, *supra* note 238, at 105-15.

246. *Id*. at 117.

247. *See* MERGES, JUSTIFYING, *supra* note, 129, at 295 (emphasis omitted); *see also* Sichelman, *supra* note 176, at 406 (acknowledging "positive rights" in his proposal for commercialization patents).

portant role played by individual users and programmers and commented that "[d]iscrete works, originating from and belonging to an individual or small creative team, are decidedly yesterday's news. These works, and the property rights associated with them, will for the most part just wither away in the future."[248]

Yochai Benkler identified the inclusive side of property rights as a "commons" and found that the inclusive side is indispensable for the property system to function.[249] He explained "commons" in light of the symmetrically-privileged freedom and commented on the central role played by commons in the current information-and-open-innovation-central economy as complementing the traditional "property" that asymmetrically allocates rights to control resources.[250] Another U.S. scholar, Colleen Chien, also argues for the use of patents inclusively through pledges, waivers, and contracts to share patents.[251]

This article embraces the above views advanced by these U.S. and European scholars in recognizing patents as two-sided rights. Post-*eBay*, case law has stripped the exclusive side of patent rights from U.S. patent owners when any of four equitable factors set forth by the Supreme Court is not established.[252] However, patents are not worthless for lack of the availability of injunctions for patent owners. Commercial firms still file patent applications and obtain patents because of the inclusive side of patent rights: the right to practice and share a patented invention. In other words, the inclusive side gives patent owners the power to execute a contract: an open patent license. Such open patent licenses authorize others to practice the patented invention and impose an obligation on others to grant back a license on improvements to the patent owners or anyone specified in the contract.[253] For many commercial firms that engage in open innovation, in particular firms in complex technologies, the exclusive side of patent rights is not only useless but is also harmful to their reputation and to their work with innovators who subscribe to the open source philosophy. Thus, many of them voluntarily renounce their exclusive patent rights through open patent licenses and pledges.

B. *Inclusive Side of Patents*

Adam Mossoff has urged U.S. scholars and lawyers to rediscover the inclusive side of patent rights by comparing property and patent theory side-

248. MERGES, JUSTIFYING, *supra* note 129, at 294.

249. Yochai Benkler, *Between Spanish Huertas and the Open Road: A Tale of Two Commons, in* GOVERNING KNOWLEDGE COMMONS 3-4 (B. M. Frischmann et al., eds., 2014).

250. *Id.* at 19.

251. *See* Chien, *supra* note 193, at 840-45.

252. *See supra* notes 100-103 and accompanying text.

253. Overwalle, *supra* note 236, at 227-29 (inclusive patent proposed by author has only a one-sided right to conclude licenses to establish sharing behavior).

by-side.[254] Although Mossoff's argument is based on historical and philosophical perspectives, this article argues for the rediscovery of the inclusive side of patents in light of the incentive-to-share theory. The exclusive and inclusive sides of patent rights should be well-balanced so as to be neutral to those who engage in both open and closed innovations, as well as to various types of innovators. As will be discussed, the exclusive side should be weakened or limited through introduction of a compulsory license or limitation to infringement remedies while enhancing the inclusive side for patent owners who engage open innovation to guarantee their freedom to operate and share technologies.

The current patent policies' overemphasis on the exclusive side has encouraged PAEs' aggressive patent assertions and the development of practicing patent owners' private ordering mechanisms through voluntary contracts to defend such assertions. The mechanism gives firms that practice their patents and sell products the incentive to share their technologies with competitors to get access to competitors' technologies through cross-licenses. In contrast, these private ordering mechanisms cannot make patents to give PAEs the incentive to share because they are not interested in getting access to others' technologies and executing voluntary contracts to share technologies. Thus, this article calls for a public law mechanism, *i.e.*, patent law reform. Such reform is very timely because a recent case, *Oil State*, gave Congress an opportunity to reevaluate the nature of patent rights and revitalize the inclusive side of the property dichotomy. In its opinion, the Supreme Court endorsed the power of Congress to reevaluate the exclusive and inclusive sides of patent rights as public franchises.[255]

The current one-sided patent protection is inconsistent with the fundamental principle of promoting the progress of useful arts for failing to take into account the new defensive and proactive uses of patents that have developed in complex technologies – the core technologies of Industry 4.0. The rationales of the traditional incentive theories fail in many technological sectors because the theories are based on an unrealistic assumption of the patent owner's market control.[256] In other words, the current patent rights were structured with the franchise for enhancing closed innovations. Patent rights should be reevaluated to be consistent with the franchise for enhancing open innovations, considering all types of innovators and their respective uses of patents, with special regard to firms in complex technologies and user-innovators who use patents for sharing their innovations.[257]

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254. Mossoff, *Exclusion*, *supra* note 237, at 325-26.

