Fall 2015

The Uniformed Topograhy of Patent Scope

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THE UNINFORMED TOPOGRAPHY OF PATENT SCOPE

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CITE AS: 19 STAN. TECH. L. REV. 150 (2015)

ABSTRACT

Setting and ascertaining patent scope are among the most important questions in patent law. However, we cannot accurately set patent scope. This is because patent scope has a sequence-of-information problem. Patent scope is set at the time that a patent is granted, while the information necessary to set and measure patent scope is not obtained until many years later. In consequence, the scope of any given patent is very likely to contain significant "error," meaning that the scope is broader or narrower than the theoretical ideal (the minimum amount of scope necessary to incentivize innovation). Deviation from the theoretical ideal has practical consequences because scope error in either direction has a chilling effect on incentives to innovate. The sequence-of-information problem additionally presents implementability challenges for patent theory, which often calls for ex ante calibrations of scope without recognizing that its prescription is challenging to implement without ex post scope adjustment. This Article contributes to the literature by introducing the sequence-of-information problem of patent law. It additionally creates a framework for analyzing and understanding the sequence-of-innovation problem and presents proposals for improving the comprehensibility and implementability of policy relating to patent scope.

* Academic Fellow in Private Law and Intellectual Property, Project on the Foundations of Private Law, Harvard Law School. I thank Yonathan Arbel, Daniel Gilman, John Goldberg, John Golden, Peter Barton Hutt, Josh Lerner, Benjamin Roin, Steven Shavell, Henry Smith, Haris Tabakovic, Tess Wilkinson-Ryan, and Tom Wollmann.

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INTRODUCTION

Setting and ascertaining patent scope are among the most important questions in patent law.[1] However, we cannot accurately set patent scope. This is

1. *See, e.g.*, Festo Corp. v. Shoketsu Kinzoku Kogyo Kabushiki, Co., 234 F.3d 558, 574 (Fed. Cir. 2000), *vacated*, 535 U.S. 722 (2002) ("[T]he notice function of patent claims has become paramount, and the need for certainty as to the scope of patent protection has been emphasized."); Ian Ayres & Paul Klemperer, *Limiting Patentees' Market Power Without Reducing Innovation Incentives: The Perverse Benefits of Uncertainty and Non-Injunctive Remedies*, 97 MICH. L. REV. 985, 988 (1999) (stating that one core issue of patent policy is "how much of a reward should be granted to induce sufficient innovation"); John M. Golden, *Construing Patent Claims According to Their "Interpretive Community": A Call for an Attorney-Plus-Artisan Perspective*, 21 HARV. J.L. & TECH., 321, 322 (2008) ("Determination of the scope of a patented invention is one of the most contentious and difficult tasks of modern patent law."); Paul Klemperer, *How Broad Should the Scope of Patent Protection Be?*, 21 RAND J. ECON. 113, 113 (1990) ("Another important policy question . . . is, What is the optimal *width* of patent protection?"); Kimberly A. Moore, *Are District Court Judges Equipped to Resolve Patent Cases?*, 15 HARV. J.L. & TECH. 1, 8 (2001) ("Determining the scope of the patent claims is the most important issue in a patent infringement suit.").

because patent scope has a sequence-of-information problem. Patent scope is set at the time that a patent is granted, while the information necessary to set and measure patent scope is not obtained until many years later. In consequence, the scope of any given patent is very likely to contain significant error, meaning that the scope is broader or narrower than the theoretical ideal (the minimum amount of scope necessary to incentivize innovation). This Article is the first to present a model of the sequence-of-information problem and to propose methods of resolving the problem.

The sequence-of-information problem is strikingly under recognized in patent scholarship. Because correct patent scope is vital to a properly functioning patent system, there are frequent discussions of how to set and ascertain proper patent scope; however, the resultant proposals are often difficult to implement because they do not account for the sequence-of-information problem. For example, it is common to call for the grant of "broad patents" or "narrow patents," but these recommendations often fail to recognize that the information necessary to know if a patent is broad or narrow is not available at the time patent scope is set. Thus, these proposals, while valuable contributions to patent theory, struggle with practical execution. Judicial efforts to implement patent scope goals have been called "doctrinal chaos."[2]

How does the sequence-of-information problem arise? Patents do not cover only the specific physical form created by the patentee and use envisioned by the patentee (called "an embodiment"), patents additionally cover the "principle" or "substance" of the invention.[3] The purpose of this broader coverage is to provide protection against downstream innovators who make a product different from the patentee's embodiment.[4] How different a downstream innovator's product must be before it ceases to infringe on the upstream patent is a function of the upstream patent's scope. Thus, a patent's scope is generally thought of as the universe of later-developed products that infringe on the patent.[5] A broad patent encompasses many downstream products, while a narrow patent encompasses only a few. It follows that in order to know the scope of a particular patent, something must be known about these downstream products. Patent scope, defined by the claims of the patent,[6] is largely set at the time a patent is granted. The sequence-of-information problem occurs because most downstream products will not yet be conceived of or developed when the patent is granted.

Examples from Edmund Kitch's influential article on patent scope illustrate the sequence-of-information problem. Kitch describes an inventor of a lubricant,

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2. Kevin Emerson Collins, *Enabling After-Arising Technology*, 34 J. CORP. L. 1083, 1085-89 (2009); *see also* Bernard Chao, *Rethinking Enablement in the Predictable Arts: Fully Scoping the New Rule*, 2009 STAN. TECH. L. REV. 3, 50-52.

3. Cont'l Paper Bag Co. v. E. Paper Bag Co., 210 U.S. 405, 418-19 (1908); Winans v. Denmead, 56 U.S. 330, 343 (1853).

4. *See* Cont'l Paper Bag Co., 210 U.S. at 419-22.

5. *See, e.g.*, General Motors Corp. v. Kesling, 164 F.2d 824, 832-33 (1947).

6. *See infra* Part I.A.

who patents the substance believing that its only use is as a lubricant. If someone else later discovers that it is an excellent fuel additive, the original inventor's patent also includes use of the substance as a fuel additive in its scope.[7] Similarly, the inventor of the diode vacuum tube obtained a patent that claimed two electrodes, but a court later held that the patent also included the triode (which has three electrodes), even though the triode has additional functionality that the diode does not.[8] Kitch cites these examples as part of his argument that patents should have scope broad enough to enable upstream patent holders to control downstream innovation.[9] I draw a different conclusion. In my view, these examples demonstrate that, as downstream innovation progresses, the scope of a patent may change in ways that were unexpected by the upstream patentee. The second example demonstrates that patentees may not have sufficient information to draft a broad patent when the patent is filed, and must rely instead on ex post scope adjustment during litigation.

These examples show that ensuring that a patent claim adheres to policy prescriptions for a "broad" or "narrow" scope is at least partly a matter of guesswork: an attempt to predict the shape of downstream innovation. The unsurprising result is that the patent system consistently grants patents that have the "wrong" scope, meaning scope that is either broader or narrower than the minimum necessary to incentivize innovation.[10] Overly broad scope is essentially a windfall to the patent owner, to the detriment of both the public and follow-on innovators. The legal system does not correct overly broad patents.[11] Overly narrow scope hurts innovators and may disincentivize future innovation. The legal system rarely corrects overly narrow patents.[12] Where the legal system does correct overly narrow patents, it engenders confusion about the boundaries of the patents, defeating the essential notice function of patents.[13] Policy

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7. Edmund W. Kitch, *The Nature and Function of the Patent System*, 20 J.L. & ECON. 265, 269 (1977). Note that the later inventor could also obtain a patent on use of the substance as a fuel additive. The later inventor could then exclude anyone (including the earlier inventor) from using the substance as a fuel additive.

8. *Id.* (citing Marconi Wireless Tel. Co. v. De Forest Radio Tel. & Tel. Co., 236 F. 65 (S.D.N.Y. 1916), *aff'd*, 243 F. 373 (2d Cir. 1977)).

9. *Id.* at 266-67.

10. The primary purpose of the patent system is to incentivize innovation. *See infra* note 29.

11. The legal system does correct patents that are overly broad so as to be invalid, but it does not correct patents that are overly broad so as to give more monopoly than necessary to incentivize innovation. The exception to this rule is the use of the reverse doctrine of equivalents; however, that doctrine is used so infrequently in practice that its effect is negligible. Robert P. Merges & Richard R. Nelson, *On the Complex Economics of Patent Scope*, 90 COLUM. L. REV. 839, 864 (1990); *see also*, Ethyl Molded Prods. Co. v. Betts Package, Inc., 9 U.S.P.Q.2d 1001, 1036 (E.D. Ky. 1988) ("The reverse doctrine of equivalents, although frequently argued by infringers, has never been applied by the Federal Circuit.").

12. Through the doctrine of equivalents. *Infra* Part III.B.2.a.

13. It is a fundamental principle of patent law that the patent put others on notice of the boundaries claimed by the patent. *See, e.g.*, Mark A. Lemley, *The Changing Meaning of Patent*

recommendations calling for particular scope parameters as tools to incentivize innovation are useful in theory, but they are disconnected from our practical ability to define patent scope through written patent claims.

Challenges in implementing policy because of predictive uncertainty are not unique to patent law,[14] but are particularly severe in patent law because there is no mathematical metric to measure patent scope and a patent's scope by definition covers a novel invention, therefore prediction cannot be based on preexisting information.[15] The problem of predictive uncertainty is further aggravated in patent law because of patent policy's emphasis on using patent scope as a lever for incentivizing innovation—the central purpose of patent law—and patent scholarship's failure to recognize the sequence-of-information problem.

The impact of the sequence-of-information problem on patent policy is perhaps most apparent in comparison to real property policy. Real property has only a minimal sequence-of-information problem,[16] therefore using scope to calibrate incentives works.

In the mid-nineteenth century, some members of Congress "desir[ed] to see the Western States peopled to their fullest capacity," debated how best to incentivize Americans to move west.[17] In 1862, Abraham Lincoln signed the Homestead Act, granting homesteaders access to small farms of 160 acres on land west of the Mississippi River.[18] By the early twentieth century, most of the desirable, low-lying land had been acquired, leaving only less productive, more marginal lands available. To ensure that settlers continued to have sufficient incentive to migrate, Congress passed the Enlarged Homestead Act, doubling the

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Claim Terms, 104 MICH. L. REV. 101, 103 (2005). Doctrines about patent scope are constantly in tension with the notice function of patents. *Id.* at 113 ("In recent years, the Federal Circuit has repeatedly emphasized the notice function of patent claims, limiting the reach of patent law's doctrine of equivalents [a doctrine about patent scope] because of concerns that competitors could not predict how that doctrine might be applied.").

14. Uncertainty is not, of course, a problem unique to patent law. All areas of law must accommodate uncertainty—for example, the parties to a contract cannot be sure of the future when they sign the contract. However, responsibility for predictive errors in a contract can be placed on the responsible private party; predictive errors in patent law will often fall on the public.

15. In the real property context, it is known to be more difficult to assign rights when the scope of the rights is difficult to predict ex ante. For example, it was more difficult to assign rights to subsurface ore than surface ore, because the former was "accessed later in development, [therefore] . . . there was less information regarding the extent and direction of the underground ore vein." GARY D. LIBECAP, CONTRACTING FOR PROPERTY RIGHTS 32-33 (1989).

16. Generally, the scope of real property is known ex ante. However, on the margins, there is some uncertainty that can affect rights in real property, for example, eminent domain.

17. CHAUNCEY F. CLEVELAND, SPEECH OF HON. C.F. CLEVELAND, OF CONNECTICUT, IN THE HOUSE OF REPRESENTATIVES, APRIL 1, 1852, ON THE HOMESTEAD BILL 2 (1852).

18. Homestead Act, ch. 75, 12 Stat. 392 (1862) (repealed 1976). The land was provided at a nominal price. *See* George J. Stigler, *Two Notes on the Coase Theorem*, 99 YALE L.J. 631, 632 (1989).

amount of land given to each farmer to 320 acres.[19]

Incentivizing behavior through grants of real property is an implementable policy. The amount of profit that can be obtained from farming a plot of land of a given size is (roughly) known when the land grant is provided. If policy makers were to determine that $1,000 in profit per year was needed to incentivize settlers to "[g]o west, young man,"[20] then the size of the land grant needed to provide such an incentive could be calculated and provided. If that incentive proved to be too small, policy makers could increase the size of the land grant in a predictable and consistent way and be reasonably confident that the size of the incentive was increasing correspondingly. While the accuracy of the incentive as to each person and each land grant could not be absolute, the incentive could be calibrated in a general sense, because most information about the scope of the incentive would be known when the land grant was made.

Patents, like real property, are tools of incentivization. The primary, perhaps only, purpose of patents is to incentivize innovation.[21] Like land grants (which were originally also called "patents", although that usage has fallen out of favor[22]), a major policy lever to achieve innovation is the size, or scope, of the patent grant. As with land grants, policy makers frequently recommend adjusting the scope of a patent to provide greater or lesser incentives for particular behaviors.

However, here patents part ways from real property grants. The scope of a

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19. Enlarged Homestead Act, ch. 160, 35 Stat. 639 (1909); GREG BRASHDER, HOW THE WEST WAS SETTLED: THE 150-YEAR-OLD HOMESTEAD ACT LURED AMERICANS LOOKING FOR NEW LIFE AND NEW OPPORTUNITIES 35 (2012). For further discussion of the history of land grants from the federal government, see THOMAS W. MERRILL & HENRY E. SMITH, PROPERTY: PRINCIPLES AND POLICIES 121-27 (2007).

20. This common saying is attributed to Horace Greeley. JOSIAH BUSHNELL GRINNELL, MEN AND EVENTS OF FORTY YEARS: AUTOBIOGRAPHICAL REMINISCENCES OF AN ACTIVE CAREER FROM 1850 TO 1890, 86 (1891). Surprisingly for the period, homesteaders included not only men and families, but also single, widowed, and divorced women. Brashder, *supra* note 19, at 27.

21. *See, e.g.*, Graham v. John Deere Co., 383 U.S. 1, 5-6 (1966) ("Congress in the exercise of the patent power may not . . . enlarge the patent monopoly without regard to the innovation, advancement or social benefit gained thereby."); Alan Devlin & Neel Sukhatme, *Self-Realizing Inventions and the Utilitarian Foundation of Patent Law*, 51 WM. & MARY L. REV. 897, 901 (2009) ("Almost all commentators and judges agree that utilitarian considerations enjoy hegemonic status in patent jurisprudence, such that the purpose of the patent system is to induce the creation and commercialization of technology that otherwise could be easily appropriated."); David S. Olson, *Taking the Utilitarian Basis for Patent Law Seriously: The Case for Restricting Patentable Subject Matter*, 82 TEMP. L. REV. 181, 181 (2009) ("[P]atent rights exist to provide incentives for innovation by allowing inventors to recoup their costs of research and development . . . ."); David W. Opderbeck, *Patents, Essential Medicines, and the Innovation Game*, 58 VAND. L. REV. 501, 503 (2005) ("Intellectual Property Rights . . . are utilitarian tools designed to encourage innovation and public disclosure.").

22. *See* Arnold B. Tschirgi, *Record of Mineral Reservations in Patents*, 12 WYO. L.J. 151, 151 (1957) ("A patent is an instrument issued by a state or the federal government to one to whom it has transferred or agreed to transfer land . . . . A patent is roughly the equivalent of a deed given by the ordinary grantor, although as a deed of the government it has some peculiar characteristics worth considering . . . .").

patent cannot be measured in units. A patent might claim "a mousetrap," but this is not some number of units large and cannot be numerically compared to a patent claiming "a computer mouse." While we, with hindsight bias, might know that a patent claiming a "computer mouse" is likely to be far broader than a patent claiming a "mousetrap," an inventor in the early twentieth century, when mousetraps were commonplace and computer mice still a pipe dream,[23] would not have known. Worse still, patent grants typically extend somewhat beyond the physical invention created by the patentee.[24] The patent claim does not solely cover the "computer mouse" or "mousetrap"; it covers an additional set of computer-mouse-like and mousetrap-like inventions. Thus, unlike real property, there is no basis in current knowledge to predict the scope of the claimed invention, because parts of the claimed invention do not yet exist.

If the cost to incentivize desirable intellectual innovation—like the creation of the computer mouse—were $1,000, how could one write a patent claim that was likely to supply $1,000 in profit? Patents provide the right to exclude others from making or using an invention,[25] meaning that profit comes in the form of monopoly profits, licensing fees, or royalties. Thus, their breadth, and their ability to incentivize, comes from their predicted effect on downstream technological progress. Consider the following claim adapted from a patent on a computer mouse filed in the early 1980s: "A cursor control device including: a planar grid pattern comprising grid lines of uniform spacing . . . and a sensor array means to receive and detect radiation from said grid pattern . . . ."[26]

When this patent was filed, it might have appeared to claim a relatively narrow device. However, with hindsight, we know that this technology is used very broadly, from computer mice, to touchpads, to touchscreens, to medical devices.[27] The inventor was (presumably) incentivized to create and disclose the technology with the reward of a patent on a computer mouse.[28] Because the scope of a patent is not clear when it is filed, the inventor was rewarded with an

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23. The precursor to the modern day computer mouse may have been invented in the 1940s. Jasper Copping, *Briton: 'I Invented the Computer Mouse 20 Years Before the Americans'*, THE TELEGRAPH (July 11, 2013), http://www.telegraph.co.uk/technology/news/10174366/Briton-I-invented-the-computer-mouse-20-years-before-the-Americans.html [http://perma.cc/3JV8-2DCE].