255. Oil States Energy Servs., LLC v. Greene's Energy Grp., LLC, 138 S. Ct. 1365, 1375 (2018).

256. *See* David J. Teece & Edward F. Sherry, *On "Patent Monopolies": An Economic Re-Appraisal*, ANTITRUST CHRON., Apr. 2017, at 2 (2017).

257. VON HIPPEL, FREE, *supra* note 55, at 3-10.

Because these new innovators in complex technologies cannot enjoy sales profits with supracompetitive prices, they should instead be rewarded with the freedom to operate and innovate. To ensure this freedom, the inclusive side of patent rights must be enhanced through the introduction of a mechanism that guarantees patent owners the right to practice and improve their inventions. Germany, Japan, and many other countries have guaranteed such a right through compulsory licenses.[258]

The U.S. patent system does not provide a compulsory license. The lack of the license is predicated on the assumption that the patent owners of prior inventions and those who own patents for follow-on inventions should be able to reach an agreement that is mutually beneficial.[259] Any such bargain can only occur if the follow-on invention adds significant value to the prior invention, and will bear a sufficient profit for the owner of the prior invention. To guarantee a fair bargain for both parties, TRIPS requires that follow-on inventions involve an important technical advance of considerable economic significance from the prior invention.[260] Thus, the patent owner of the follow-on invention should have bargaining leverage through her patent exclusivity, even if she is unable to practice the follow-on invention without a license from the pioneer patent owner.[261] In addition, high litigation costs encourage both patent owners to reach an agreement. As well exemplified by patent owners in complex technologies, most patent owners prefer a royalty-free cross license or a Mexican Standoff, *i.e.,* multiple infringers independently decide not to sue each other, to avoid the high transaction cost of royalty calculation and litigation.[262]

However, such an assumption under standard economic theory may not, in reality, happen because of the difficulty of estimating profits from the follow-on invention and the inherently unequal bargaining power between prior and follow-on patent owners.[263] Patent owners tend to undervalue other patent owners' inventions, which often prevents patent owners from reaching an agreement.[264] Moreover, this assumption does not apply to a bargain between PAEs that do not practice their patents and a follow-on patent owner that practices its patents. Regardless of the economic significance of follow-on inventions, PAEs would not be interested in royalty-free cross-

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258. Merges, *Bargaining Breakdown*, *supra* note 229, at 105; *see also supra* notes 231-36 and accompanying text.

259. *See* Merges*, Bargaining Breakdown*, *supra* note 229, at 77-78.

260. Agreement on Trade-Related Aspects of Intellectual Property Rights art. 31(i), Apr. 15, 1994, Marrakesh Agreement Establishing the World Trade Organization, Annex 1C, 1869 U.N.T.S. 299, 33, I.L.M. 1197 (1994). Almost all UN member states including US, the EU member states, and Japan are signatories of TRIPS and are under obligations to meet the minimum standards for IP protection set forth in TRIPS.

261. Merges & Nelson, *supra* note 166, at 862.

262. Egan & Teece, *supra* note 199, at 14.

263. Merges, *Bargaining Breakdown*, *supra* note 229, at 89.

264. *Id.* at 89-90.

licensing or any discount on royalty rates. The failure to reach a cross-licensing agreement between prior and follow-on patent owners has the potential to significantly delay commercialization of new technologies, and creates a significant loss to the general welfare.[265] Other countries' patent systems are better balanced between the inclusive and exclusive sides, and the recognition of the inclusive side guarantees patent owners the right to practice their inventions. In other words, the current U.S. patent system benefits only firms that use patents for excluding others, particularly PAEs that do not practice patents over those that practice and improve their inventions to promote useful arts.

Despite the numerous benefits for innovators who use patents for sharing instead of excluding, it is likely that enhancing the inclusive side of U.S. patents and introducing a compulsory license will face challenges. The American patent system disfavors any compulsory license that allows courts – instead of the parties – to set license terms because the invention valuation problem is often exacerbated by the fact that judges often lack technology-specific knowledge and are not well versed in industry licensing practices or norms.[266] However, the *eBay* decision rendered this problem moot by requiring courts to calculate reasonable royalties for future infringement (the ongoing royalty) if courts decline to award an injunction and allow the adjudicated infringer to continue to practice the invention.[267] There is disagreement among U.S. legal scholars as to whether judicial unwillingness to enforce the exclusive side of patent rights operates as a *de facto* compulsory license.[268] The high degree of knowledge necessary for judges to valuate complex inventions has further exacerbated the difficult situation in which patentees find themselves. Judges should be able to handle a royalty calculation for a compulsory license if they can calculate an ongoing royalty based

265. *See id.* at 87.

266. F. M. SCHERER, THE ECONOMIC EFFECTS OF COMPULSORY PATENT LICENSING 47-48 (Edwin J. Elton & Martin J. Gruber eds., 1977).

267. *E.g.*, ActiveVideo Networks, Inc. v. Verizon Commc'ns, Inc., 694 F.3d 1312, 1343 (Fed. Cir. 2012); *see also* Sichelman, *supra* note 176, at 407 (citing *eBay* for supporting the positive right that assures using his proposed commercialization patents without undue interference from blocking patents).

268. JOHN R. THOMAS, CONG. RES. SERV., R43266, COMPULSORY LICENSING OF PATENTED INVENTIONS 8 (2013) (distinguishing the judicial unwillingness from the compulsory license as the former applies to any entity that meets the statutory requirement whereas the latter applies to the specific adjudicated entity). *Compare* Christopher A. Cotropia, *Compulsory Licensing under TRIPS and the Supreme Court of the United States Decision in* eBay v. MercExchange, *in* PATENT LAW AND THEORY 557, 573 (Toshiko Takenaka & R. Moufang, eds., 2008) (acknowledging that judicial unwillingness created a de facto compulsory license) *with* Paul M. Janicke*, Implementing the 'Adequate Remedy at Law' for Ongoing Patent Infringement After* eBay v. MercExchange, 51 IDEA: INTELL PROP. L. REV. 163, 176 (2011) (recognizing the judicial unwillingness as a compulsory license and arguing that courts have no authority to grant a compulsory license).

on projected future sales because both calculations require a certain degree of speculation.[269]

In particular, U.S. patent owners disfavor drug compulsory licenses because they are known, historically, as a mechanism for introducing patented drugs in developing countries with a lower price than the preferred supracompetitive price to which the patentee is entitled.[270] However, an empirical study shows otherwise; the prices set by compulsory licenses are often lower than the price resulting from international procurement, which is the current alternative.[271] Moreover, U.S. patent owners are suspicious about the risk of bias because non-U.S. judges decide the price and compensation. No such risk is involved under the compulsory license system that this article proposes because U.S. judges would decide the reasonable compensation in a manner similar to the ongoing royalty adopted in cases since *eBay*.

One might argue that a compulsory license is not necessary if judicial unwillingness to award injunctions already functions as a *de facto* compulsory license. Yet, compulsory licenses are preferable to the judicial unwillingness to award injunctions because it encourages *ex ante* patent transactions instead of *ex post* transactions. The 2011 U.S. Federal Trade Commission's patent law and competition policy intersection report emphasized the benefits of *ex ante* patent transactions through licenses before adopting a technology, which is in stark contrast to the detrimental and ambiguous effects of *ex post* transactions, which can lead to negotiation and litigation after the adoption of a technology without a license and, thus, infringement.[272] The *ex post* patent transaction can distort competition in technology markets and may deter innovation through the risk that patent holders may seek a higher royalty than the rate that would have resulted from an *ex ante* transaction.[273] A compulsory license encourages *ex ante* patent transactions and provides an incentive to owners of follow-on inventions to approach the owner of prior inventions because of the expectation that they will be granted a compulsory license if they do not reach an agreement on royalties. In Germany, the patent owners of follow-on inventions can file an action with the Federal Patent Court to request a grant of compulsory li-

269. Mark A. Lemley, *The Ongoing Confusion over Ongoing Royalties*, 76 MO. L. REV. 695, 700 (2011).

270. John M. Wechkin, *Drug Price Regulation and Compulsory Licensing for Pharmaceutical Patents: The New Zealand Connection*, 5 PAC. RIM L. & POL'Y J. 237, 238-43 (1995).

271. Reed F. Beall et al., *Compulsory Licensing Often Did Not Produce Lower Prices for Antiretrovirals Compared to International Procurement*, 34 HEALTH AFF. 493, 493 (2015).

272. FED. TRADE COMM'N, THE EVOLVING IP MARKETPLACE-ALIGNING PATENT NOTICE AND REMEDIES WITH COMPETITION 9, 40 (2011).

273. *Id.* at 50.

cense.[274] In Japan, such a request can be filed with the Japan Patent Office ("JPO") so that the commissioner grants a license.[275] In the United States, district courts should decide the request to grant a compulsory license as these courts grant an ongoing license. Patent owners can resort to the compulsory licenses only if the patent owners of follow-on inventions asked for licenses from the patent owners of the prior inventions and were unable to reach an agreement on the grant of license. These countries' experiences with compulsory license regimes suggest that the threat of compulsory licenses also encourages patent owners of prior inventions to reach an agreement with those who own the patents on the improvements.[276]

Another frequently raised argument against a compulsory license is that it weakens the economic incentive to invent.[277] As discussed above, the incentive to invent theory is obsolete for many patent owners in complex technologies in light of the lack of control and market power, as well as the way these firms engage in innovation in the era of Industry 4.0.[278] Patent owners in the discrete technologies who engage in closed innovation may want to continue to exclude others and oppose any type of compulsory license but such industrial sectors have become the minority as a result of the spread of open innovation and the IoT. Moreover, studies by economics scholars do not clearly support the proposition that a diminished incentive to invent has an impact on actual innovation activities.[279] Even if there is any impact, such impact is expected to be very marginal.[280] In any event, post-*eBay* case law has already created a change that should result in an impact on innovation activities. Nevertheless, innovation has decidedly not ended.