24. Tun-Jen Chiang, *The Levels of Abstraction Problem in Patent Law*, 105 NW. U. L. REV. 1097, 1133 (2011).

25. 35 U.S.C. § 271(a) (2013) ("Except as otherwise provided in this title, whoever without authority makes, uses, offers to sell, or sells any patent invention, within the United States or imports into the United States any patented invention during the term of the patent therefor, infringes the patent.").

26. Adapted from U.S. Patent No. 4,409,479 claim 1 (filed Dec. 3, 1981).

27. *See, e.g.*, U.S. Patent No. 8,109,924 (filed Mar. 24, 2011) (relating to use of optical radiation to treat dermatological problems, citing U.S. Patent No. 4,409,479).

28. This example is adapted from U.S. Patent No. 4,409,479 (filed Dec. 3, 1981) (a real patent filed by Xerox). I am not aware of the true expectations of the company when they filed the patent as to downstream development.

unexpected windfall: a patent covering many downstream uses. The public suffers from that windfall because the price of downstream innovation is raised, and the public did not receive reward greater than it would have received from a narrower patent. A patent system attempting to implement a policy that patents be "narrow" might grant this patent with the belief that it conforms to the policy's prescription, only to find out years later that it in fact does not. Courts are then faced with the option of correcting scope—to the detriment of the important notice function of patents—or ignoring the problem—to the detriment of downstream innovation. This is a quintessential example of the sequence-of-information problem and why it stymies patent policy implementation.

To be implementable, policy recommendations for setting and ascertaining patent scope must be coupled with an understanding of the sequence-of-information problem. This Article presents a model of the sequence-of-information problem in order to improve our ability to concretize our thinking about patent scope and, using the consequently developed framework, proposes coherent methods of implementing patent policy.

Parts I and II of this Article delineate the challenges of moving from abstract to implementable discussions of patent scope, with emphasis on the sequence-of-information problem. Part III classifies methods for setting scope and obtaining scope information in order to demonstrate that there are certain systematic ways of talking about patent scope that render it less abstract. Through this process, the Article constructs the first model for concretizing patent scope using analogues, suggesting that we think of scope as being set by and informed through a series of analogues, a method of conceptualizing patent scope that has not been proposed in the literature.

Finally, in Part IV, this Article seeks to resolve the sequence-of-information problem by providing patent policy suggestions that reduce the temporal distance between scope setting and scope information acquisition. Resolving the sequence-of-information problem is possible, but it requires a shift in thinking about patent scope. There are three categories of methods to resolve the sequence-of-information problem: (1) move scope setting closer to information acquisition, (2) move information acquisition closer to scope setting, or (3) eliminate the concept of scope entirely. This Article provides examples of solutions within each category. Irrespective of exactly how the sequence-of-information problem is diminished, patent law will benefit greatly by being cognizant of the problem and considering the timing of information availability when making policy recommendations.

I. PATENT SCOPE

The purpose of patents is to promote innovation.[29] Patents incentivize

29. *See supra* note 21.

innovation by granting monopoly rights in exchange for full disclosure of the invention.[30] Patent law exists in a careful balance. If inventors receive too little reward for their invention, innovation is insufficiently incentivized and may be stifled.[31] If inventors receive too much reward for their invention, their monopoly rights prevent secondary innovation[32] and may prevent optimal public use.[33] There is general agreement that some form of monopoly incentive for

30. *See, e.g.*, Graham v. John Deere Co., 383 U.S. 1, 9 (1966) ("The patent monopoly was not designed to secure to the inventor his natural right to his discoveries. Rather, it was a reward, an inducement, to bring forth new knowledge."); 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.'"); Dan L. Burk & Mark A. Lemley, *Policy Levers in Patent Law*, 89 VA. L. REV. 1575, 1575 (2003) ("Patent law is our primary policy tool to promote innovation, encourage the development of new technologies, and increase the fund of human knowledge."); Mark A. Lemley & David McGowan, *Legal Implications of Network Economic Effects*, 86 CAL. L. REV. 479, 526 (1998) ("Indeed, the principle behind intellectual property law is that competition should be sacrificed to some extent in order to give sufficient incentive for innovation."); Lawrence Lessig, *Intellectual Property and Code*, 11 ST. JOHN'S J. LEGAL COMMENT. 635, 638 (1996) ("[W]hile we protect real property to protect the owner from harm, we protect intellectual property to provide the owner sufficient incentive to produce such property.").

31. *See, e.g.*, Mark F. Grady & Jay I. Alexander, *Patent Law and Rent Dissipation*, 78 VA. L. REV. 305, 307 (1992).

32. *See, e.g.*, Lab. Corp. of America Holdings v. Metabolite Labs., Inc., 548 U.S. 124, 126-27 (2006) (Breyer, J., dissenting) ("[S]ometimes *too much* patent protection can impede rather than 'promote the Progress of Science and useful Arts' .... [P]atents do not only encourage research by providing monetary incentives for invention. Sometimes their presence can discourage research by impeding the free exchange of information, for example by forcing researchers to avoid the use of potentially patented ideas . . . and by raising the costs of using patented information, sometimes prohibitively so."); Jonathan M. Barnett, *Cultivating the Genetic Commons: Imperfect Patent Protection and the Network Model of Innovation*, 37 SAN DIEGO L. REV. 987, 1000 (2000) ("Today academic and industrial researchers commonly lament the ballooning costs of navigating around proliferating clusters of patent claims, and some commentators contend that patent claims ultimately will result in upstream strangleholds on basic-research discoveries that will significantly impede downstream technological applications."); Michael A. Carrier, *Resolving the Patent-Antitrust Paradox Through Tripartite Innovation*, 56 VAND. L. REV. 1047, 1081-82 (2003) (explaining how patents can interfere with cumulative innovation); Michael A. Heller & Rebecca S. Eisenberg, *Can Patents Deter Innovation? The Anticommons in Biomedical Research*, 280 SCI. 698, 698 (1998) (arguing in the context of biomedical research that patent holders can impede downstream research); Lisa Mandrusiak, *Balancing Open Source Paradigms and Traditional Intellectual Property Models to Optimize Innovation*, 63 ME. L. REV. 303, 310-11 (2010) (providing an overview of the anticommons patent problem); Robert P. Merges & Richard R. Nelson, *On the Complex Economics of Patent Scope*, 90 COLUM. L. REV. 839, 843 (1990). *But see* Kitch, *supra* note 7, at 276-77 (arguing that the original innovator is in the best position to develop and coordinate downstream innovation).

33. By charging inflated prices for the product, which increases prices for consumers. *See* Joseph A. Franco, *Limiting the Anticompetitive Prerogative of Patent Owners: Predatory Standards in Patent Licensing*, 92 YALE L.J. 831, 836 (1983) (arguing that the patent system reflects "a tradeoff between dynamic and static efficiency"). A related problem is the rise of patent trolls. For more information on the problem of patent trolls *see, e.g.*, Einer Elhauge, *Do Patent Holdup and Royalty Stacking Lead to Systematically Excessive Royalties?*, 4 J. COMPETITION L. & ECON. 535, 537 (2008); Damien Geradin et al., *The Complements Problem Within Standard Setting: Assessing the Evidence on*

innovation is justifiable.[34] However, there is less agreement on what form and scope this monopoly should take.

In exchange for the limited monopoly granted by a patent, the patentee must "demarcate the boundaries of the purported invention, in order to provide notice to others of the limits 'beyond which experimentation and invention are undertaken at the risk of infringement.'"[35] This "notice function" of patents is central to patent law.[36] The Supreme Court has explained, "patent law . . . leave[s] no excuse for ambiguous language or vague description. The public should not be deprived of rights supposed to belong to it, without being clearly told what it is that limits these rights."[37]The notice function of patents is also central to incentivizing innovation, as poorly defined boundaries may inhibit development of the surrounding space by other parties.[38]

The claims of the patent demarcate a defined space over which the patentee is granted the right to exclude others.[39] Due to the inherent ambiguity of language, patent claims do not form the more easily surveyable boundaries that characterize

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Royalty Stacking, 14 B.U. J. SCI. & TECH. L. 144, 145 (2008); John M. Golden, *"Patent Trolls" and Patent Remedies*, 85 TEX. L. REV. 2111, 2145-47 (2007); J. Gregory Sidak, *Holdup, Royalty Stacking, and the Presumption of Injunctive Relief for Patent Infringement: A Reply to Lemley and Shapiro*, 92 MINN. L. REV. 714, 714 (2008). However, note that the negative view of patent trolls is not unanimous. Some think that they provide a useful economic function. *See, e.g.*, Sannu K. Shrestha, *Trolls or Market-Makers? An Empirical Analysis of Nonpracticing Entities*. 110 COLUM. L. REV. 114, 115-16 (2010) (suggesting that patent trolls enhance innovation by "providing capital to independent inventors and creating an efficient market for trade in technological information"); *see also* James F. McDonough III, *The Myth of the Patent Troll: An Alternative View of the Function of Patent Dealers in an Idea Economy*, 56 EMORY L.J. 189, 190 (2006) ("[T]rolls act as a market intermediary in the patent market. Patent trolls provide liquidity, market clearing, and increased efficiency to the patent markets—the same benefits securities dealers supply capital markets.").

34. Burk & Lemley, *supra* note 30, at 1580.

35. Rengo Co. v. Molins Mach. Co., 657 F.2d 535, 551 (3d Cir. 1981) (citing Norton Co. v. Bendix Corp., 449 F.2d 553, 555 (2d Cir. 1971)).

36. *See, e.g.*, McClain v. Ortmayer, 141 U.S. 419, 424 (1891) ("The object of the patent law . . . is not only to secure to [the patentee] all to which he is entitled, but to apprise the public of what is still open to them."); Halliburton Energy Services, Inc. v. M-I LLC, 514 F.3d 1244, 1249 (Fed. Cir. 2008) ("[T]he patent statute requires that the scope of the claims be sufficiently definite to inform the public of the bounds of the protected invention . . . . Otherwise, competitors cannot avoid infringement, defeating the public notice function of patent claims."); Hoganas AB v. Dresser Indus., 9 F.3d 948, 951 (Fed. Cir. 1993) (stating that the purpose of claims is to "put competitors on notice of the scope of the claimed invention"). It has been suggested that patent disclosures also serve purposes beyond the notice function, for example, the codification of knowledge. *See, e.g.*, Dan L. Burk, *The Role of Patent Law in Knowledge Codification*, 23 BERKELEY TECH L.J. 1009, 1012 (2008). *But see* Alan Devlin, *The Misunderstood Function of Disclosure in Patent* Law, 23 HARV. J.L. & TECH. 401, 404 (2009) ("To a surprising degree, inventors simply ignore patents.").

37. Merrill v. Yeomans, 94 U.S. 568, 573 (1876).

38. Peter S. Menell & Michael J. Meurer, *Notice Failure and Notice Externalities*, 5 J. LEGAL ANALYSIS 1, 4 (2013).

39. *See, e.g.*, Christopher A. Cotropia, *Patent Claim Interpretation Methodologies and Their Claim Scope Paradigms*, 47 WM. & MARY L. REV. 49, 65 (2005).

real property,[40] but patent law nonetheless charges patent drafters with writing claims that set out "the metes and bounds" of the patent right.[41]

The patentee drafts the claims during prosecution of the patent. At this stage, the examiner may reject the claims, giving the patent applicant an opportunity to re-draft and re-submit the claims. Once the patent is granted, the claims are set and, when the patent is published, provide public notice of the patent's boundaries.[42] Competitors are then encouraged to use the claims as a guide to designing around the patent.[43] The Supreme Court promotes reliance on claims to develop work-arounds, stating, for example, that claims "inform the public during the life of the patent of the limits of the monopoly asserted, so that it may be known which features may be safely used or manufactured without a license and which may not."[44]

A. *Defining Patent Scope*

What is "patent scope"? While there are few explicit definitions of patent

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40. *See, e.g.*, William R. Hubbard, *Efficient Definition and Communication of Patent Rights: The Importance of* Ex Post *Delineation*, 25 SANTA CLARA COMPUTER & HIGH TECH. L.J. 327, 328 (2009).

41. *See, e.g.*, Festo Corp. v. Shoketsu Kinzoku Kogyo Kabushiki Co., 234 F.3d 558, 622 (Fed. Cir. 2000) *vacated*, 535 U.S. 722 (2002) ("In drafting an original claim of a patent application, the writer sets out the metes and bounds of the invention . . . ."); Markman v. Westview Instruments, Inc., 52 F.3d 967, 1000 (Fed. Cir. 1995) ("The legal effect of the patent claim is to establish the metes and bounds of the patent right to exclude . . . ."); Zenith Labs., Inc. v. Bristol-Myers Squibb Co., 19 F.3d 1418, 1424 (Fed. Cir. 1994) ("It is the claim that sets the metes and bounds of the invention entitled to the protection of the patent system."); Corning Glass Works v. Sumitomo Elec. U.S.A., Inc., 868 F.2d 1251, 1257 (Fed. Cir. 1989) ("A claim in a patent provides the metes and bounds of the right which the patent confers on the patentee to exclude others from making, using or selling the protected invention.").

42. PSC Comput. Prods., Inc. v. Foxconn Int'l, Inc., 355 F.3d 1353, 1359 (Fed. Cir. 2004) ("[C]laims serve the important notice function of informing the public that anyone who makes, uses, or sells the claimed invention infringes the patent.").

43. *See, e.g.*, Read Corp. v. Porter, Inc., 970 F.2d 816, 823 (Fed. Cir. 1992) ("We have often noted that one of the benefits of the patent system is the incentive it provides for 'designing around' patented inventions, thus creating new innovation."); Slimfold Mfg. v. Kinkead Indus., 932 F.2d 1453, 1457 (Fed. Cir. 1991) ("Designing around patents is, in fact, one of the ways in which the patent system works to the advantage of the public in promoting progress in the useful arts, its constitutional purpose."); State Indus., Inc., v. A.O. Smith Corp., 751 F.2d 1226, 1236 (Fed. Cir. 1985) ("One of the benefits of a patent system is its so-called 'negative incentive' to 'design around' a competitor's products, even when they are patented, thus bringing a steady flow of innovation to the marketplace. It should not be discouraged . . . ."). However, courts do not always regard designing-around as a benefit of the patent system. *See, e.g.*, Graver Tank & Mfg. Co. v. Linde Air Prods. Co., 339 U.S. 605, 607 (1950) (worrying that allowing too much design-around would "convert the protection of the patent grant into a hollow and useless thing"); *see also* Chiang, *supra* note 24, at 1138 ("If the patent's scope is confined to precise replication . . . then pirates would quickly learn to copy the principle or the heart of the patent without replicating the precise embodiment . . . protection limited to literal reproduction is worthless and easily circumvented.").

44. Permutit Co. v. Graver Corp., 284 U.S. 52, 60 (1931).

scope, it is used in the general lexicon to refer to the breadth of the patent, or how much intellectual space resides within the metes and bounds of the patent claims. Courts have asked, "[w]hat is meant (in a legal sense) by the "scope" of a patent? A general definition may well be that the scope of a patent is the boundaries (or limits) of the invention protected by the patent."[45]

This definition manifests in practice as the universe of inventions that infringe on the patent.[46]

From its nature, this "scope" must find its expression in general terms—such as "broad" or "narrow." "Like other general legal terms—such as negligence or fraud—the practical use of a definition of the scope of a patent comes only in its application to specific cases of infringement."[47]

Thus, while patent scope can be described in the abstract as the metes and bounds of the patent, in practice, it is implemented only with respect to infringing products. A broad patent precludes many infringing products, while a narrow patent precludes few. Errors in setting patent scope are also discernible only in comparison to potentially infringing products. An overly broad patent will

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45. Smith v. Mid-Continent Inv. Co., 106 F.2d 622, 624 (8th Cir. 1939); *see also* Markman v. Westview Instruments, Inc., 517 U.S. 370, 373 (1996) ("The claim 'define[s] the scope of a patent grant . . . .'"); Vitronics Corp. v. Conceptronic, Inc., 90 F.3d 1576, 1582 (Fed. Cir. 1990) ("[W]e look to the words of the claims themselves . . . to define the scope of the patented invention."); Philip A. Hunt Co. v. Mallinckrodt Chem. Works, 177 F.2d 583, 585 (2d Cir. 1949) ("[O]ne of the offices of claims in general . . . is to advise the art of the scope of the monopoly . . . ."); Motion Picture Co. v. Universal Film Co., 243 U.S. 502, 505 (1917) ("The scope of every patent is limited to the invention described in the claims contained in it, read in the light of the specification. These so mark where the progress claimed by the patent begins and where it ends that they have been aptly likened to the description in a deed, which sets the bounds to the grant which it contains."); Stanley M. Besen & Leo J. Raskind, *An Introduction to the Law and Economics of Intellectual Property*, 5 J. ECON. PERSP. 3, 7 (1991) ("The scope of protection offered by a patent is determined by its claims, which are technical descriptions of the process, machine, method, or matter contained in the original patent application.").