Alternatively, a mechanism to guarantee patent owners the right to practice their patented inventions could be defined as a limitation on remedies for certain types of infringement.[281] I am proposing a revision that accomplishes the same effect as a grant of a compulsory license by limiting remedies—allowing a patent owner to obtain only a remedy of a reasonable royalty in case of infringement.[282] Even if follow-on patent owners had knowledge that their practice of the inventions covered by the prior patents constituted infringement, no enhanced damages should be available to pun-

274. Patentgesetz [PatG] [Patent Act], Dec. 16, 1980, BUNDESGESETZBLATT, Teil I [BGBL I] at 1, § 24(1), as amended, Oct. 8, 2017, at 3546, art. 4 (Ger.).

275. Tokkyohō, [Patent Act], Act No. 121 of 1959, art. 92, para. 3 (Japan).

276. Merges, *Bargaining Breakdown*, *supra* note 229, at 105.

277. *E.g.*, Alan M. Fisch, *Compulsory Licensing of Pharmaceutical Patents: An Unreasonable Solution to an Unfortunate Problem*, 34 JURIMETRICS J. 295, 297 (1994).

278. *See* discussion in Part II.A.

279. Stephanie Lee, Compulsory Licensing and Domestic Innovation: Evidence from the Trading with the Enemy Act after World War II 7 (May, 2011) (unpublished B.A. thesis, Stanford University) (on file with Stanford University).

280. Merges, *Bargaining Breakdown*, *supra* note 229, at 105.

281. 35 U.S.C. § 287(c) (2012) (establishing the medical practitioner's defense).

282. 35 U.S.C. § 284 (2012).

ish a follow-on inventor who previously sought a license.[283] This definition of the inclusive side of patent rights—as a denial of injunction instead of a grant of license—is more in line with remedies presently available under post-*eBay* case law.

The proposed compulsory license and remedy limitation are designed to limit the negative effects that PAEs have had on the US patent system. Under the proposed framework, patent owners of follow-on inventions are awarded with the freedom to operate only if their follow-on inventions involve an important technical advance of considerable economic significance in comparison with the technical advance of the prior invention claimed in the prior patent, as required by TRIPS.[284] A valid separate patent on a follow-on invention should give rise to a presumption of the required technical advance. Thus, patent owners may continue to prevent imitations that are not separately patentable. The economic significance and benefits resulting from the avoidance of litigation cost should give the owner of prior patents the incentive to share their technologies to reach a voluntary cross-license agreement. If both patent owners are practicing entities, it is likely that such a cross-license leads to portfolio licensing.

Such a voluntary bargain should fail to happen (1) if a follow-on invention does not, in fact, involve the required technical advance or (2) the blocking prior patent owner is a PAE and is not interested in practicing any patent regardless of any technical advance. Because prior patent owners frequently undervalue follow-on inventions held by others, they bear the burden of overcoming the presumption by establishing the lack of the required technical advance. In making a comparison, the technical advance of the prior invention should be discounted if the prior patent is not practiced at all and is thus a paper patent; paper patents are of less value to the public than practiced patents.[285] In particular, if the blocking patent is owned by a litigation PAE that never practices any of their inventions and settles with royalties less than the lower bound to avoid infringement litigation costs, their patents only have nuisance value.[286] As a result, prior patent owners can avoid a compulsory license or remedy limitation if they do not undervalue follow-on inventions: in fact, the follow-on inventions lack the required technical advance. In contrast, non-practicing patent owners, in particular, litigation PAEs, will find it difficult to avoid the compulsory license or rem-

283. *Id.* In some cases, courts enhanced on-going damages due to willful infringement. J. Gregory, Sidak, *Ongoing Royalties for Patent Infringement*, 24 TEX. INTELL. PROP.L.J. 161, 175 (2016).

284. Agreement on Trade-Related Aspects of Intellectual Property Rights art. 31(i), Apr. 15, 1994, Marrakesh Agreement Establishing the World Trade Organization, Annex 1C, 1869 U.N.T.S. 299, 33, I.L.M. 1197 (1994).

285. John F. Duffy, *Reviving the Paper Patent Doctrine,* 98 CORNELL L. REV. 1359, 1360 (2013).

286. FTC, *supra* note 98, at 43.

edy limitation and will be forced to share their technologies with follow-on patent owners.

C. *Exclusive Side of Patents*

The exclusive side of U.S. patent rights should also be reevaluated in light of the incentive to share theory to guarantee innovators a right to operate and innovate on patented inventions. The proposed compulsory license or remedy limitation gives prior patent owners the incentive to share their inventions with follow-on patent owners while follow-on patent owners are rewarded with the freedom to operate their follow-on inventions. In other words, to promote technology sharing, patents should encourage innovators to innovate on patented inventions, which would result in follow-on inventions involving the technical advance over the patented invention. The U.S. patent system has already incorporated several mechanisms to encourage technology-sharing in the form of exceptions and limitations on patent rights.[287] However, the U.S. patent system creates a strong disincentive for innovators to operate and innovate on patented inventions by failing to include a statutory experimental use exception, thus preventing others from conducting experiments on patented inventions in order to develop improvements.

In Europe and Asia, patent law regimes provide for statutory experimental use exceptions.[288] For example, the Federal Court of Justice in Germany interpreted the exception to cover all types of activities to innovate patented inventions, which activities would otherwise give rise to infringement without the exception.[289] The German Patent Act provides separately for an exception to cover activities for collecting data through clinical trials for a marketing approval.[290] The Supreme Court of Japan also has interpreted the exception broadly to cover not only activities for improving patented

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287. *E.g.*, 35 U.S.C. § 273(b) (2012) (establishing the first inventor defense); 35 U.S.C. § 287(c) (2012) (establishing the medical practitioner's defense).

288. *E.g.*, Patentgesetz [PatG] [Patent Act], Dec. 16, 1980, BUNDESGESETZBLATT, Teil I [BGBL I] at 1, § 11(2), (2a), (2h), as amended, Oct. 8, 2017, 3546, art. 4 (Ger.); Tokkyoh , [Patent Act], Act No. 121 of 1959, art. 69, para. 1 (Japan). For more discussions on the experimental use exception in Europe, see Hans-Rainer Jaenichen & Johann Pitz, *Research Exemption/Experimental Use in the European Union: Patents Do Not Block the Progress of Science*, 5 COLD SPRING HARBOR PERSP. MED. 2 (2015); Roman Fischer et al., *Assessing the Economic Impacts of Changing Exemption Provisions During Patent and SPC Protection in Europe* (Oct. 5, 2017), https://op.europa.eu/en/publication-detail/-/publication/6e4ce9f8-aa41-11e7-837e-01aa75ed71a1/language-en (stating that "most Member States also have experimental use exemptions that cover the experimental use of patented compounds to discover new uses, indications etc.").

289. Bundesgerichtshof [BGH] [Federal Court of Justice] July 11, 1995, OFFICIAL J. EPO 588, 1997 (Ger.); Bundesgerichtshof [BGH] [Federal Court of Justice] Apr. 17, 1998, 115 REP. PAT., DESIGN & TRADE MARK CASES 423, 1998 (Ger.).

290. Patentgesetz [PatG] [Patent Act], Dec. 16, 1980, BUNDESGESETZBLATT, Teil I [BGBL I] at 1, § 11(2b), as amended, Oct. 8, 2017, 3546, art. 4 (Ger.).

inventions but also clinical trials conducted on patented drugs by generic drug manufacturers.[291] This exception is endorsed by the international patent community as shown by the flexibility to carve out the scope of patent protection under TRIPS.[292]

U.S. scholars cite various reasons to import a fair-use-type infringement exception from copyrights to patents.[293] However, these proposals urge courts to apply the exception on a case-by-case basis with respect to a set of factors,[294] which may result in uncertainty surrounding the right to operate and innovate on patented inventions. Other proposals are very modest, and build on the common law experimental use doctrine.[295] These proposals have attempted to clarify and expand the marginal scope of the exception available under current case law.[296] Rebecca Eisenberg made a unique proposal that addresses the needs of the bioscience community. Her proposal considers researchers and scientists in public and industrial laboratories as the main innovators and recommends excluding ordinary consumers from the protections of an experimental exception.[297] Although her proposal gives research activities leading improvements immunity from injunction, it requires a royalty payment to the patent holder if the activities result in an improvement that does not fall within the scope of the original patent.[298] Despite the numerous proposals that have been made by scholars,[299] the Federal

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291. Saikō Saibansho [Sup. Ct.] Apr. 16, 1999, 1998 (Ju) 153, SAIK SAIBANSHO MINJI HANREISHŪ [MINSHŪ] 627 (Japan),; Christopher Heath, *Japan: Patent Act, Sec. 69 – "Procaterole"*, 30 IIC INT'L REV. INDUS. PROP. & COPYRIGHT L. 454, 455-56 (1999); Jennifer A. Johnson, *The Experimental Use Exception in Japan: A Model for U.S. Patent Law?*, 12 PAC. RIM L. & POL'Y J. 499 (2003).