46. *See, e.g.*, *Festo*, 234 F.3d at 589 (Rader, J., concurring in part) ("The limitations of a patent's claims provide an initial measure of the effective scope of the patent . . . ."); *Vitronics*, 90 F.3d at 1582 ("[C]ompetitors are entitled to review the public record, apply the established rules of claim construction, ascertain the scope of the patentee's claimed invention and, thus, design around the claimed invention."); Christopher A. Cotropia, *After-Arising Technologies and Tailoring Patent Scope*, 61 N.Y.U. ANN. SURV. AM. L. 151, 172-73 (2005) ("[T]he broader the patent scope, the more protection the patent holder receives and the more competing products she can exclude. A patent's breadth defines the universe of products or activities that cannot replace the patented technology during the patent's statutory lifetime."); Klemperer, *supra* note 1, at 113 (discussing the "optimal width [scope] of patent protection . . . [f]or example, if a company invents a new drug to alleviate a heart condition, how similar a drug should a competitor be allowed to sell? If a computer software firm markets a new program, how different should any rival product be required to be?"); Merges & Nelson, *supra* note 11, at 839 ("The economic significance of a patent depends on its scope: the broader the scope, the larger the number of competing products and processes that will infringe the patent.").

47. Gen. Motors Corp. v. Kesling, 164 F.2d 824, 832 (8th Cir. 1947). The challenge of defining scope has many elements of the intension/extension distinction. *See* Henry E. Smith, *Emergent Property*, *in* PHILOSOPHICAL FOUNDATIONS OF PROPERTY LAW 320-38 (James Penner & Henry E. Smith eds., 2013).

preclude too many potentially infringing products and may prevent too much downstream innovation, while an overly narrow patent will preclude too few and may provide insufficient upstream incentive to innovate.[48]

The term "patent scope" occasionally includes the length of patent protection, as well as the breadth, but it is more common to use "scope" synonymously only with breadth, as I will do here.[49]

II. THE SEQUENCE-OF-INFORMATION PROBLEM OF PATENT SCOPE

Perhaps as a result of the abstract nature of patent scope, and the often conceptual nature of discussions of patent scope, a fundamental requirement to set patent scope is frequently neglected: information. It is axiomatic that in order to set the scope of a patent to any given breadth, there is a subset of information that must be known.

The scope of a patent is the universe of products covered by that patent.[50] In order to set the scope of a particular patent, something must be known about that universe of infringing products. The problem is that almost all potentially infringing products will be conceived of or developed after the patent is granted. In contrast, patent scope, defined by the claims of the patent,[51] is set before patent grant. Thus, patent scope has a sequence-of-information problem. Scope is set early in the life of a patent, while the information necessary to define the scope of a patent is created much later.

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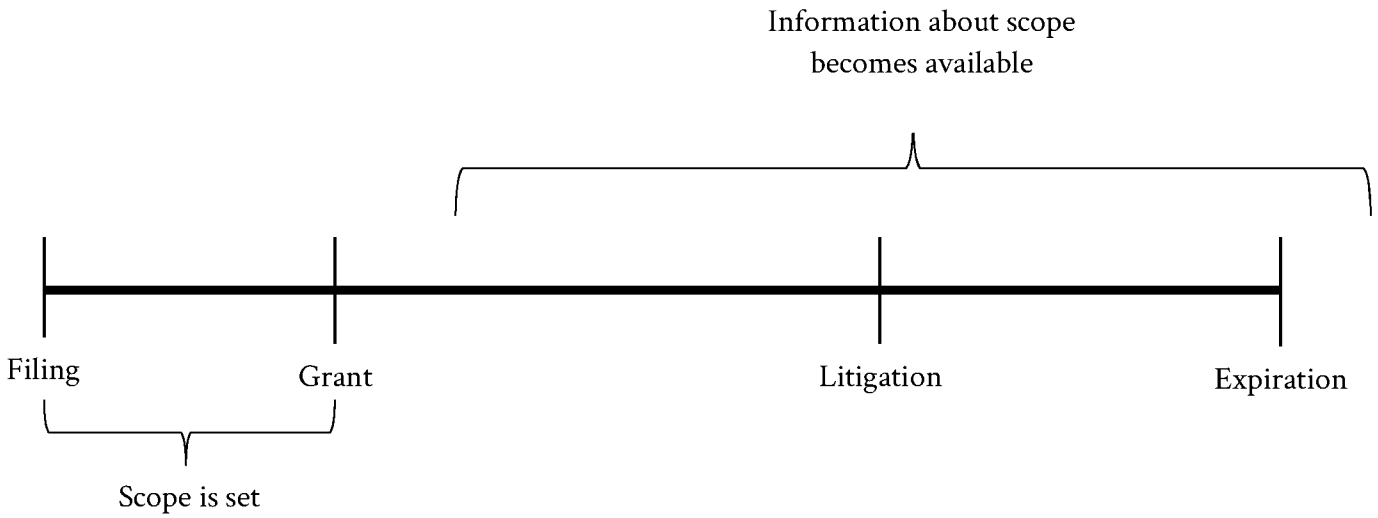
48. Eric Bond & Ben Zissimos, Patent Breadth in an International Setting, at 3 (July 14, 2010), http://web.stanford.edu/group/SITE/archive/SITE_2010/segment_4/segment_4_papers/zissimos.pdf [http://perma.cc/AM7U-GHP3] ("The choice of patent breadth involves a trade-off . . . . A broader patent will make innovative activity more profitable and thus make it more likely that there is a successful innovation. However, broader patent protection will also result in greater static deadweight loss due to less intense competition in output markets.").

49. *See, e.g.*, Klemperer, *supra* note 1, at Abstract (exploring "the trade-off between a patent's length (that is, its lifetime) and its width (that is, its scope of coverage)").

50. *See supra* Part I.B.

51. *See supra* Part I.A.



This problem has practical implications. Take, for example, an upstream innovator who creates (and patents) a fundamental platform technology and several downstream innovators who develop useful improvements to that technology. A classic problem in patent law is how to divide rewards between upstream and downstream innovators.[52] This struggle is, fundamentally, about determining the scope of the upstream patent. If it is broad enough to cover the downstream innovations, the downstream innovators may not be sufficiently incentivized to create those innovations. If it is too narrow to cover the downstream innovations, the upstream innovator may not be sufficiently incentivized to create the upstream innovation. In attempting to solve this problem, theorists may conclude that the upstream patent should have a certain breadth—that it should be broad enough to cover the downstream innovations or that it should not be.

How can the desired solution be implemented? What does it mean for a patent to be broad enough to cover downstream innovation? What guidance can be provided to a drafter of a patent application? Let us return to the hypothetical of the mousetrap and the computer mouse. Perhaps a court has ruled that a patent claiming a computer mouse is too broad. The court's decision implements a policy that the computer mouse patent covers too many downstream computer mouse-iterations. The next day, an attorney sits down to draft a patent on an unrelated invention—say, a mousetrap. What guidance does this court decision provide for

52. *See, e.g.*, Clarisa Long, *Patents and Cumulative Innovation*, 2 WASH. U. J.L. & POL'Y 229, 237-38 (2000) ("Under some circumstances, strong protection for certain discoveries too early in their evolution will retard future development or redirect research in less beneficial directions."); Peter Menell, *The Challenges of Reforming Intellectual Property Protection for Computer Software*, 94 COLUM. L. REV. 2644, 2646 (1994) ("Excessive protection for first generation innovation can impede later stages, thereby undermining some of the salutary effects of strong intellectual property protection.").

the drafter of a patent on a mousetrap? How can the mousetrap patent apply the court's guidance? The drafter of the mousetrap application may be well aware of the current state of the mousetrap art. She will certainly avoid drafting a patent covering any aspect of any existing mousetrap innovation or any concepts that are but a small leap from currently existing mousetraps.[53] Any ideas for new and improved mousetraps that are known by the drafter will be included in the patent application. The remaining type of future mousetrap innovation—downstream innovation—is by definition unknown to her. It is therefore impossible to implement patent scope policy by requiring patent drafters to accurately shape their claims to either encompass or avoid downstream innovation.

This is the sequence-of-information problem of patent scope. Over the years of the patent's life, competitors may develop inventions falling into the scope of the patent that were not imagined by the patentee during prosecution of the patent. These after-arising inventions cannot be accounted for in patent scope set before their conception.

Note that the sequence-of-information problem is not the only challenge in setting and interpreting patent scope. Because scope is defined by words, it is subject to the inherent limitations and ambiguity of language. There is a vast literature describing the problems (and advantages) of ambiguous patent language.[54] This issue is beyond the scope of this Article, but it is important to recognize that there are other dimensions to the problem of patent scope.

III. MEASURING AND SETTING PATENT SCOPE

The previous Parts of this Article provided an overview of elements of patent scope that we do not know and cannot measure. However, patent scope is not entirely abstract and unmeasurable. There are certain analytical strategies that can

53. This is required by law. 35 U.S.C. § 102 (2013).

54. *See, e.g.*, John M. Golden, *Construing Patent Claims According to Their Interpretive Community: A Call for an Attorney-Plus-Artisan Perspective*, 21 HARV. J.L. & TECH. 321, 329 (2008); Kristen Jakobsen Osenga, *Linguistics and Patent Claim Construction*, 38 RUTGERS L.J. 61, 62 (2006); Christa J. Laser, *A Definite Claim on Claim Indefiniteness: An Empirical Study of Definiteness Cases of the Past Decade with a Focus on the Federal Circuit and the Insolubly Ambiguous Standard*, 10 CHI.-KENT J. INTELL. PROP. 25, 38 (2010); Jeffrey A. Lefstin, *Claim Construction, Appeal, and the Predictability of Interpretive Regimes*, 61 U. MIAMI. L. REV. 1033, 1033 (2007); Mark A. Lemley, *The Changing Meaning of Patent Terms*, 104 MICH. L. REV. 101, 106 (2005); Peter S. Menell, et al., *Patent Claim Construction: A Modern Synthesis and Structured Framework*, 25 BERKELEY TECH. L.J. 711, 717 (2010); Emily Michiko Morris, *Res or Rules? Patents and the (Uncertain) Rules of the Game*, 18 MICH. TELECOMM. & TECH. L. REV. 481, 483 (2012); Kimberly A. Moore, *Markman Eight Years Later: Is Claim Construction More Predictable?*, 9 LEWIS & CLARK L. REV. 231, 233 (2005); Kelly Casey Mullally, *Patent Hermeneutics: Form and Substance in Claim Construction*, 59 FLA. L. REV. 333, 334 (2007); S. Jay. Plager, *Challenges for Intellectual Property Law in the Twenty-First Century: Indeterminacy and Other Problems*, 2001 U. ILL. L. REV. 69, 71 (2001); Michael Risch, *The Failure of Public Notice in Patent Prosecution*, 21 HARV. J.L. & TECH. 179, 182 (2007); David L. Schwartz, *Practice Makes Perfect? An Empirical Study of Claim Construction Reversal Rates in Patent Cases*, 107 MICH. L. REV. 223, 259 (2008).

render scope more concrete. The following section proposes a framework for concretizing patent scope: defining scope by comparison to tangible analogues.[55] There are three types of tangible analogues available to set and measure scope. These are the prior art (earlier-developed inventions), the patent itself, and later-developed inventions. Although not previously explicitly recognized, most currently used tools for setting patent scope rely on these analogues.

Part A explains how scope can be understood in relation to each of the three categories of analogues. Part B creates a taxonomy of tools for setting patent scope classified by analogue. This is relevant to the sequence-of-information problem because each analogue has a temporal aspect relative to patent grant, meaning that it is available either ex ante or ex post. The taxonomy explains what information and which scope-setting resources are available ex ante, and which are available only ex post. This helps to incorporate considerations about the timing of information availability into patent scope setting policy.

A. *Setting Patent Scope Using Analogues*

Given that patent scope cannot be measured numerically or in the abstract, a useful source of information about patent scope is obtained through comparison to an analogue. To put this in more definite terms, consider a patent claiming a mousetrap. In the abstract, we cannot quantify the intellectual breadth of a mousetrap. However, if we put our patent for a mousetrap beside a patent for a trap that can catch either rats or mice, we can be confident that the second patent has a broader scope. There are three types of analogues: earlier-developed inventions (prior art), the patent itself, and later-developed inventions.

Prior-Art: It is possible to set boundaries on patent scope through comparison to similar inventions already in the public domain (called prior art). For example, this can be done using the doctrines of novelty and nonobviousness,[56] which do not permit patents to claim an invention that is already prior art or would be obvious from the prior art. Returning to the mousetrap example, if a mousetrap had previously been invented, but could only catch mice, not rats, a new patent on a mere mousetrap would not be valid, but a patent on a trap that catches both rats and mice might be. The comparison between the patent and the prior art enables drawing a clear scope line: a patent on a rat- and mousetrap has a scope that does not include traps that are capable of catching only mice, but not rats. Thus, patent scope can be set by comparison to a prior art analogue of a patent.

The Patent: An additional analogue that can be used to bound patent scope is

55. The possibility of defining scope in comparison to analogues appears, although infrequently, in old case law. *See, e.g.*, General Motors Corp. v. Kesling, 164 F.2d 824, 832 (8th Cir. 1947). However, there is no detailed framework explaining how scope is defined in comparison to analogues or classifying scope-setting tools in comparison to analogues.

56. Described in more detail *infra* Part III.A.1.

the patent itself. For example, patents may contain two types of claims, independent claims and dependent claims. Independent claims do not refer back to any other claims.[57] Dependent claims refer back to and limit another claim in the same patent.[58] Dependent claims are required by statute to be narrower in scope than the independent claims from which they depend because the dependent claims must both "incorporate by reference all limitations of the" independent claim and "specify a further limitation of the subject matter claimed."[59] Consider the independent-dependent claim pair below:

> 1. A mouse trap comprising a spring bar.
>
> 2. The mouse trap of claim 1 wherein the spring bar is attached to a wooden base.

The dependent claim (claim 2) complies with the statutory requirement to specify an additional limitation because the intellectual property bounded by the claim consists not only of a trap with a spring bar, but a trap with both a spring bar and a wooden base, a narrower universe of possibilities.[60] Thus, claim scope is limited by internal comparison within a patent.

Later-Developed Inventions: Claim scope is also set by reference to a third type of analogue: potentially infringing inventions. Infringing inventions are generally developed after the grant of the patent; therefore they cannot be specifically taken into account when patent scope is set. However, the relationship between the scope of the patent and the infringing product is a question at every patent infringement trial. Judges must always answer the question of whether the accused product falls within the scope of the claims of the patent.[61] For the most part, courts consider only the present scope of the claims, not whether the scope of the claims should be different. However, on occasion, courts will use a utilitarian calculus to assess whether the scope of the patent should be altered – either to cover or to avoid covering – the accused product.[62] Thus, claim scope is expanded or retracted by comparison to a potentially infringing invention. For example, if the owner of a patent claiming "a trap for catching mice" were to sue the maker of a trap for catching rats (but not mice) a court might decide that catching rats is sufficiently similar to catching mice that the defendant's invention should infringe on the plaintiff's patent.

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57. 37 C.F.R. § 1.75(c) (2009).

58. *Id.*

59. 35 U.S.C. § 112(e) (2013).

60. The first claim covers a spring bar attached to, for example, a wooden base, a metal base, a plastic base, or no base at all.

61. Formally, this rule requires "that the accused device contains each limitation of the asserted claim(s)." Bayer AG v. Elan Pharm. Research Corp., 212 F.3d 1241, 1247 (Fed. Cir. 2000).

62. The doctrine of equivalents, see *infra* Part III.A.2(a).

Altering patent scope based on later-developed inventions is a well-characterized problem in patent law. It creates uncertainty, which violates one of the most essential (but perhaps least well implemented) tenets of patent law: that the boundaries of a patent must be well defined. The tension between correcting scope errors using later-developed inventions (and therefore later-acquired information) has many elements of the classic rules versus standards problem.[63] Generally speaking, rules provide more certainty but get more cases wrong. Standards provide more flexibility, and therefore the potential to get more cases right, but at the cost of inconsistency and unpredictability. Similarly, altering patent scope ex post may improve the accuracy of patent scope, but also decreases the predictability of patent scope.

B. *A Taxonomy of Tools for Setting Patent Scope*

Because patent scope is both informed by and bounded through comparison to analogues, tools for setting patent scope rely on such comparisons. Two types of analogues—the prior art and the patent itself—are available ex ante, before the patent is granted. The third type of analogue— potentially infringing inventions—is available only ex post. The taxonomy below divides scope-setting tools based on whether they rely on analogues available ex ante or analogues available ex post. Doing so demonstrates when information becomes available for various ways of setting patent scope.

Note that some tools may be used either by the patent examiner to reject a patent application prior to grant or by a court to invalidate a granted patent in later litigation. I classify these tools as ex ante tools for two reasons. First, patent scope is not altered or refined by a court's decision with respect to these tools; a patent is merely determined to be valid or invalid. Second, no new information is available ex post that was not available ex ante. While litigants often bring new analogues to light that were not considered by the patent office, these analogues were available to the patent office and thus could have been considered ex ante.

1. *Ex Ante Tools for Measuring Patent Scope*

The sections below describe doctrines by which scope can be constrained ex

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63. Isaac Ehrlich & Richard A. Posner, *An Economic Analysis of Legal Rulemaking*, 3 J. LEGAL STUD. 257 (1974); Louis Kaplow, *Rules Versus Standards: An Economic Analysis*, 42 DUKE L.J. 557 (1992); Kathleen M. Sullivan, *The Supreme Court, 1991 Term—Foreword: The Justices of Rules and Standards*, 106 HARV. L. REV. 22 (1992); Cass R. Sunstein, *Problems with Rules*, 83 CAL. L. REV. 953 (1995). Tun Jen Chiang has recognized that patent scope regulation is a rules versus standards problem. Tun Jen Chiang, *The Rules and Standards of Patentable Subject Matter*, WISC. L. REV. 1353, 1357 (2010) ("[S]tandards governing patent scope . . . can be precisely tailored to prevent excessive monopolies. Despite all of the administrative costs of this type of standard, critics can point to no alternative, since the alternative to flexible standards are categorical rules . . . .").

ante (before the patent is granted), specifically the doctrines of (a) novelty, (b) nonobviousness, and (c) enablement and written description.

a. *Novelty*

A patent must be novel.[64] A patent is novel if the invention has not been described, used, or made otherwise available to the public prior to the patent's filing date.[65] A patent application may be rejected for lack of novelty by a patent examiner during prosecution, or may be invalidated after the patent's grant during litigation.