292. Charles T. Collins-Chase, *The Case against TRIPS-Plus Protection in Developing Countries Facing AIDS Epidemics*, 29 U. PA. J. INT'L L. 763, 773 (2008).

293. Joshua I. Miller, *Patent Fair Use 2.0*, 2 INTELL. PROP. BRIEF 56 (2011); Maureen A. O'Rouke, *Toward a Doctrine of Fair Use in Patent Law*, 100 COLUM. L. REV. 1177 (2000); Katherine J. Strandburg, *Patent Fair Use 2.0*, 1 U.C. IRVINE L. REV. 265, 266 (2011).

294. O'Rouke, *supra* note 293, at 1198; Strandburg, *supra* note 293 at 293.

295. Richard E. Bee, *Experimental Use as an Act of Infringement*, 39 J. PAT. OFF. SOC'Y 357 (1957); Steven J. Grossman, *Experimental Use or Fair Use as a Defense to Patent Infringement*, 30 IDEA 243, 247 (1990); Ronald D. Hantman, *Experimental Use as an Exception to Patent Infringement*, 67 J. PAT. OFF. SOC'Y 617 (1985).

296. The scope of the exception covers only activities engaged in for the sole purpose of gratifying a philosophical taste, or curiosity, or for mere amusement. Roche Pharm., Inc. v. Bolar Pharm. Co., 733 F.2d 858, 862 (Fed. Cir. 1984) (citing Poppenhusen v. Falke, 19 F. Cas. 1048, 1049 (S.D.N.Y. 1861)).

297. Rebecca S. Eisenberg, *Patents and the Progress of Science: Exclusive Rights and Experimental Use*, 56 U. CHI. L. REV. 1017, 1078 (1989).

298. *Id*.

299. *E.g*., HAROLD C. WEGNER, PATENT LAW IN BIOTECHNOLOGY, CHEMICALS & PHARMACEUTICALS *passim* (2d ed. 1994); Lauren C. Bruzzone, *The Research Exception: A Proposal*, 21 AIPLA Q.J. 52 *passim* (1993); Rochelle C. Dreyfuss, *Varying the Course in Patenting Genetic Material: A Counter-Proposal to Richard Epstein's Steady Course*, 50 ADVANCES GENETICS 195, 204-08 (2003); Rebecca S. Eisenberg & Arti K. Rai, *Bayh-Dole Reform and the Progress of Biomedicine*, 66 L. & CONTEMP. PROBS. 289, 310-13 (2003); Ir-

Circuit has refused to expand the marginal scope of the common law experimental exception doctrine.[300] Moreover, the Supreme Court made clear that the scope does not automatically cover university-based research activities.[301]

Congress has also made attempts to codify the exception, but has yet to do so due to the lack of consensus on the scope of the proposed exception and the difficulty presented by its implementation.[302] A 1990 bill provided immunity when using and making a patented invention for research or experimental use purposes regardless of the field of technology.[303] Another bill introduced in 2002 restricted the application of such an exception to inventions in a specific field of technology.[304] The National Science Foundation ("NSF") campaigned to codify the exception by publishing reports and proposing language defining the scope of the exception.[305] The American Intellectual Property Law Association ("AIPLA") supported NSF's efforts.[306]

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ving N. Feit, *Biotechnology Research and the Experimental Use Exception to Patent Infringement*, 71 J. PAT. & TRADEMARK OFF. SOC'Y 819, 840 (1989); Ned A. Israelsen, *Making, Using, and Selling Without Infringing: An Examination of 35 U.S.C. § 271(e) and the Experimental Use Exception to Patent Infringement*, 16 AIPLA Q.J. 457, 472-78 (1988-1989); Suzanne T. Michel, *The Experimental Use Exception to Infringement Applied to Federally Funded Inventions*, 7 BERKELEY TECH. L.J. 369, 397-409 (1992); Janice M. Mueller, *No "Dilettante Affair": Rethinking the Experimental Use Exception to Patent Infringement for Biomedical Research Tools*, 76 WASH. L. Rev. 1, 1 (2001); Nicholas Short, *A Research Exemption for the 21st Century*, 50 U. MICH. J.L. REFORM CAVEAT 1, 1 (2016); Patricia M. Thayer & Richard A. De Liberty, *The Research Exception to Patent Infringement: The Time Has Come for Legislation*, 4 J. BIOLAW & BUS. 15, *passim* (2000); Jordan P. Karp, Note, *Experimental Use as Patent Infringement: The Impropriety of a Broad Exception*, 100 YALE L.J. 2169, 2186 (1991).