Novelty affects patent scope because it sets outer boundaries on permissible scope. Novelty demarcates where old knowledge ends and new invention begins. It bounds scope because a patent's scope cannot extend past the boundary into old knowledge. Determining novelty "require[s] the court [or the patent examiner] to compare the . . . claims to the available prior art."[66] If the claims of the patent are disclosed in the prior art, the patent is not novel, and thus not valid. This means that the scope of a patent cannot be so broad as to encompass ideas that have already been made.

Novelty is an ex ante tool to refine patent scope. Prior to a patent's grant, patent examiners make novelty decisions by comparing the claimed invention with a single prior art reference.[67] If the single prior art reference contains all elements of the claimed invention, the examiner will reject the patent application, and the patentee must narrow her invention until it is no longer fully disclosed by the prior art reference. Novelty thus affects patent scope by requiring comparison of a patent application to an analogue: a piece of prior art describing a similar invention.

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64. 35 U.S.C. § 102(a) (2013) ("A person shall be entitled to a patent unless (1) the claimed invention was patented, described in a printed publication, or in public use, on sale, or otherwise available to the public before the effective filing date of the claimed invention; or (2) the claimed invention was described in a patent issued under section 151, or in an application for patent published or deemed published under section 122(b), in which the patent or application, as the case may be, names another inventor and was effectively filed before the effective filing date of the claimed invention.").

65. *Id.*; *see also*, Verdegaal Bros v. Union Oil Co. of California, 814 F.2d 628, 631 (Fed. Cir. 1987) ("A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference."); U.S. PATENT & TRADEMARK OFFICE, MANUAL OF PATENT EXAMINATION PROCEDURE § 2131 (2014) [hereinafter MPEP] ("A claimed invention may rejected under 35 U.S.C. § 102 when the invention is anticipated (or is 'not novel') over a disclosure that is available as prior art. To anticipate a claim, the disclosure must teach every element of the claim.").

66. Genetics Inst., LLC v. Novartis Vaccines & Diagnostics, Inc., 655 F.3d 1291, 1302 (Fed. Cir. 2011).

67. MPEP § 2131.

b. *Nonobviousness*

A patent must be nonobvious.[68] An invention is obvious if the invention is only a small—and obvious—jump from the prior art.[69] Whether a jump is obvious depends on "what a person of ordinary skill in the pertinent art would have known at the time of the invention, and on what such a person would have reasonably expected to have been able to do in view of that knowledge."[70] The obviousness requirement seeks to bar the mere "results of ordinary innovation" from patentability.[71] A patent application may be rejected for obviousness by a patent examiner during prosecution, or may be invalidated after the patent's grant during litigation.

Like novelty, obviousness affects patent scope because it sets outer boundaries on permissible scope.[72] Determining obviousness requires the court or patent examiner to compare the claims of the invention to the prior art. Thus, "[t]he breadth of patent protection is in part a function of how different the invention is from the prior art."[73] If the claims of the patent are rendered obvious by the prior art, the patent is obvious, and thus not valid. This means that the scope of a patent cannot be so broad as to encompass ideas that are obvious in the prior art. The obviousness standard can be changed to expand or contract available patent scope.[74]

Obviousness is an ex ante tool to refine patent scope. Prior to a patent's grant,

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68. 35 U.S.C. § 103 (2013) ("A patent for a claimed invention may not be obtained, notwithstanding that the claimed invention is not identically disclosed as set forth in section 102, if the differences between the claimed invention and prior art are such that the claimed invention as a whole would have been obvious before the effective filing date of the claimed invention to a person having ordinary skill in the art to which the claimed invention pertains.").

69. *Id.*

70. MPEP § 2141.

71. KSR Int'l Co. v. Teleflex Inc., 127 U.S. 1727, 1746 (2007) ("We build and create by bringing to the tangible and palpable reality around us new works based on instinct, simple logic, ordinary inferences, extraordinary ideas, and sometimes even genius. These advances, once part of our shared knowledge, define a new threshold from which innovation starts once more. And as progress beginning from higher levels of achievement is expected in the normal course, the results of ordinary innovation are not the subject of exclusive rights under the patent laws . . . . These premises led to the bar on patents claiming obvious subject matter . . . .").

72. *See, e.g.*, DAN L. BURK & MARK A. LEMLEY, THE PATENT CRISIS AND HOW THE COURTS CAN SOLVE IT 112 (2010) ("Patent scope is necessarily interrelated with obviousness.").

73. *Id.*

74. *See, e.g.*, R. Polk Wagner, *Of Patents and Path Dependency: A Comment on Burk and Lemley*, 18 BERKELEY TECH. L.J. 1341, 1348 (2003) ("[T]he obviousness requirement [is] scope-affecting . . . . [T]he obviousness standard will . . . affect scope: a reduced standard of (non)obviousness will allow a patentee to establish claims 'closer' to any relevant prior art. An extremely reduced version of the obviousness standard—call it 'anticipation'—will allow claims that merely avoid the disclosure of the prior art, as well as those that cover more innovative subject matter. Conversely, a higher standard of (non)obviousness will yield claims that are more distinct (in physical terms, more distant) from the prior art, and thus narrower.").

patent examiners make obviousness decisions by comparing the claimed invention with the prior art.[75] If the prior art reference renders the claimed invention obvious, the examiner will reject the patent application, and the patentee must narrow his invention until it is no longer obvious in light of the prior art.[76] Obviousness, like novelty, thus affects patent scope by requiring a comparison of a patent application to an analogue: a piece of prior art on describing a similar invention.

c. *Enablement and Written Description*

An invention must be enabled by and adequately described in a patent's specification.[77] Enablement requires that "the specification describe the invention in such terms that one skilled in the art can make and use the claimed invention" in order to "ensure that the invention is communicated to the interested public in a meaningful way."[78] A patent claim is invalid if the specification does not enable the claimed invention.[79] The written description doctrine requires that the specification "describe the claimed invention in sufficient detail that one skilled in the art can reasonably conclude that the inventor had possession of the claimed invention."[80] The goals of the written description requirement are to "clearly convey the information that an applicant has invented the subject matter which is claimed"[81] and "to satisfy the inventor's obligation to disclose the technologic knowledge upon which the patent is based."[82] Although enablement and written description are distinct legal doctrines,[83] they are often considered together in discussing patent theory because they are difficult to separate conceptually and because both relate to the information provided in the specification of the patent,[84] and I do so here.

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75. MPEP § 2141.

76. Polk, *supra* note 74, at 1348 (discussing the "typicality of scope-reducing claim amendments as a means to overcome examiner rejections" on the basis of obviousness).

77. 35 U.S.C. § 112(a) (2013) ("The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same, and shall set forth the best mode contemplated by the inventor or joint inventor of carrying out the invention.").

78. MPEP § 2164.

79. *Id.*

80. MPEP § 2163.

81. In re Barker, 559 F.2d 588, 592 n.4 (C.C.P.A. 1977).

82. Capon v. Esshar, 418 F.3d 1349, 1357 (Fed. Cir. 2005); *see also*, Regents of the Univ. of Cal. v. Eli Lilly, 119 F.3d 1559, 1566 (Fed. Cir. 1997).

83. MPEP § 2164, citing Vas-Cath, Inc. v. Mahurkar, 935 F.2d 1555, 1563 (Fed. Cir. 1991) ("The enablement requirement . . . is separate and distinct from the written description requirement."). *But see*, Christopher M. Holman, *Is Lilly Written Description a Paper Tiger?*, 17 ALB. L. J. SCI. & TECH. 1, 17, 80 n.48 (2007) (arguing that judicial interpretation does not differentiate between written description and enablement).

84. *See, e.g.*, Janice M. Mueller, *The Evolving Application of the Written Description*

As with novelty and obviousness, the doctrines of enablement and written description are ex ante tools to affect patent scope. The patent examiner will compare the invention disclosed in each claim of the patent application with the teachings of the specification. The patent examiner may make a rejection based on either or both doctrines, and the patent applicant may then amend the claims to bring the scope of the claimed matter into line with the disclosure of the specification.[85] Thus, both doctrines rely on comparison of the patent's claims with an analogue: the patent's specification.

These doctrines of enablement and written description affect the permissible scope of a patent because they restrict the scope of the patent claims to the matters enabled by and described in the specification.[86] It is widely recognized, however, that patent scope may reach somewhat beyond the material strictly in the specification.[87] Thus, the analogue (the patent specification) sets a baseline for permissible scope, while some additional scope penumbra is permitted expanding beyond the analogue.

Requirement to Biotechnology Inventions, 13 BERKELEY TECH. L.J. 615, 617 (1998) (arguing that it is difficult to maintain "a clear demarcation between the written description and enablement requirements").

85. Although the patent applicant has the option of amending the specification to broaden the disclosure therein, as a practical matter this is rarely done because it would result in a later priority date for the patent application.

86. *See, e.g.*, Chiang, *supra* note 43, at 1101 ("[P]atent law's doctrines of enablement and written description seek to define monopoly scope by equating such scope to the "invention" contributed."); Merges & Nelson, *supra* note 46, at 844 ("[A]nother requirement relates more directly to the scope of the claims—enablement, which largely concerns how the invention is described and claimed in the patent."); *Id.* at 852 ("Doctrines relating to enablement have provided a way of determining the appropriate scope of claims."); *see also* Burk & Lemley, *supra* note 72, at 74 (arguing that in the context of biotechnology, "enablement and written description standards dramatically narrow the scope of the resulting claims."); Robert P. Merges, *Software and Patent Scope: A Report from the Middle Innings*, 85 TEX. L. REV. 1628, 1627 (2007) ("Proper application of enablement principles will help insure reasonable scope for software patents.").

87. Invitrogen Corp. v. Clontech Laboratories, Inc., 429 F.3d 1052, 1071 (Fed. Cir. 2005) ("Enablement does not require the inventor to foresee every means of implementing an invention at pains of losing his patent franchise."); Spectra-Physics, Inc. v. Coherent, Inc., 827 F.2d 1524, 1533 (Fed. Cir. 1987) (finding that a claim is valid even though it "reads on another embodiment of the invention which is inadequately disclosed"); Chiang, *supra* note 43, at 1114 ("[A] literal application of the full scope rule would invalidate every patent in existence. This is because . . . every patent covers an infinite array of embodiments, which cannot all be taught in the specification."); Kevin Emerson Collins, *The Reach of Literal Claim Scope into After-Arising Technology: On Thing Construction and the Meaning of Meaning*, 41 CONN. L. REV. 493, 494 (2008) ("The literal scope of a patent claim is not limited to the particular things that an inventor actually discloses in detail in her patent application."); Merges & Nelson, *supra* note 46, at 857 ("[C]urrent practice seems to permit a range of claims that may stretch beyond the spirit of the enablement doctrine. If the patent examiner can point to something in the prior art that indicates that some embodiments of the claimed invention will be impossible to make without more information than the inventor has disclosed, then the application may be rejected. But if the examiner cannot point to such an indication in the prior art, patent office policy dictates that even very broad claims may be allowed.").

While novelty, nonobviousness, enablement, and written description all define scope by comparison to another description of the same or a related invention, novelty and nonobviousness define scope by reference to an external document, while enablement defines scope through internal comparison.[88] Novelty and nonobviousness may thus be viewed as definite outer bounds of permissible scope, which the patentee may or may not fully occupy, while enablement and written description are bounds set by the patentee.

2. *Ex Post Tools for Measuring Patent Scope*

The sections below describe doctrines by which scope can be constrained *ex post* (after the patent is granted, generally in litigation), specifically (a) the doctrine of equivalents, (b) the reverse doctrine of equivalents, and (c) claim construction rules and procedures.

a. *The Doctrine of Equivalents*

The doctrine of equivalents permits courts to find that an accused product infringes on a patent even if the product does not fall into the literal scope of the patent if the product does "the same work in substantially the same way and accomplish[es] substantially the same result" as the patent claims, "even though [it] differ[s] in name, form or shape."[89] The purpose of the doctrine is to prevent "fraud on a patent" by averting instances where a patentee does not get the full benefit of his patent because a copyist changes a minor detail of the invention.[90] The effect of the doctrine is to expand the scope of a patent beyond the literal words of the claim, thus encompassing later-developed products.[91]

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88. Jeffrey A. Lefstin, *The Formal Structure of Patent Law and the Limits of Enablement*, 23 BERKELEY TECH. L.J. 1141, 1151 (2008) ("While the doctrines of novelty and nonobviousness define the limits of the inventor's claims imposed by the prior art, an axiom of claim scope must define the extent of the inventor's entitlement as a function of what the inventor has created or described in his patent application.").

89. Union Paper-Bag Mach. Co. v. Murphy, 97 U.S. 120, 125 (1877).

90. Graver Tank & Mfg. Co. v. Linde Air Prods. Co., 339 U.S. 605, 608 (1950). Note that some cases object to the doctrine of equivalents on the grounds that it discourages efforts to design-around a patent, an oft-stated goal of the patent system. *See, e.g.*, Read Corp. v. Portec, Inc., 970 F.2d 816, 828 (Fed. Cir. 1992) ("We have often noted that one of the benefits of the patent system is the incentive it provides for 'designing around' patented inventions, thus creating new innovation."); Slimfold Mfg. v. Kinkead Indus., 932 F.2d 1453, 1457 (Fed. Cir. 1991) ("Designing around patents is, in fact, one of the ways in which the patent system works to the advantage of the public in promoting progress in the useful arts, its constitutional purpose."); State Indus. v. A.O. Smith Corp., 751 F.2d 1226, 1236 (Fed. Cir. 1985) ("One of the benefits of a patent system is its so-called 'negative incentive' to 'design around' a competitor's products, even when they are patented, thus bringing a steady flow of innovations to the marketplace. It should not be discouraged . . . .").

91. Tate Access Floors, Inc. v. Interface Architectural Res., Inc., 279 F.3d 1357, 1367 (Fed. Cir. 2002) ("The doctrine of equivalents expands the reach of claims beyond their literal

The doctrine of equivalents determines a patent's scope by comparing the patent claims to an analogue: a potentially infringing product. If the court deems that the product is sufficiently similar to the patent claims, then the patent's scope is expanded to cover the product. Thus, patent scope is set ex post by reference to competing products that were likely developed after the patent was granted.[92]

The doctrine of equivalents is justified on utilitarian grounds. Michael Meurer and Craig Allen Nard explain that the modern justification for the doctrine is "the belief that the patent system generally works to give inventors patent claims with the proper breadth; but sometimes frictions in the system cause patent claims to be too narrow."[93] The proper role of the doctrine of equivalents is to fix these overly narrow claims.[94]

Within the doctrine of equivalents, a sub-doctrine, the doctrine of pioneer patents, is available to further refine patent scope. The doctrine of pioneer patents is evidence of the utilitarian purpose of the doctrine of equivalents and the manner in which it is designed to adjust patent scope ex post based on later-arising inventions while maintaining incentives to innovate.

The doctrine of pioneer patents states that the range of equivalents that may be claimed under the doctrine of equivalents depends on the nature of the patentee's invention.[95] A pioneer invention is "commonly understood to denote a patent covering a function never before performed, a wholly novel device, or one of such novelty and importance as to mark a distinct step in the progress of the art, as distinguished from a mere improvement or perfection of what ha[s] gone before."[96] It is therefore entitled to a greater scope of protection.[97] "Mere

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language."); Mark A. Lemley, *The Economics Improvement in Intellectual Property Law*, 75 TEX. L. REV. 989, 1001 (1997) ("[T]he doctrine of equivalents provides a means for broadening the scope of a patent beyond the literal language of the claims (and hence beyond the invention originally made by the patent owner) . . . . The effect is to create a 'penumbra' around the literal scope of the claims, and therefore to expand the protection given to patent owners."); Michael J. Meurer & Craig Allen Nard, *Invention, Refinement and Patent Claim Scope: A New Perspective on the Doctrine of Equivalents*, 93 GEO. L.J. 1947, 1951 (2004) ("The DOE [doctrine of equivalents] allows patent scope to grow over time as technology advances. In particular, patent owners exert control over products and processes that incorporate technology developed after the patent issues, and thus do not literally infringe. Expansion of scope is possible because equivalents are evaluated at the time of infringement, not the time of invention, filing, or issuance.").

92. One could alternatively view this as *acknowledging* patent scope ex post, rather than *setting* patent scope ex post. In this view, the initially granted patent was for both the literal scope and all equivalents, therefore the ex post determination does not actually change the scope; it merely implements and interprets the originally set scope. Under either view, there is a notice problem.

93. Meurer & Nard, *supra* note 91, at 1953.

94. *Id. See also* R. Polk Wagner, *Reconsidering Estoppel: Patent Administration and the Failure of* Festo, 151 U. PA. L. REV. 160, 201 (2002) ("[T]he use of the 'doctrine of equivalents' to expand the right to exclude is justified on the grounds that it better reflects the intellectual contribution of the inventor.").

95. Boyden Power-Brake Co. v. Westinghouse, 170 U.S. 537, 561-62 (1898).

96. Cont'l Paper Bag Co. v. E. Paper Bag Co., 210 U.S. 405, 414 (1908). The extent to

improvement" inventions, on the other hand, are granted a narrower scope of equivalents, and thus a narrower scope of protection.

This reflects the understanding that pioneer patents deserve broad patent protection and that broad patent protection is required to sufficiently incentivize pioneering innovation. It similarly reflects the understanding that "mere improvements" are less deserving of protection and incentives. This is a practical manifestation of the prior described problem of splitting patent rewards between upstream and downstream innovators.[98] The doctrine of pioneer patents grants greater rewards to pioneering upstream innovators than "mere improving" upstream (or downstream) innovators. Thus, patent scope is adjusted to better reflect fundamental principles of patent theory. The doctrine of pioneer patents is necessary because scope cannot be set accurately at patent grant. Because implementation of this doctrine relies on comparison to an ex post analogue,[99] the pioneer patent adjustment is necessarily done long after patent scope is first set.

b. *The Reverse Doctrine of Equivalents*

The reverse doctrine of equivalents functions, as the name suggests, in reverse to the doctrine of equivalents. When a potential infringer is "within the letter of [the patent's] claims" but has "so far changed the principle of the device that the claims of the patent, literally construed, have ceased to represent his actual invention" the potential infringer is not liable for patent infringement.[100]

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which the pioneer doctrine is still good law is debatable. The Federal Circuit appeared to have overruled it in *Texas Instruments, Inc. v. U.S. Int'l Trade Comm'n*, writing that a patent's "'pioneer' status does not change the way infringement is determined." 846 F.2d 1369, 1370 (Fed. Cir. 1998). However, the pioneer doctrine continues to be used by both the Federal Circuit and lower courts. For an extensive survey of the doctrine, see Brian J. Love, *Interring the Pioneer Invention Doctrine*, 90 N.C. L. REV. 379, 389-404 (2012).

97. However, it has been noted that patent law's conception of pioneering inventions does not always match the social value of an invention. John R. Thomas, *The Question Concerning Patent Law and Pioneer Inventions*, 10 HIGH TECH L.J. 35, 37 (1995).

98. *See supra* Part II.

99. For example, the court in *Hoganas AB v. Dresser Industries, Inc.*, compared the plaintiff's patent to the defendant's product and chose not to expand the scope of the plaintiff's patent to cover the defendant's product because the plaintiff's invention was "only a modest advance . . . and thus [was] not entitled to pioneering status . . . ." 9 F.3d 948, 954 (Fed. Cir. 1993).

100. Westinghouse v. Boyden Power Brake Co., 170 U.S. 537, 568 (1898); *see also* SRI Int'l v. Matsushita Elec. Corp. of America, 591 F.Supp. 464, 468 (N.D. Cal. 1984) ("The law . . . acknowledges that one may only appear to have appropriated the patented contribution, when a product precisely described in a patent claim is in fact 'so far changed in principle' that it performs in a 'substantially different way' and is not therefore an appropriation . . . ."); Karl Bozicevic, *The "Reverse Doctrine of Equivalents" in the World of Reverse Transcriptase*, 71 J. PAT. & TRADEMARK OFF. SOC'Y 353, 361 (1989); William S. Galliani, *Patent Infringement Amidst Rapidly Evolving Technologies: New Equivalents, the Doctrine of Equivalents and the Reverse Doctrine of Equivalents*, 6 SANTA CLARA COMPUTER & HIGH TECH. L.J. 75, 91 (1990); Robert P. Merges, *A Brief Note on Blocking Patents and Reverse Equivalents: Biotechnology as an Example*, 73 J. PAT. &

The reverse doctrine of equivalents "requires that facts specific to the accused device be determined and weighed against the equitable scope of the claims . . . ."[101] The reverse doctrine of equivalents adjusts scope based on an analogue: the allegedly infringing product.

Like the doctrine of equivalents, the reverse doctrine of equivalents is an ex post tool, only applied by the courts when a patent is faced with a potential infringer. Perhaps because it represents such a departure from the principles of patent law, the reverse doctrine is rarely used.[102] The reverse doctrine affects patent scope by narrowing the scope of the patent to exclude certain areas covered by the literal language of the claims when this is merited. The doctrine can provide social value by minimizing the holdup problem[103] in situations where a first patent contributes little value and a second improvement product has contributed significant value.[104] The reverse doctrine thus allows courts to

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TRADEMARK OFF. SOC'Y 878, 892 (1991); Andrew Wasson, *Protecting the Next Small Thing: Nanotechnology and the Reverse Doctrine of Equivalents*, 10 DUKE L. & TECH. REV. 10, 36 (2004).

101. Scripps Clinic & Research Found. v. Genetech, 927 F.2d 1565, 1581 (Fed. Cir. 1991), *overruled on other grounds by* Abbott Laboratories. v. Sandoz, Inc., 566 F.3d 1282 (Fed. Cir. 2009)

102. Merges & Nelson, *supra* note 46, at 864; *see also*, Ethyl Molded Prods. Co. v. Betts Package, Inc., 9 U.S.P.Q.2d 1001, 1026 (E.D. Ky. 1988) ("The reverse doctrine of equivalents, although frequently argued by infringers, has never been applied by the Federal Circuit."); Philips Petroleum Co. v. U.S. Steel Corp., 673 F.Supp. 1278, 1350 (D.Del. 1987). A Westlaw search in 2010 for federal cases containing the terms "reverse doctrine of equivalents" and "patent" turned up only 160 results, most finding against the use of the doctrine. Janet Freilich, *A Nuisance Model for Patent Law*, 2011 U. ILL. J.L. TECH. & POL'Y 329, 346 n. 95 (2011).

103. The holdup problem arises, broadly speaking, "when a gap between economic commitments and subsequent commercial negotiations enables one party to capture part of the fruits of another's investment . . . Hold-up generally leads to economic inefficiency . . . ." Joseph Farrell, John Hayes, Carl Shapiro, & Theresa Sullivan, *Standard Setting, Patents, and Hold-Up*, 74 ANTITRUST L.J 603, 604-05 (2007). Holdup occurs when the owner of a patent behaves in such a way that he opportunistically leverages his right to exclude over another party's actions extract a payment that far exceeds the value of the patent. Christopher M. Newman, *Patent Infringement as Nuisance*, 59 CATH. U.L. REV. 61, 68 (2009); *see also*, Carl Shapiro, *Navigating the Patent Thicket: Cross Licenses, Patent Pools, and Standard Setting*, 1 INNOVATION POLICY AND THE ECONOMY 1, 10 (2001); Thomas F. Cotter, *Patent Holdup, Patent Remedies, and Antitrust Responses*, 34 J. CORP. L. 1151, 1160 (2009); Mark A. Lemley & Carl Shapiro, *Patent Holdup and Royalty Stacking*, 85 TEX. L. REV. 1991, 2003 (2007). Some scholars have argued that holdup behavior may be socially valuable in some circumstances; *see, e.g.*, Einer Elhauge, *Do Patent Holdup and Royalty Stacking Lead to Systematically Excessive Royalties?* 4 J. COMPETITION & ECON. 535, 537 (2008); Damien Geradin, *The Complements Problem Within Standard Setting: Assessing the Evidence on Royalty Stacking*, 14 B.U. J. SCI. & TECH. L. 144, 145 (2008); John M. Golden, *"Patent Trolls" and Patent Remedies*, 85 TEX. L. REV. 2111, 2145-47 (2007); J. Gregory Sidak, *Holdup, Royalty Stacking, and the Presumption of Injunctive Relief for Patent Infringement: A Reply to Lemley and Shapiro*, 92 MINN. L. REV. 714, 718 (2008).

104. Robert Merges, *Intellectual Property Rights and Bargaining Breakdown: The Case of Blocking Patents*, 62 TENN. L. REV. 75, 75 (1994) ("The reverse doctrine can be understood . . . as a judicial response to the likelihood of a breakdown in bargaining between inventors who pioneer a new technology and those who later develop key improvements . . . the reverse doctrine serves as a judicial 'safety valve,' releasing pressure that builds up when pioneers and improvers fail to agree to a license.").

conduct an ex post scope adjustment to ensure that a patent complies with the utilitarian goal of patent law to promote innovation.[105]

The existence of both the doctrine of equivalents and the reverse doctrine of equivalents is evidence that there is large error in the initial scope setting process. The doctrines additionally demonstrate that this error cannot be fixed until the ex post analogues–the potentially infringing products–come into existence.

c. *Claim Construction*[106]

Claim construction is the process by which judges interpret the meaning of terms in a patent claim.[107] Claims are interpreted first by reference to the words of the claims themselves,[108] then by reference to the specification.[109] A patentee may be his own lexicographer, as long as the term is defined in the specification.[110] Courts "should also consider the patent's prosecution history, if it is in evidence."[111] Courts may also consider extrinsic evidence, although this is less relevant.[112]

Claim construction is perhaps the most widely recognized tool for interpreting patent scope.[113] As a theoretical matter, claim construction is

105. *See supra* note 21.

106. Ex post tools are defined earlier in this section as tools that use information available only after patent grant. If claim construction only clarifies claim scope, but does not change it, claim construction should only be using tools available prior to patent grant (namely, the patent itself, the prosecution history, and extrinsic evidence (e.g. dictionaries and treatises)). Phillips v. AWH Corp., 415 F.3d 1303, 1317-19 (Fed. Cir. 2005). Conversely, if claim construction adjusts patent scope, that adjustment is likely made based on the accused product at trial, and thus is based on information that was probably not available at patent grant. Thus, if claim construction is a tool for scope adjustment, it is an ex post tool.

107. *See* Markman v. Westview Instruments, Inc., 517 U.S. 370, 383 (1996) (holding that claim construction is a matter of law).

108. Vitronics Corp. v. Conceptronics, Inc., 90 F.3d 1576, 1582 (Fed. Cir. 1996); *see also*, Bell Commc'n Research, Inc. v. Vitalink Commc'ns Corp., 55 F.3d 615, 620 (Fed. Cir. 1995).

109. Takeda Pharm. Co. v. Zydus Pharms., 743 F.3d 1359, 1363 (Fed. Cir. 2014) ("[I]t is axiomatic that the claims 'must be read in view of the specification, of which they are a part.'") (quoting Phillips v. AWH Corp., 415 F.3d 1303, 1314 (Fed. Cir. 2005)).

110. Hoechst Celanese Corp. v. BP Chems. Ltd., 78 F.3d 1575, 1578 (Fed. Cir. 1996) ("A technical term used in a patent document is interpreted as having the meaning that it would be given by persons experienced in the field of the invention, unless it is apparent from the patent and the prosecution history that the inventor used the term with a different meaning."); Hormone Research Found., Inc. v. Genentech, Inc., 904 F.2d 1558, 1563 (Fed. Cir. 1990) ("It is a well-established axiom in patent law that a patentee is free to be his or her own lexicographer and thus may use terms in a manner contrary to or inconsistent with one or more of their ordinary meanings.").

111. Markman, v. Westview Instruments, Inc., 52 F.3d 967, 980. (Fed. Cir. 1995).

112. Elcommerce.com, Inc. v. SAP AG, 745 F.3d 490, 508 (Fed. Cir. 2014); Helmsderfer v. Bobrick Washroom Equip., Inc., 527 F.3d 1379, 1382 (Fed. Cir. 2008); Finisar Corp. v. DirecTV Grp., Inc., 523 F.3d 1323, 1328 (Fed. Cir. 2008); Metabolite Labs., Inc. v. Lab. Corp. of Am. Holdings, 370 F.3d 1354, 1360 (Fed. Cir. 2004).

113. *See* Chiang, *supra* note 43, at 1105-09 (discussing the use of claim construction as a

supposed to be a tool for *clarifying* patent scope, not adjusting it.[114] However, "[a]s a practical matter, judges occasionally creatively 'interpret' rather than outright invalidate claims to achieve a desired level of scope."[115] Additionally, there is some historical understanding that construing a patent provides opportunities for adjusting patent scope to implement policy goals:

> In administering the patent law the court first looks into the art to find what the real merit of the alleged discovery of invention is and whether it has advanced the art substantially. If it has done so, then the court is liberal in its construction of the patent to secure to the inventor the reward he deserves. If what he has done works only a slight step forward and that which he says is a discovery is on the border line between mere mechanical change and real invention, then his patent, if sustained, will be given a narrow scope and infringement will be found only in approximate copies of the new device.[116]

Certainly claim construction has the potential to be used to alter scope. As explained by Dan Burk and Mark Lemley, "[d]efine an element narrowly—limit it to a single word, say—and you will tend to narrow the resulting patent. By contrast, defining an element broadly tends to broaden the patent."[117] Peter Menell, Matthew Powers, and Steven Carlson have explained that some doctrines of claim construction "tend to narrow claim scope, while others broaden it."[118] To take a specific example, the Federal Circuit construed the term "about 1:5"

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tool to alter claim scope); Peter Lee, *Patent Law and the Two Cultures*, 120 YALE L.J. 2, 29 (2010) (referring to claim construction as "interpreting the meaning and scope of claims."); John R. Thomas, *Claim Re-Construction: The Doctrine of Equivalents in the Post-Markman Era*, 9 LEWIS & CLARK L. REV. 153, 155 (2005) (calling claim construction "a protocol for determining the scope of patent claims."). Claim construction is also widely used. *See* Jeffrey A. Lefstin, *The Measure of Doubt: Dissent, Indeterminacy, and Interpretation at the Federal Circuit*, 58 HASTINGS L.J. 1025, 1071 (2007) (concluding that claim construction was at issue in 51% of Federal Circuit opinions during the period studied).

114. Cimiotti Unhairing Co. v. Am. Fur Ref. Co., 198 U.S. 399, 410 (1905) ("[Courts] may not add to or detract from the claim."); *Markman*, 52 F.3d at 978-79 ("[C]ompetitors should be able to rest assured, if infringement litigation occurs, that a judge, trained in the law, will similarly analyze the text of the patent and its associated public record and apply the established rules of construction, and in that way arrive at the true and consistent scope of the patent owner's rights to be given legal effect."); Scripps Clinic & Research Found. v. Genentech, Inc., 927 F.2d 1565, 1580 (Fed. Cir. 1991) ("[T]he construction of claims is simply a way of elaborating the normally terse claim language: in order to understand and explain, but not to change, the scope of the claims."); Autogiro Co. of Am. v. United States, 384 F.2d 391, 396 (Ct. Cl. 1967) ("Courts can neither broaden nor narrow the claims to give the patentee something different than what he has set forth. No matter how great the temptations of fairness or policy making, courts do not rework claims.").

115. Tun-Jen Chiang, *The Rules and Standards of Patentable Subject Matter*, 2010 WISC. L. REV. 1353, 1371 n.104 (2010); *see also*, R. Polk Wagner & Lee Petherbridge, *Did Phillips Change Anything? Empirical Analysis of the Federal Circuit's Claim Construction Jurisprudence, in* INTELLECTUAL PROPERTY AND THE COMMON LAW 123 (Shyamkrishna Balganesh ed., 2013).

116. Eibel Process Co. v. Minn. & Ont. Paper Co., 261 U.S. 45, 63 (1923).

117. Dan L. Burk & Mark A. Lemley, *Quantum Patent Mechanics*, 9 LEWIS & CLARK L. REV. 29, 29 (2005).

118. Peter S. Menell, Matthew D. Powers, & Steven C. Carlson, *Patent Claim Construction: A Modern Synthesis and Structured Framework*, 25 BERKELEY TECH. L.J. 711, 742 (2010).

(referring to a ratio between two components) to mean "a ratio up to and including 1:7.1 and a ratio down to and including 1:3.6."[119] It is evident that the numbers chosen by the court to fall within the meaning of "about" will determine the scope of the claim.

Even if not deliberately used by courts to alter scope, the difficulties of consistent construction[120] create an opportunity for litigants to opportunistically seek scope refinement.[121] Litigants are incentivized to use claim construction to adjust scope in the manner most advantageous to their respective positions. For example, if it is not clear whether a claim covers the defendant's products, the plaintiff will seek an interpretation that stretches the scope to do so.[122]

Thus, claim construction allows decisions to be made about patent scope through comparison to a potentially infringing product. However, unlike the doctrine of equivalents and reverse doctrine of equivalents, it is less common for claim construction scope decisions to be guided by a purposeful, utilitarian desire to incentivize innovation.

IV. SOLUTIONS FOR COHERENT SCOPE SETTING

In order for a recommendation for patent scope to be implementable, it must account for the sequence-of-information problem. To accomplish this, scope recommendations must move the time at which scope is set and the time at which scope setting information is available closer together.