300. Embrex, Inc. v. Serv. Eng'g Corp., 216 F.3d 1343, 1352 (Fed. Cir. 2000).

301. Madey v. Duke Univ., 307 F.3d 1351, 1360 (Fed. Cir. 2002). Some proposed to give an umbrella protection for university-based research activities. *E.g.*, Eyal H. Barash, Comment, *Experimental Uses, Patents, and Scientific Progress,* 91 NW. U. L. REV. 667, 699-700 (1997); Kevin Sandstrom, Note, *How Much Do We Value Research and Development?: Broadening the Experimental Use Exemption to Patent Infringement in Light of* Integra Lifesciences I, Ltd. v. Merck KGaA*, 331 F.3d 860 (Fed. Cir. 2003)*, 30 WM. MITCHELL L. REV. 1059, 1111-12 (2004).

302. *See* Joshua D. Sarnoff & Christopher M. Holman, *Recent Developments Affecting The Enforcement, Procurement, and Licensing of Research Tool Patents*, 23 BERKELEY TECH. L.J. 1299, 1310-14 (2008).

303. *See, e.g.*, Patent Competitiveness and Technological Innovation Act of 1990, H.R. 5598, 101st Cong. § 402 (1990) (proposed 35 U.S.C. § 2710).

304. *See, e.g.*, Genomic Research and Diagnostic Accessibility Act of 2002, H.R. 3967, 107th Cong. § 2 (2002) (explaining the exception covered only patents on genetic sequences); *see also* Genomic Research and Accessibility Act, H.R. 977, 110th Cong. § 2 (2007).

305. NAT'L RESEARCH COUNCIL, REAPING THE BENEFITS OF GENOMIC AND PROTEOMIC RESEARCH: INTELLECTUAL PROPERTY RIGHTS, INNOVATION, AND PUBLIC HEALTH *passim* (Stephen A. Merrill & Anne-Marie Mazza, eds., 2006); *see* NAT'L ACAD. SCI., A PATENT SYSTEM FOR THE 21ST CENTURY *passim* (Stephen A. Merrill et al. eds., 2004).

306. *See* AM. INTELL.L PROP. LAW ASS'N, AIPLA RESPONSE TO THE NATIONAL ACADEMIES REPORT ENTITLED "A PATENT SYSTEM FOR THE 21ST CENTURY", 1-3 23-27

Although none of these efforts led to the codification of an experimental exception, recent case law developments at the Supreme Court have provided some reprieve to researchers in the biomedical field by banning the patenting of isolated DNA[307] and expanding the clinical trial exception to cover new drug development activities.[308] Also, state universities and research institutions are protected from infringement assertion through state sovereign immunity regardless of the nature of their activities.[309]

Unfortunately, these case law developments provide no comfort to commercial firms that use or innovate on patented inventions. The majority of these proposals and public campaigns focused on immunizing basic research rather than applied research.[310] Some proposals at least acknowledged the network effect of the computer industry through standards and urged weaker patent protection by introducing a fair use defense.[311] Additionally, the lack of a statutory exception discourages users from reconstructing patented products for experimentation and eliminates the opportunity for firms to learn from users and improve the success rate of new products.[312]

Moreover, the U.S. patent system discourages individual innovators from engaging in any type of innovation because the U.S. Patent Act provides no statutory exception for private, non-commercial uses of patented inventions. In Europe and Asia, a private use exception protects individual innovators who practice and improve patented inventions.[313] U.S. patent owners typically do not sue individuals, but more often will sue commercial firms, *i.e.,* indirect infringers who aid individuals, *i.e.,* direct infringers.[314]

(2004), https://www.aipla.org/docs/default-source/advocacy/documents/nas092304.pdf?sfvrsn=d8f7fdf8_3.

307. Ass'n for Molecular Pathology v. Myriad Genetics, Inc., 569 U.S. 576, 596 (2013).

308. Merck KGaA v. Integra Lifesciences I, Ltd., 545 U.S. 193, 208 (2005).

309. *See* Seminole Tribe v. Florida, 517 U.S. 44, 77 (1996) (Stevens, J., dissenting); *see also* Florida Prepaid Postsecondary Educ. Expense Bd. v. Coll. Sav. Bank, 527 U.S. 627, 647 (1999).