There are three ways to temporally reconcile scope setting with scope information availability: scope setting can be delayed until scope information is available, the availability of scope information can be improved to be accessible at the time scope is set, or scope can be eliminated entirely. The first two options are depicted diagrammatically:

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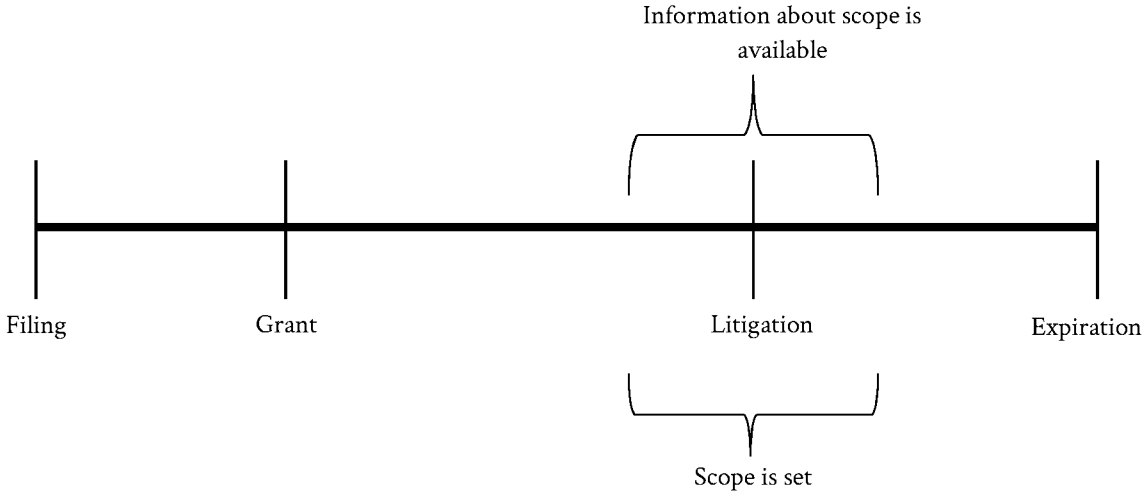
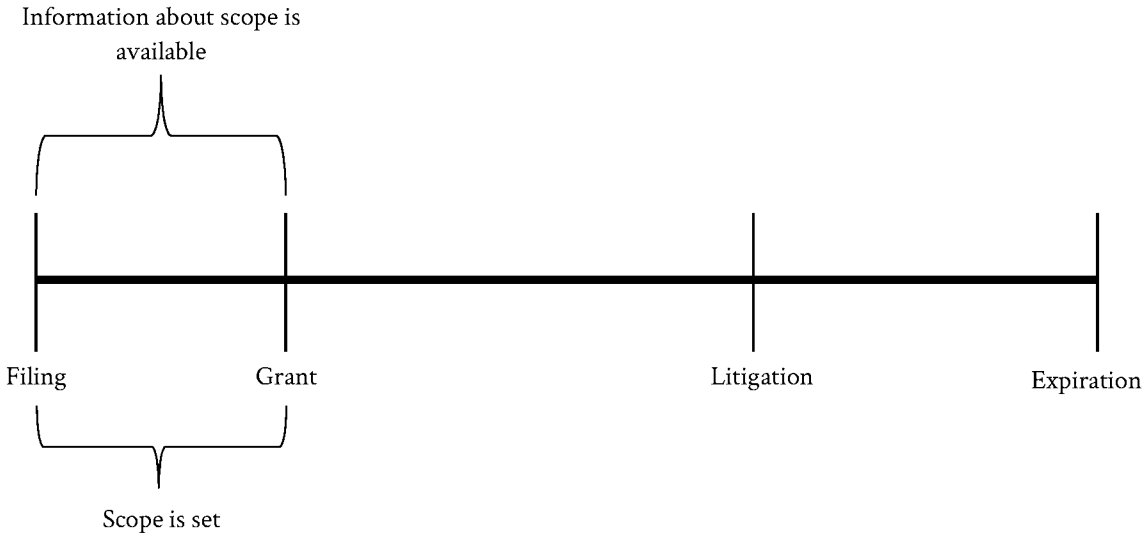
119. Ortho-McNeil Pharm., Inc. v. Caraco Pharm. Labs., Ltd., 476 F.3d 1321, 1326 (Fed. Cir. 2007).

120. *See, e.g.*, Kimberly A. Moore, *Markman Eight Years Later: Is Claim Construction More Predictable?*, 9 LEWIS & CLARK L. REV. 231, 233 (2005) (finding a 34.5% claim construction reversal); Kristen Jakobsen Osenga, *Linguistics and Patent Claim Construction*, 38 RUTGERS L.J. 61, 71 (2006) (discussing "the frequent reversals of district court claim constructions and resultant uncertainty in claim scope . . . .").

121. Christopher A. Cotropia, *Patent Claim Interpretation Methodologies and Their Claim Scope Paradigms*, 47 WM. & MARY L. REV. 49, 99 (2005) ("The discretion left to the courts when approaching claim construction creates an uncertainty itself. Because no statute describes exactly how courts should interpret claims, observers must look to the courts for guidance on interpretation issues. Without clear direction from the courts in the form of a single methodology, one cannot predict a claim's meaning . . . .").

122. Mark A. Lemley, *The Meaning of Claim Terms*, 104 MICH. L. REV. 104, 112 (2005).





The sections below explore a variety of policy options that either reduce or eliminate the sequence-of-information problem. Subpart (A) explores delaying patent scope setting until later inventions have been developed, providing the information necessary to set patent scope. Subpart (B) explores either eliminating or modifying the concept of patent scope in order to remove the need to obtain information to set patent scope. Subpart (C) explores altering the information necessary to set patent scope to that information available at patent grant, so that all essential information is available contemporaneously with patent scope setting.

Most of these solutions have been examined by others, but not in the context of or with full recognition of the sequence-of-information problem. The policies

in the first category, delaying scope setting to a time when information is available, have been recognized to improve scope setting, although at the cost of reducing the notice function of patents.[123] The policies in the second two categories have not formerly been recognized as improving the accuracy of scope setting. Thus, it was previously thought that to improve the accuracy of scope setting, it was necessary to sacrifice notice. As demonstrated in Subpart (B) and (C), that assumption is not true, although other tradeoffs must be made.

This Article does not take a position on which solution is preferred, as each method of reducing the sequence-of-information problem has benefits and detriments and thus the best method will vary in different situations. Rather, the contribution of this Article is to demonstrate that patent policy can avoid the sequence-of-information problem. It is important to highlight many possible solutions because patent policy will benefit by being cognizant of multiple methods, each with their own advantages, by which it is possible to address the sequence-of-information problem.

C. *Delaying Scope Setting*

One method to bring scope setting closer to the time at which relevant information is obtained is to delay scope setting. Patents could either be granted later, after commercial development, or claim scope could be adjusted throughout the life time of the patent.

The idea that granting patents or rewards later in the development process improves the patent system because better information is available is not new. In 1883, R.W. Thomson, the President of the Royal Scottish Society of Arts wrote that

> It would be very easy for a scientific tribunal sitting now to determine the value of inventions which have been in use for a number of years. . .the inventor is simply to register his invention and send it out into the world, letting all who wish bring it into use and work what improvements they please upon it, postponing the reward to the inventor until time has been given to ascertain the value of his invention . . . .[124]

Others have discussed delay more recently.[125] Deferred scope setting reduces

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123. *See, e.g., supra* notes 119-122.

124. R.A. MACFIE, COPYRIGHT AND PATENTS FOR INVENTIONS, 36 (1883).

125. Michael Abramowicz, *Perfecting Patent Prizes*, 56 VAND. L. REV. 115, 176 (2003); Douglas Lichtman, *Substitutes for the Doctrine of Equivalents: A Response to Meurer and Nard*, 93 GEO. L.J. 2013, 2023 (2005) (favoring delayed patent grant, "because patents are both rarely asserted and rarely read, it is probably inefficient to expend significant resources improving patent clarity across the board"). *But see* JAMES BESSEN & MICHAEL J. MEURER, PATENT FAILURE 222 (2008) (criticizing Lichtman's contention that "decisions about patent boundaries are 'better' if made later." "If boundaries set at trial (or on appeal) often depend on newly available information, then it necessarily follows that boundaries will be unclear at an earlier date when the given technology is adopted. Neither the patentee nor potential infringers will have the information required to know exactly how the boundaries will be construed at trial.").

drafting costs for patentees and enables more rational and responsive scope decisions.[126] Tun-Jen Chiang notes the advantages of delayed scope setting when information is scarce:

> Both [Congress and the PTO] must determine patent scope ex ante, and, in the case of Congress, a great deal ex ante through use of blunt legislative rules. This poses a problem given that judges determine scope through ex post adjudication, when more information is available. If, as is almost certainly the case, judges have a difficult time determining optimal scope ex post because of the complexity of the inquiry, then it is almost impossible to imagine how Congress or the PTO will have the capability to determine a method of computing optimal (or at least better) scope ex ante when less information is available.[127]

Delayed scope setting may additionally reduce administrative costs because only a small fraction of patents are relevant ex post, therefore "careful consideration of patent scope" will need to be done for very few patents.[128]

Postponing the time at which scope is set may be most appealing to proponents of cumulative innovation theory, which models innovation as a joint effort between initial innovators and follow-on innovators.[129] Thus, "[w]here innovation is cumulative, patent law must decide how to allocate rights between" these two interests.[130] This allocation is difficult to determine ex ante, prior to the occurrence of the downstream innovation, because the nature and importance of the downstream innovation may vary. However, appropriate allocation can be accomplished with narrow upstream patents (to create room for downstream innovation under all circumstances)[131] accompanied by ex post adjustment.[132] In situations where the incentive needed to create an upstream innovation is very

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126. *See* Jeanne C. Fromer, *Claiming Intellectual Property*, 76 U. CHI. L. REV. 719, 759 (2009) ("[P]ostponing delineation of the extent of the set of protected works under a central claiming regime until adjudication—as with standards in general—typically means less expenditure on claim drafting . . . .").

127. Chiang, *supra* note 43, at 1129.

128. Meurer & Nard, *supra* note 91, at 1953; *see also* Mark A. Lemley, *Rational Ignorance at the Patent Office*, 95 NW. U. L. REV. 1495, 1500-08 (2001). It is not clear that Meurer and Nard are correct in concluding that delayed scope setting reduces administrative costs. Although scope would be set for fewer patents, presumably more patents would be litigated because it would be substantially less clear whether a patent covered a competing product. Moreover, unless patents had no defined scope whatsoever before trial, the Patent and Trademark Office would still need to review patents and set a preliminary scope.

129. *See, e.g.*, Clarisa Long, *Patents and Cumulative Innovation*, 2 WASH. U. J.L. & POL'Y 229 (2000) (exploring cumulative innovation in the biotechnology industry); Suzanne Scotchmer, *Standing on the Shoulders of Giants: Cumulative Research and the Patent Law*, 5 J. ECON. PERSP. 29, 30 (1991).

130. *See, e.g.*, Burk & Lemley, *supra* note 72, at 1583.

131. Arti K. Rai, *Fostering Cumulative Innovation in the Biopharmaceutical Industry: The Role of Patents and Antitrust*, 16 BERKELEY TECH. L.J. 813, 837 (2001). Arti Rai's suggestion applies only to the biopharmaceutical industry, but she notes that it may also be relevant to other industries.

132. Howard F. Chang, *Patent Scope, Antitrust Policy, and Cumulative Innovation*, 26 RAND J. ECON. 34, 34 (1995).

large, and downstream innovations are minor, the upstream patent could, for example, be given expansive equivalents under the doctrine of equivalents.[133]

The disadvantage of all delayed scope setting proposals is a reduction in the notice function of patents. In order to grant patents late enough to obtain substantial scope-setting information, the patent would have to be granted after potentially infringing products had been created. Competitors developing potentially infringing products would likely not be aware of whether a patent covered their product.[134] Not only is this problematic from a notice perspective, it also reduces incentives for follow-on innovation because companies would not know if they could reap the rewards of their innovations.[135]

Various proposals for delayed scope setting are explored below. Note that this is merely a sample, not a comprehensive list.

1. *Registration or "Soft-Look"*

Some scholars have suggested a registration model where patent applications must be registered but are not examined.[136] In this model, the Patent Office would only review patents to ensure that the formalities are properly implemented.[137] Detailed determinations of validity would occur later, during litigation.[138] A weaker version of the proposal recommends that the Patent Office use a "soft-look" approach, conducting only a cursory review for basic validity components.[139] One criticism of these proposals is that the cost of Patent Office examination is a useful screen against low-value patents.[140]

2. *Central Claiming*

An alternative method to delay scope setting is the use of central claiming.

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133. *See, e.g.*, Christopher A. Cotropia, *"After-Arising" Technologies and Tailoring Patent Scope*, 61 NYU ANN. SURV. AM. L. 151, 178-85 (2005).

134. Although it is theoretically possible that a competitor could predict a court's later analysis of a patent and adapt its behavior to reflect the prediction.

135. John F. Duffy, *On Improving the Legal Process of Claim Interpretation: Administrative Alternatives*, 2 WASH. U. J.L. & POL'Y 109, 115 (2000) ("The quality of an authoritative claim interpretation depends not on its fidelity to some abstract ideal of interpretation, but on its *predictability*.").

136. F. Scott Kieff, *The Case for Registering Patents and the Law and Economics of Present Patent-Obtaining Rules*, 45 B.C. L. REV. 55, 74 (2003); Adam Mossoff, *Who Cares What Thomas Jefferson Thought About Patents? Reevaluating the Patent "Privilege" in Historical Context*, 92 CORNELL L. REV. 953, 999 n.219 (2007).

137. R. Polk Wagner, *Understanding Patent-Quality Mechanisms*, 157 U. PA. L. REV. 2135, 2162 (2009).

138. Kieff, *supra* note 136, at 72.

139. Wagner, *supra* note 137, at 2162.

140. *See, e.g.*, David Fagundes & Jonathan S. Masur, *Costly Intellectual Property*, 65 VAND. L. REV. 677, 690-91 (2012).

Currently, patent claiming is "peripheral," meaning that the claims set the outer boundaries of the patent right.[141] However, historically patents used a system of "central" claiming,[142] and the concept is now back in vogue in the patent literature.[143] Central claiming requires the patent to describe a "central" set of embodiments that courts then use during litigation to assess whether similar products should fall within the patent right.[144] This permits delayed scope setting.

3. *Expanded Use of the Doctrine of Equivalents or Claim Construction*

The doctrine of equivalents, which also permits delayed scope setting, grew out of the fading practice of central claiming.[145] A milder method to delay setting patent scope is to allow the adjustment or clarification of patent scope in litigation based on policy considerations. This describes our current system, as patent scope may be adjusted during litigation using the doctrine of equivalents.[146] Some scholars endorse increased use of the doctrine of equivalents and use of claim construction during litigation to adjust patent scope, precisely because more information is available at that stage. For example, Meurer and Nard recommend that "courts should be allowed to expand claim scope at trial because the passage of time and the adversarial nature of the proceeding gives them better information than the earlier ex parte proceeding at the PTO."[147] At present, use

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141. J. Dennis Malone & Richard L. Schmalz, *Peripheral Definition Theory v. Central Definition Theory in Patent Claim Interpretation: A Survey of the Federal Circuits*, 32 GEO. WASH. L. REV. 609, 610 (1964). *See also* John M. Golden, *Construing Patent Claims According to Their "Interpretive Community": A Call for an Attorney-Plus-Artisan Perspective*, 21 HARV. J.L. & TECH. 322, 348-50 (2008).

142. The Patent Act of 1790 did not require peripheral claims. *See also* Karl B. Lutz, *Evolution of the Claims of U.S. Patents*, 20 J. PAT. OFF. SOC'Y 134, 140 (1938).

143. *See* J. Jonas Anderson & Peter S. Menell, *Informal Deference: A Historical, Empirical, and Normative Analysis of Patent Claim Construction*, 108 NW. U. L. REV. 1, 11-14 (2014); Kevin Emerson Collins, *Patent Law's Functionality Malfunction and the Problem of Overbroad, Functional Software Patents*, 90 Wash. U. L. Rev. 1399, 1408 (2013); Fromer, *supra* note 126. *See generally* Dan L. Burk & Mark A. Lemley, *Fence Posts or Sign Posts? Rethinking Patent Claim Construction?*, 157 U. PA. L. REV. 1743 (2009) (calling for a return to central claiming).

144. Fromer, *supra* note 126, at 726-27 ("[O]ne might publicly describe only some members of the set, which are clearly protected under the right, and use them to determine whether other items are similar enough to the enumerated members to fall also within the same right. This sort of claiming is known as central claiming, in that the rightsholder describes the central, or prototypical, set members, but the right tends to cover a broader, similar set of items.").

145. *Id.* at 735.

146. *See, e.g.*, Meurer & Nard, *supra* note 91, at 1948-49; David L. Schwartz, *Explaining the Demise of the Doctrine of Equivalents*, 26 BERKELEY TECH. L.J. 1157, 1176 (2011).

147. Meurer & Nard, *supra* note 91, at 1953 n.27; *see also* Douglas Lichtman, *Rethinking Prosecution History Estoppel*, 71 U. CHI. L. REV. 151, 154 n.19 (2004). Meurer and Nard further argue that only a small fraction of patents are relevant, therefore delaying "careful consideration of patent scope" reduces administrative costs because so few patents must be addressed." Meurer & Nard, *supra* note 91, at 1953 n.27

of the doctrine of equivalents is relatively rare and thus most patents are read literally.[148]

Delayed scope setting tools are designed to permit adjustment that reflects contribution by after-arising technologies. For example, the Federal Circuit has stated that a "primary justification for the doctrine of equivalents is to accommodate after-arising technologies"[149] and has called later-occurring technologies "the quintessential example of an enforceable equivalent."[150]

Claim construction could also be used as an ex post tool to adjust patent scope after development of follow-on technologies (although it is not—consciously—used this way at present).[151] For example, interpreting claims during litigation using the present-day meaning of a term can allow patents to cover later-developed technologies, which may be valuable "particularly for pioneering inventions at an early stage in the development of a technology."[152]

D. *Eliminating or Altering Patent Scope*

Scope setting is challenging because it requires knowledge of later occurring events. Scope is, at present, a fundamental aspect of our patent system, but the patent system could, if significantly altered, remove the problem of scope setting by either eliminating patent scope or significantly changing how we conceive of patent scope.

4. *Scope Defined by Profit*

A seminal article on patent scope, Richard Gilbert and Carl Shapiro's *Optimal*

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148. John R. Allison & Mark A. Lemley, *The (Unnoticed) Demise of the Doctrine of Equivalents*, 59 STAN. L. REV. 955, 958 (2007) ("[T]he doctrine of equivalents was already near death by the late 1990s. Even under the relatively permissive doctrine of equivalents rules in place before 2000, equivalents claims usually failed, most often on summary judgment."); *see also* Lee Petherbridge, *On the Decline of the Doctrine of Equivalents*, 31 CARDOZO L. REV. 1371 (2010); Schwartz, *supra* note 146, at 1157.

149. *Festo* Corp. v. Shoketsu Kinzoku Kogyo Kabushiki Co., 234 F.3d 558, 619 (Rader, J., concurring in part, dissenting in part). However, this represents only the modern view of the doctrine of equivalents. Historically, its rationale was fairness. *See* Tex. Instruments Inc. v. U.S. Int'l Trade Comm'n, 988 F.2d 1165, 1173 (Fed. Cir. 1993) ("[T]he doctrine of equivalents has been 'judicially devised to do equity' . . . ."); Mark A. Lemley, *The Economics of Improvement in Intellectual Property Law*, 75 TEX. L. REV. 989, 1003 (1997).

150. Smithkline Beecham Corp. v. Excel Pharm., Inc., 356 F.3d 1357, 1364 (Fed. Cir. 2004); *see also* Glaxo Welcome, Inc. v. Impax Labs. Inc., 356 F.3d 1348, 1354 (Fed. Cir. 2004).

151. Chiang, *supra* note 24, at 1130-31.

152. *See* Lemley, *supra* note 13 at 120. Lemley concludes that, although "[t]he protection provided by a patent may be hollow if it does not confer the ability to prevent logical applications of the principle of the invention to new and unforeseen circumstances . . . [p]atentees can use the doctrine of equivalents to reach such technologies," negating the need to use claim construction for purposeful alteration in scope.

Patent Length and Breadth,[153] defines patent breadth as "the flow rate of profits, π, available to the patentee while the patent is in force."[154] Gilbert and Shapiro recognize that "'breadth' can mean many different things" but defend their simplified model because "any definition of breadth involves the idea that a broader patent allows the innovator to earn a higher flow rate of profits during the lifetime of the patent."[155] Simplifying further, patent breadth could be defined as synonymous with value.

If this were the case, scope could be set at an appropriate level ex ante that was commensurate with empirical data on incentives to innovate. For example, scope might be set at $1 million, or 150% of research and development costs. Patentees might then keep a record of all profits earned from an invention, and, when profits reached the set level, the patent would expire. Maximum patent length could remain at today's levels.

Under such a system, patentees could choose to write their claims broadly or narrowly ex ante (within the limits of standard patent doctrines such as enablement, novelty, and nonobviousness) and no changes to scope would occur after patent grant. If the patentee drafted a broad claim, and obtained a broader monopoly, he might increase profits, and therefore the patent would expire sooner. A narrow patent might face more competition and draw lower profits, and therefore expire later.

There are obvious administrative difficulties with this scheme,[156] and some will find it inherently distasteful because it does not allow for higher rewards for the most valuable inventions.

1. *Prizes: A Way to Eliminate Scope*

A more established proposal that drastically changes our conception of patent scope is the use of prizes to reward innovation.[157] Prizes provide a monetary reward for innovation and then place the innovation in the public domain.[158]

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153. Richard Gilbert & Carl Shapiro, *Optimal Patent Length and Breadth*, 21 RAND J. ECON. 106, 107 (1990).

154. *Id.*

155. *Id.*

156. For example, determining research and development costs, tracking profits accurately, and finding a level of compensation that all parties involved in setting patent policy can agree on.

157. I include in this discussion the related proposal of "patent buyouts" wherein the government purchases patents at an auction. *See, e.g.*, Michael Kremer, *Patent Buyouts: A Mechanism for Encouraging Innovation*, 113 Q. J. ECON. 1137 (1998). The concepts discussed in relation to patent prizes are equally applicable to patent buyouts.

158. Scholars envision systems with many variations on this theme. *See, e.g.*, Steve P. Calandrillo, *An Economic Analysis of Property Rights in Information: Justifications and Problems of Exclusive Rights, Incentives to Generate Information, and the Alternative of a Government-Run Reward System*, 9 FORDHAM INTELL. PROP. MEDIA & ENT. L.J. 301 (1998); Robert C. Guell & Marvin Fischbaum, *Toward Allocative Efficiency in the Prescription Drug Industry*, 73 MILBANK Q. 213

Once the reward has been provided, the scope of the innovation is irrelevant, because it is in the public domain. As a result, there is no notice problem because potential competitors need no notice. Ex post changes to the size of the prize[159] are similarly not a problem from a notice perspective because they do not create uncertainty about whether the later innovation infringes.

There are a number of criticisms of prize proposals, which have been well established by others.[160] From the perspective of this Article, the most important problem is that most schemes for innovation prizes call for a dual prize-patent system, where innovators have the option to choose between prizes and patents.[161] In these schemes, patents still exist, and thus patent scope must still be set. The number of patents may be reduced, but the sequence-of-information problem is no less problematic for those that remain.[162]

A. *Advancing Information for Scope Setting*

A third solution to the sequence-of-information problem is to set scope using information available early in the patenting process, thereby moving the time at which scope-setting information can be obtained closer to the time at which scope is set. Scope can be accurately set ex ante if one of two conditions is met: the scope is known ex ante, or downstream innovation is so predictable that scope can be anticipated ex ante. At present, scope is difficult to know ex ante because patents cover somewhat more than the invention actually created by the patentee and difficult to predict ex ante because a patent's scope by definition covers a novel invention, therefore prediction cannot be based on past information. There are mechanisms to reduce these difficulties, but they are not presently recognized as such in the prior literature. I explore these mechanisms below.

(1995); Hugo Hopenhayn et al., *Rewarding Sequential Innovators: Prizes, Patents, and Buyouts*, 114 J. POL. ECON. 1041 (2006); James Love and Tim Hubbard, *The Big Idea: Prizes to Stimulate R&D for New Medicines*, 82 CHI.-KENT L. REV. 1519 (2007); Steven Shavell & Tanguy van Ypersele, *Rewards Versus Intellectual Property Rights*, 44 J.L. & ECON. 525 (2001); Marlynn Wei, *Should Prizes Replace Patents? A Critique of the Medical Innovation Prize Act of 2005*, 13 B.U. J. SCI. & TECH. L. 25 (2007); Brian D. Wright, *The Economics of Invention Incentives: Patents, Prizes, and Research Contracts*, 73 AM. ECON. REV. 691 (1983).

159. Some proposals for patent prizes allow the government to supplement rewards over time to reflect use or sales information about the product. *See, e.g.*, Abramowicz, *supra* note 125, at 7-8 (advocating for delay in granting prizes to "subject[] claimants to the test of time" and "prevent[] prize applicants from being influenced by the identity and idiosyncratic preferences of those granting the rewards"); Shavell, *supra* note 158, at 542 ("It would be a gross mistake to envision the reward as having to be premised on the government's estimate of valuation at the time an innovation is registered.").

160. *See, e.g.*, Abramowicz, *supra* note 125, at 40-66; F. Scott Kieff, *Property Rights and Property Rules for Commercializing Inventions*, 85 MINN. L. REV. 697, 705-17 (2001); Arti K. Rai, *The Information Revolution Reaches Pharmaceuticals: Balancing Innovation Incentives, Cost, and Access in the Post-Genomic Era*, 2001 U. ILL. L. REV. 173, 198-202 (2001).

161. Shavell, *supra* note 158, at 527.

162. Abramowicz, *supra* note 125, at 6.

1. *Narrowing Patents*

If the patent grant is limited to the actual invention in the possession of the inventor at the time the patent is filed, all information about the patent grant is already known; therefore, there is less guesswork involved in determining the scope of the patent. This is in contrast with the current practice of granting the patentee some additional scope beyond the invention described in the patent's specification.[163] Narrowing patent scope can help solve the sequence-of-information problem.

The reason that restricting patent scope to a narrow range increases ex ante knowledge of scope is that there is more information available defining the narrow end of the scope spectrum than the broad end.[164] The narrowest scope of a patent is the precise invention as described in detail in the specification, including the exact method of making the invention, and perhaps even down to the color of the invention. The patentee will usually be in possession of this information. Narrow scope, thus, can be defined ex ante, because it consists of precisely what has already been invented.

Broad scope, by contrast, is defined only ex post, because broad patents encompass later-developed inventions. As patent scope gets broader, it at some point moves beyond the information possessed by the inventor. Any scope beyond this point will necessarily be less well defined or understood than scope consisting of information possessed by the inventor.

Broad scope is not only less predictable than narrow scope, it is also less concrete. The concreteness of scope declines with breadth because scope moves from the realm of products to the realm of ideas. While it is possible to write a patent claim that is closer to an idea than to a product or process, it is not possible to file an infringement suit on an idea if that idea does not manifest as a product or method of creating or using a product.[165] Put another way, it is possible for a patent to describe an idea without implementation, and for implementation of that idea to be infringing, but it does not work in the reverse: a mere idea, without implementation, cannot infringe a patent. Thus, the application of patent scope to a potentially infringing product requires more interpretation, and is therefore more vague and creates more room for error, if the scope extends into the realm of ideas.

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163. Bernard Chao, *The Infringement Continuum*, 35 Cardozo L. Rev. 1359, 1360-61 (2014).

164. The exception being extraordinarily broad patents. A patent so broad that it covered everything would have an easy to determine scope.

165. How would one enforce an injunction on use of an idea that did not manifest as a product? How would one calculate damages on use of an idea if it was not connected to a product? In the context of enablement, Tun-Jen Chiang explains that, "the 'invention' being referenced is a physical thing or process, since intangible ideas cannot be made, nor even 'used' in an observable manner." Chiang, *supra* note 117, at 1365. This principle applies equally well to infringement: the act of infringement involves making or using a tangible thing, process, or method. Another way to infringe is to sell or offer for sale. It is possible, of course, to sell ideas, but this is typically seen as a copyright violation, not a patent violation.

Scholars have proposed various methods of narrowing patents, generally achieved through strict use of the enablement and written description requirements.[166] The precise implementation strategy is beyond the scope of this Article. Instead, the contribution of this Article is the recognition that, at the narrow end of the scope spectrum, we possess better scope information. Note that the major criticism of proposals for narrowing patents is that overly narrow patents will reduce incentives for innovation,[167] although some models suggest that it may be possible to compensate for reduced incentives for innovation by lengthening the patent term.[168]

2. *Industry Specific Monopolies*

A second method to set scope ex ante is through use of a different source of scope information than those explored thus far: industry specific information. In certain very limited situations, the form in which downstream innovation will occur is so predictable that it is essentially known at the time of patent grant, even though it has not yet occurred. Thus, the sequence-of-innovation problem is minimized in these situations, because the shape of downstream innovation can be predicted with reasonable accuracy. As discussed below, there are current policies in place that use industry-specific information, but these policies have not been recognized as setting accurate and predictable scope. This Article adds to the literature by demonstrating how these policies use industry-specific information to reduce the sequence-of-information problem.

The sequence-of-information problem arises because the shape of downstream innovation is not known when the patent is filed. In highly regulated industries, downstream innovation is closely controlled; therefore, the shape of downstream innovation *is* known when the patent is filed. For example, in the pharmaceutical industry, competition on a patented invention will almost certainly come from generic companies. Generic companies do not have to copy the brand name company's product exactly—they can make minor changes—but the FDA only allows generic companies to make changes in a small number of categories.[169] Thus, it is highly likely that downstream innovation on the

166. *See, e.g.*, Alison E. Cantor, *Using the Written Description and Enablement Requirements to Limit Biotechnology Patents*, 14 HARV. J.L. & TECH. 267, 290 (2000); Janice M. Mueller, *The Evolving Application of the Written Description Requirement to Biotechnological Inventions*, 13 BERKELEY TECH. L.J. 615 (1998); Sean B. Seymore, *Heightened Enablement in the Unpredictable Arts*, 56 UCLA L. REV. 127, 154 (2008); Emanuel Vacchiano, *It's a Wonderful Genome: The Written-Description Requirement Protects the Human Genome From Overly-Broad Patents*, 32 J. MARSHALL L. REV. 805, 808 (1999).

167. *E.g.*, Scotchmer, *supra* note 129, at 30.

168. Nancy T. Gallini, *Patent Policy and Costly Imitation*, 23 RAND J. ECON. 52, 53 (1992) (explaining the problems with models presented in the prior literature finding that narrow, infinitely long patents are optimal).

169. Janet Freilich, *The Paradox of Legal Equivalents and Scientific Equivalence: Reconciling Patent Law's Doctrine of Equivalents With the FDA's Bioequivalence Requirement*, 66 S.M.U. L. REV.

patented product will take the form of a change in one of those small numbers of categories.

As a result, industry specific monopolies in highly regulated industries can provide protection with a scope that is well defined ex ante. These monopolies can be predictable even though they are "broad" in the sense that they can extend beyond the exact information possessed by the inventor.

Downstream innovation is easiest to predict through use of industry specific information in industries that are highly regulated. Fortunately, highly regulated industries also tend to be industries where monopoly protection is necessary to provide incentives to innovate. The overlap between highly regulated industries and industries where patents are agreed to be both beneficial and necessary for innovation (primarily the biomedical industries) occurs in large part because the need for strong patent protection results from regulation: regulation increases research and development costs, and thus requires increased incentives to innovate. For example, developing a new pharmaceutical drug has been estimated to cost close to a billion dollars, and much of that cost is spent on satisfying the FDA's clinical trial requirements.[170] Regulation also increases the time it takes for products to get to market, which necessitates early investment in research and development, increasing the expense and risk.

There is a plethora of recent scholarship assessing whether differential creation or application of patent rules to different industries in various contexts would be advantageous.[171] The scholarship agrees that industry specific rules are

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59, 73 (2013).

170. Rebecca Eisenberg, *Patents, Product Exclusivity, and Information Dissemination: How Law Directs Biopharmaceutical Research and Development*, 72 FORDHAM L. REV. 477, 481 (2003); *see also*, Ceci Connolly, *Price Tag for a New Drug: 802 Million*, WASH. POST, Dec. 1, 2001, A10, https://www.washingtonpost.com/archive/politics/2001/12/01/price-tag-for-a-new-drug-802-million/23c367a3-9efd-46f2-b669-ddfe79d15f51/ [https://perma.cc/ZE6G-G8KK] (reporting that research and development costs for a new drug were $802 million in the 1990s).

171. Burk & Lemley, *supra* note 30, at 1577-79 ("[C]loser examination of patent law demonstrates that it is unified only in concept. In practice the rules actually applied to different industries [by the courts] increasingly diverge . . . concerns about rent seeking and the inability of industry specific statutes to respond to changing circumstances lead us to conclude . . . that we should not jettison our nominally uniform patent system in favor of specific statutes that protect particular industries."); Martin Campbell-Kelly, *Not All Bad: A Historical Perspective on Software Patents*, 11 MICH. TELECOMM. & TECH. L. REV. 191, 195 (2005) (concluding that, over time, patents will benefit the software industry); Julie E. Cohen & Mark A. Lemley, *Patent Scope and Innovation in the Software Industry*, 89 CAL. L. REV. 1, 8 (2001) ("[W]e conclude that . . . issued software patents may enjoy very broad scope. The rapid rise of software patents thus affords an opportunity to test an important theoretical model, and to consider whether it is the right one for this industry . . . we contend that it is not, and that courts should be careful to restrict the scope of software patents so that innovation will not suffer."); Rai, *supra* note 131, at 837 ("I would argue that because the language of the patent statute is broad, and because patents play such different roles in different industries, courts can, and should, develop a federal common law of patents that is tailored to the economic realities of different industries."); *see also* Russell Moy, *A Case Against Software Patents*, 17 SANTA CLARA HIGH TECH. L.J. 67 (2000); James Bessen, *A Generation of Software Patents*, 18 B.U. J. SCI. & TECH. L. 241 (2012); Brian C.

difficult to implement because of concerns about (1) line-drawing,[172] (2) administrative difficulties, (3) quick obsolescence of rules, and (4) the government's inability to obtain sufficient information to properly design industry specific rules.[173]

These problems can be avoided, but only if use of industry-specific scope rules is restricted to industries where innovation is strictly regulated. With respect to concerns about line-drawing and administrative difficulties, agencies overseeing highly regulated industries will generally already have mechanisms for line drawing and administration, because the agency must already determine whom to regulate.[174] With respect to obsolescence, the concern is that, because government regulation is notoriously slow moving, industry specific regulation will always trail the need for it.[175] The rate of change and type of change in highly

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Cannon, *Toward a Clear Standard of Obviousness for Biotechnology Patents*, 79 CORNELL L. REV. 735 (1994); Cantor, *supra* note 166; Colleen Chien, *Reforming Software Patents*, 50 HOUS. L. REV. 325 (2012); Andrew Chin, *Computational Complexity and the Scope of Software Patents*, 39 JURIMETRICS J. 17 (1998); John M. Conley & Roberte Makowski, *Back to the Future: Rethinking the Product of Nature Doctrine as a Barrier to Biotechnology Patents, (Part 1)*, 85 J. PAT. & TRADEMARK OFF. SOC'Y 301 (2003); Michael A. Heller and Rebecca S. Eisenberg, *Can Patents Deter Innovation? The Anticommons in Biomedical Research*, 280 SCI. 698 (1998); David Kelly, *The Federal Circuit Transforms the Written Description Requirement into a Biotech-Specific Hurdle to Obtaining Patent Protection for Biotechnology Patents*, 13 ALB. L.J. SCI. & TECH. 249 (2003); Anna Bartow Laakmann, *Restoring the Genetic Commons: A "Common Sense" Approach to Biotechnology Patents in the Wake of KSR v. Teleflex*, 14 MICH. TELECOMM. & TECH. L. REV. 43 (2007); Mark A. Lemley, *Software Patents and the Return of Functional Claiming*, 2013 WIS. L. REV. 905 (2013); Michael S. Mireles, *An Examination of Patents, Licensing, Research Tools, and the Tragedy of the Anticommons in Biotechnology Innovation*, 38 U. MICH. J.L. REFORM 141 (2005); Robert E. Thomas, *Debugging Software Patents: Increasing Innovation and Reducing Uncertainty in the Judicial Reform of Software Patent Law*, 25 SANTA CLARA HIGH TECH. L.J. 191 (2008); Grant C. Yang, *The Continuing Debate of Software Patents and the Open Source Movement*, 13 TEX. INTELL. PROP. L.J. 171 (2005).