310. *See, e.g.*, Eisenberg, *supra* note 297, at 1078 (recommending not protecting research use of a patented invention with a primary or significant market among research users); *see also* Rochelle Cooper Dreyfuss, *Varying the Course in Patenting Genetic Material: A Counter-Proposal to Richard Epstein's Steady Course*, 50 ADVANCE IN GENETICS 195, 203-08 (2003) (proposing the scope of exception covering only a basic researcher's performance of a research activity); Eisenberg & Rai, *supra* note 299, at 295-300 (arguing for the scope covering only publicly sponsored research).

311. *See, e.g.*, O'Rourke, *supra* note 293, at 1212, 1226.

312. VON HIPPEL, DEMOCRATIZING, *supra* note 55, at 108-19.

313. *E.g.*, Tokkyohō [Patent Act], Law No. 121 of 1959, art. 69 (explaining that patent rights do not extend for the purposes of experimentation or research); Patentgesetz [PatG] [Patent Act], Dec. 16, 1980, BUNDESGESETZBLATT, Teil I [BGBL I] at 1, § 11(2b), as amended, Oct. 8, 2017, 3546, art. 4 (Ger.).

314. *Contra* Daniel Nazer, *Actually, Mr. Waxman, Consumers Are Sued for Patent Infringement All the Time*, ELECTRONIC FRONTIER FOUND. (Apr. 30, 2014), https://www.eff.org/deeplinks/2014/04/actually-mr-waxman-consumers-are-sued-patent-infringement-all-time.

Von Hippel encourages commercial firms to support user innovation by providing design tools and platform products.[315] Unfortunately, such activities may constitute inducement or contributory infringement if modifications developed by individuals infringe patented inventions.[316] Notably, a recent Supreme Court decision, *Akamai,* increased the risk of patent infringement for individual programmers who engage in distributed innovations either through the direct or control theory or the joint enterprise theory.[317] The exclusive side of U.S. patent rights should be limited by introducing a private use exception for encouraging user innovation.[318] The private use exception should protect commercial firms' activities supporting individual users' innovations. Courts should find infringement only when firms adopt modifications that are privately developed by individual users, and then go on to commercially sell products that include the modifications.

CONCLUSION

The current patent system was invented and developed in the eighteenth century, long before the development of the computer and the Internet. The hyperlinked society brought on by emerging technologies in the era of Industry 4.0 has drastically changed the way we manufacture products, deliver services, and engage in innovation. Utilitarian theories rationalizing the patent system no longer apply to firms in complex technologies – which are the core industrial sectors in the era of Industry 4.0 – because they are no longer able to profit by selling products or services at supracompetitive prices. Nevertheless, these firms continue to obtain patents because patents are required to share technologies with others. Individual users, and particularly programmers in the OSS community, also collaborate with firms in complex technologies and use patents for sharing their technological improvements. Patents provide these new innovators with incentives to share by rewarding them with the freedom to operate and innovate, thereby stimulating cooperation and collaboration in the highly distributed innovation model.

Patent policies should reflect these changes to the incentive and innovation models. Unfortunately, the current patent system continues to be based on outmoded policies developed in the pre-Internet era that focused on pro-

315. VON HIPPEL, DEMOCRATIZING, *supra* note 55, at 128.

316. *See* 35 U.S.C. § 271(b)-(c) (2012).

317. Akamai Techs., Inc. v. Limelight Networks, Inc., 797 F.3d 1020, 1024 (Fed. Cir. 2015) (en banc).

318. *See* Andrew W. Torrance & Eric von Hippel, *The Right to Innovate*, 2015 MICH. ST. L. REV. 793, 823 (2015) ("It may also be valuable to consider the wisdom of freeing producers from legal liability if they support innovating users (which they may wish to do when users are working in areas of interest to the firm) without oversight or control of what users create.").

ducer firms that practice the closed innovation model with discrete technologies. Historically, such firms used patents to exclude others and created monopoly deadweight losses, which hinder innovation. Today, patents do not provide the power to control markets, and many patent policies are outdated. In particular, an overemphasis on the exclusive side of patent rights favors non-practicing patent owners over practicing patent owners and leads to anti-patent rhetoric in the complex technology sectors of U.S. industry. Current patent policies are also outdated because they fail to consider the new ways that patents are used in open innovation. The proposed reform should make exclusive and inclusive sides of patent rights better balanced and neutrally favor all patent practicing firms that want to use patents exclusively or inclusively. The exclusive side is weakened only if the patent owner undervalues the follow-on inventions. Moreover, the weakened exclusive side discourages PAEs from enforcing patents of marginal value inventions. With a new utilitarian theory, the patent system's fundamental institutional designs and concepts could be reevaluated and updated to meet the needs of new innovators and innovation processes for Industry 4.0 and beyond. This article has begun such a reevaluation with the very basic notion of patents as property rights. Such reevaluation should continue on other basic notions in order to overhaul the patent system by highlighting the proactive role that patents might play in open innovation.