172. Patentees with an invention on the margin between two industries will have an incentive to game the system by angling for the industry that provides more favorable patent scope.

173. Benjamin Roin, *The Case for Tailoring Patent Awards Based on Time-to-Market*, 61 UCLA L. REV. 672, 681 (2014).

174. For example, the FDA has developed well-established procedures for distinguishing between small molecule drugs, biologics, medical devices, and combination products, because each type of product has its own regulatory scheme and is evaluated by a different center within the FDA. 21 C.F.R. § 3.4(a) ("To designate the agency component with primary jurisdiction for the premarket review and regulation of a combination product, the agency shall determine the primary mode of action of the product . . . ."). While there may appear to be clear differences between drugs and devices, many products can reasonably be classified as either. For example, some intra-uterine devices, despite the name, are classified as drugs (note that the intra-uterine devices in question were approved prior to the formation of the Office of Combination Products, and would likely otherwise have been classified as combination products) while some topical creams are classified as devices. Burgunda V. Sweet, Ann K. Schwemm, and Dawn M. Parsons, *Review of the Processes for FDA Oversight of Drugs, Medical Devices, and Combination Products*, 17 J. MANAGED CARE PHARMACY 40, 45-46 (2011).

175. The oft-cited example of this problem is the Semiconductor Chip Protection Act of 1984, a sui generis form of protection for semiconductor chips. 17 U.S.C. §§ 901-914 (2013). Though the Act was long sought by innovators to prevent piracy, by the time of its passage,

regulated industries is already limited by the regulatory framework. There is no reason to think that monopoly scope statutes or regulations would change any less quickly than other statutes or regulations, so scope rules need not fear being left behind as the industry evolves.

With respect to the government's inability to obtain sufficient information to properly design industry specific rules, this concern is negated in three ways in highly regulated industries. First, the agency is more likely to have detailed information about the industry. Second, the ways in which innovation can occur are likely to be constrained, making it easier to study incentives for innovation. Finally, highly regulated industries are more likely to be characterized by interest groups representing players in the industry with an incentive to gather information and provide it to the agency. Thus, many of the challenges of industry specific regulation of patents do not apply to this solution to the sequence-of-information problem. However, the downside to this solution is that it necessarily only applies in a narrow set of circumstances.

d. *Non-Patent Monopolies*

What would industry specific monopolies with a clearly defined scope look like? As an initial matter, industry specific monopolies need not be patents. A well-known example of defined monopoly scope obtainable through industry specific protection is the FDA's exclusivity rules for pharmaceutical drugs.[176] Patent protection alone does not always provide sufficient incentive for innovation in the pharmaceutical industry.[177] The FDA therefore administers a variety of other types of monopolies, one of which is "marketing exclusivity"[178]

technology had moved on, rendering the Act obsolete. For an overview of the Semiconductor Chip Protection Act, see Jay A. Erstling, *The Semiconductor Chip Protection Act and its Impact on the International Protection of Chip Designs*, 15 RUTGERS COMPUTER & TECH. L.J. 303, 315 (1989); Steven P. Kasch, *The Semiconductor Chip Protection Act: Past, Present, and Future*, 7 HIGH TECH. L.J. 71, 74-78 (1992); Charles R. McManis, *International Protection for Semiconductor Chip Designs and the Standard of Judicial Review of Presidential Proclamations Issued Pursuant to the Semiconductor Chip Protection Act of 1984*, 22 GEO. WASH. J. INT'L L. & ECON. 331, 333 (1988); Leon Radmosky, *Sixteen Years After the Passage of the U.S. Semiconductor Chip Protection Act: Is International Protection Working?*, 15 BERKELEY TECH. L. J. 1049, 1076-85 (2000); John G. Rauch, *The Realities of our Times: The Semiconductor Chip Protection Act of 1984 and the Evolution of the Semiconductor Industry*, 3 FORDHAM INTELL. PROP. MEDIA & ENT. L.J. 403, 420-27 (1993). For an article explaining the failure of the Act, *see, e.g.*, Robert L. Risberg, *Five Years Without Infringement Litigation Under the Semiconductor Chip Protection Act: Unmasking the Specter of Chip Piracy in an Era of Diverse and Incompatible Process Technologies*, 1990 WIS. L. REV. 241, 243-44 (1990).

176. The FDA also provides certain types of exclusivity for biologics and medical devices.

177. Rebecca S. Eisenberg, *The Role of the FDA in Innovation Policy*, 13 MICH. TELECOMM. & TECH. L. REV. 345, 348 (2007) ("Although the pharmaceutical industry has long been famously dependent upon patents, the term of patent protection is far from optimal for the purpose of securing rents from sales of patented drugs.").

178. Marketing exclusivity comes in several other flavors, including protection for orphan drugs, changes that require new clinical trials, conducting pediatric trials, and provisions for biologics.

for new chemical entities.[179] This monopoly power bars the FDA from accepting certain types of applications for drug products containing the protected new chemical entity for five years. The effect of this provision is that the protected new chemical entity may not be used in other drugs, even if these other drugs are intended to treat a condition different from the one targeted by the monopoly holder.[180]

The monopoly extends beyond the information in the possession of the monopoly holder. The monopoly holder possesses the information that the drug can be used to treat one condition, but many drugs can be used to treat multiple conditions,[181] and the monopoly-holder is likely unaware of the full panoply of uses for the drug. Nevertheless, these additional uses are part of the monopoly.[182] The monopoly is therefore slightly broader than the information possessed by the monopoly owner, because the monopoly owner may not be aware that the drug can be used to treat a different condition.

The scope of the monopoly is clear and easily understood by potential competitors, and can be implemented at a consistent breadth across many monopoly owners. As a result, it is amenable to study,[183] and can be refined based on empirical information about its effects on innovation.[184]

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179. 21 U.S.C. § 355(j)(5)(F)(ii) (2013).

180. Elizabeth H. Dickinson, *FDA's Role in Making Exclusivity Determinations*, 54 FOOD & DRUG L.J. 195, 200 (1999).

181. Benjamin N. Roin, *Solving the Problem of New Uses*, MICH. ST. L. REV. (forthcoming 2014).

182. Like a patent monopoly, this monopoly is a right to *exclude*, not a right to *use*. The monopoly-holder has no right to use the drug to treat other conditions, and is in fact precluded from doing so unless appropriate clinical studies are conducted.

183. *See, e.g.*, Carolyn H. Asbury, *The Orphan Drug Act: The First 7 Years*, 265 JAMA 893, 897 (1991) (concluding that the Orphan Drug Act stimulated development of drugs that would otherwise not have been developed, but that it had unintended costs to patients); Gregory J. Glover, *The Influence of Market Exclusivity on Drug Availability and Medical Innovations*, 9 THE AAPS J. E312, E312 (2007) (exploring the effects of patent law and market exclusivity provisions on biomedical research); Henry G. Grabowski and Margaret K. Kyle, *Generic Competition and Market Exclusivity Periods in Pharmaceuticals*, 28 MANAGERIAL AND DECISION ECON., 491, 501 (2007) (finding that generic challenges to blockbuster drugs have reduced their effective exclusivity period); Marlene E. Haffner et al., *Two Decades of Orphan Product Development*, 1 NATURE REVIEWS DRUG DISCOVERY 821, 824 (2002) (calling the Orphan Drug Act "one of the most successful health-care laws" because it stimulated the development of hundreds of new drugs); Aaron S. Kesselheim, *Using Market-Exclusivity Incentives to Promote Pharmaceutical Innovation*, 363 NEW ENG. J. MED. 1855, 1860 (2010) (recommending that market exclusivity provisions be better tailored to encourage investment in drug research and account for public health outcomes); Jennifer S. Li et al., *Economic Return of Clinical Trials Performed Under the Pediatric Exclusivity Program*, 297 JAMA 480, 484 (2007) (finding that the net economic return of pediatric trials performed under the pediatric exclusivity program ranged from $8.9 million to $507.9 million).

184. For example, certain loopholes were eliminated in the Medicare Prescription Drug, Improvement, and Modernization Act of 2003, Pub. L. No. 108-173, 117 Stat. 2066. *See, e.g.*, Matthew Avery, *Continuing Abuse of the Hatch-Waxman Act by Pharmaceutical Patent Holders and the Failure of the 2003 Amendments*, 60 HASTINGS L.J. 171, 184 (2008); Stephanie Greene, *A*

Industry specific information is also used to shape non-patent innovation incentives outside the biopharmaceutical industry. For example, in the nuclear weapons industry, the government has very good information about the size of the potential market for the innovation and any competitors working on downstream innovation.

Patents on nuclear weapons are forbidden by statute,[185] in the interest of national security.[186] Inventors of nuclear technology are promised "just compensation"[187] which is granted by a Patent Compensation Board.[188] The Patent Compensation Board determines a "reasonable royalty" for use that would be infringing were the invention patented,[189] although these "reasonable royalties" have been criticized as insufficient.[190] While the rules in this industry are set primarily to protect national security rather than incentivize innovation, it is an example of an industry with the administrative capability and knowledge to administer a quasi-patent system (in this case rewards rather than monopolies).

Prescription for Change: How the Medicare Act Revises Hatch-Waxman to Speed Market Entry of Generic Drugs, 30 J. CORP. L. 309, 334 (2005).

185. 42 U.S.C. § 2181 (2013) ("No patent shall hereafter be granted for any invention or discovery which is useful solely in the utilization of special nuclear material or atomic energy in an atomic weapon. Any patent granted for any such invention or discovery is revoked, and just compensation shall be made therefor."). For an overview of the patent provisions of the Atomic Energy Act, see Stefan A. Riesenfeld, *Patent Protection and Atomic Energy Legislation*, 46 CAL. L. REV. 40, 45-50 (1958) (providing a summary of the legislative history of the Atomic Energy Act).

186. Casper W. Ooms, *The Patent Provisions of the Atomic Energy Act*, 15 U. CHI. L. REV. 822, 825 (1948) ("The purpose of these provisions, wrought at a time when most nations were sincerely concerned with a vigorous attempt to fashion acceptable international control of atomic weapons, was obvious. Congress became convinced of the need for this exceptional treatment in an extended debate in which it considered the extraordinary problems which the military potentialities of atomic energy created, the indispensability of assurance that a weapon of this terrific character would remain under government control, the need for responsible administration of the entire field of atomic energy, military and industrial, and the necessity for the greatest possible secrecy of operations . . . [this] meant a corresponding prohibition to the community at large of the exercise of traditional property rights within the proscribed field.").

187. *Id.*

188. 42 U.S.C. § 2187(a) (2013).

189. 42 U.S.C. § 2187(c) (2013). Factors determining the reasonable royalty include "(A) the advice of the Patent Compensation Board; (B) any defense, general or special, that might be pleaded by a defendant in an action for infringement; (C) the extent to which, if any, such patent was developed through federally financed research; and (D) the degree of utility, novelty, and importance of the invention or discovery, and . . . the cost to the owner of the patent of developing such invention or discovery or acquiring such patent." *Id.*

190. *See, e.g.*, JOSEPH A. DIMASI AND HENRY G. GRABOWSKI, PATENTS AND R&D INCENTIVES: COMMENTS ON THE HUBBARD AND LOVE TRADE FRAMEWORK FOR FINANCING PHARMACEUTICAL R&D, 13 (2004) http://www.who.int/intellectualproperty/news/en/Submission3.pdf?origin=publication_detail [http://perma.cc/T74K-4QVB]; F.M. SCHERER, INDUSTRIAL MARKET STRUCTURE AND ECONOMIC PERFORMANCE 458 (1980) ("Munificence [of the Atomic Energy Commission's Patent Compensation Board] is a rare committee virtue.").

e. *Patent-Based Monopolies*

Some existing industry specific monopolies are patent-based. For example, the Hatch-Waxman Act expanded the scope of certain pharmaceutical patents by making it an act of patent infringement for a generic drug company to submit an application for a generic drug product (called an Abbreviated New Drug Application, or ANDA) to the FDA.[191] This statute expands patent scope because it expands the universe of potentially infringing activities. However, it does so in a very concrete way that is carefully tailored to the needs of the industry. If submission of an ANDA were not an act of infringement, brand name companies would be forced to wait until a generic product were launched to sue the generic company for patent infringement, which would be detrimental to both the brand name company (because a competitor would be on the market while the lawsuit progressed) and the generic company (who would potentially have wasted large amounts of money on a futile launch if the suit was lost). Thus, patent scope is determined in an industry specific way to incentivize innovation. This well-defined patent scope is possible because the manner in which generic drugs may launch is very constrained and therefore the industry and agency have ex ante knowledge of the nature of the downstream innovation that will be captured by the increased scope.

While certain types of downstream innovation are included in the scope of the monopoly (submitting an ANDA), other types of downstream innovation are explicitly carved out. By statute, use of a patented invention for reasons "reasonably related to the development" of a pharmaceutical drug is not patent infringement.[192] Thus, downstream innovators can begin to develop their follow-on innovation prior to the expiration of the patent or monopoly. This type of scope carve out would be difficult to accomplish outside of narrow industry specific situations.[193]

Another example, although in the context of patent length not patent breadth, is Patent Term Extension (PTE). PTE provides an opportunity to obtain several years of additional patent life and is designed to compensate patent

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191. 35 U.S.C. § 271(e)(2) (2013) ("It shall be an act of infringement to submit an application under section 505(j) of the Federal Food, Drug, and Cosmetic Act . . . for a drug claimed in a patent or the use of which is claimed in a patent.").

192. 35 U.S.C. § 271(e)(1) (2013) ("It shall not be an act of infringement to make, use, offer to sell, or sell within the United States or import into the United States a patented invention (other than a new animal drug or veterinary biological product . . . which is primarily manufactured using recombinant DNA, recombinant RNA, hybridoma technology, or other processes involving site specific genetic manipulation techniques solely for uses reasonably related to the development and submission of information under a Federal law which relates to the manufacture, use, or sale of drugs or veterinary biological products.").

193. For example, although there is a common law experimental use exemption that applies to all patents, the Federal Circuit calls it "truly narrow" and for only "dilettante affairs." *Roche Prods. v. Bolar Pharm. Co.*, 733 F.2d 858, 863 (Fed. Cir. 1984).

owners for regulatory delay[194] and to provide additional incentives for innovation.[195] PTE is available for patents on human drugs, food or color additives, medical devices, animal drugs, and veterinary products that require premarket government approval.[196]

The examples above demonstrate that industry specific information can be used to give patentees additional (or diminished) scope in ways that are predictable ex ante, and thus avoid the sequence-of-information problem.

CONCLUSION

This Article introduces the sequence-of-information problem, demonstrating how the practice of setting patent scope before information about patent scope is available leads to errors in patent scope and renders many policy recommendations difficult to implement. Mitigating the sequence-of-information problem is important in order to improve patent policy and reduce the cost to the public incurred by errors in scope setting. As demonstrated in this Article, there are a variety of ways to improve scope setting by taking the sequence-of-information problem into account. Scope setting can be delayed, for example, by the use of a registration system or increased use of the doctrine of equivalents. Alternatively, scope setting can be eliminated, by use of a different measure of the invention's value, for example, giving prizes instead of patents. Finally, the accuracy of scope prediction can be increased by restricting scope to what is known at the time scope is set or by setting scope based on predictions of downstream innovation arising from industries where downstream innovation is tightly regulated, and therefore highly predictable. Each method of reducing the sequence-of-information problem has benefits and detriments, and thus the preferred method will vary in different situations. Irrespective of exactly how the sequence-of-information problem is diminished, patent law will benefit greatly by being cognizant of the problem and considering the timing of information availability when making policy recommendations.

194. 35 U.S.C. § 156 (2013).

195. MPEP 2750 ("35 U.S.C. 156 [the statute governing PTE] was designed to create new incentives for research and development of certain products subject to premarket government approval by a regulatory agency.").

196. 35 U.S.C. § 156 (2013).