"AFTER-ARISING" TECHNOLOGIES AND TAILORING PATENT SCOPE

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INTRODUCTION

The patent law doctrine that allows patentees to gain exclusivity beyond what they literally claim in their patents—termed the "doctrine of equivalents"—has received a significant amount of attention as of late, from both courts and scholars. Of particular emphasis in this recent focus on the doctrine of equivalents is the ability of patentees to gain exclusivity over equivalent "after-arising" technologies—technologies that develop after the patent's filing date.[1] An "after-arising" technology is a technology that "come[s] into existence after the filing date of a[ ] [patent] application."[2] For example, a particular patent may claim, as part of the patented invention, a "fastener." Screws, nails, and bolts are all in existence at the time of the patent's filing and can act as possible fasteners for the patented invention. However, new types of fasteners that can be used in the invention, such as hook-and-loop fasteners, may be developed after the patent is filed. These new fasteners were not known to anyone on the patent's filing date. These new technologies are introduced, instead, at some later time and therefore are considered "after-arising" technologies. Both the Supreme Court and the United States Court of Appeals for the Federal Circuit have stressed after-arising equivalents protection—protection over these later-developed technologies—in their recent discussions regarding the doctrine of equivalents. As one judge on the Federal Circuit, the court that handles patent appeals, recently stated, "A primary

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1. *See, e.g.*, Festo Corp. v. Shoketsu Kinzoku Kogyo Kabushiki Co., 535 U.S. 722, 731–32 (2002); Anthony H. Azure, Festo*'s Effect on After-Arising Technology and the Doctrine of Equivalents*, 76 WASH. L. REV.1153, 1181 (2001); Martin Adelman, *Is the Use of the Doctrine of Equivalents to Fix Mistakes a Mistake?*, 27 N. KY. L. REV. 1021, 1023 (2000).

2. *In re* Hogan, 559 F.2d 595, 605 (C.C.P.A. 1977).

justification for the doctrine of equivalents is to accommodate after-arising technology."[3]

With this recent emphasis have come questions regarding the propriety of after-arising equivalents protection in patent law. The debate focuses on two questions. First, commentators question whether the doctrine of equivalents is needed to facilitate the patentee's exclusion of those who use after-arising technologies to practice her invention. Some contend that a patent claim drafter cannot anticipate and account for later-developed substitutes for a claim element, and that therefore the doctrine of equivalents is needed. Others suggest that the literal scope of the patent's claims—the traditional metric of the patent's scope of exclusivity—can provide the patentee with protection against later-developed technologies. Second, even if the doctrine is the only mechanism through which the patentee can gain protection for after-arising equivalents, questions still arise as to whether the patent system should provide such protection. Allowing the patentee to exclude the use of technology developed after her invention can be seen as giving the patentee too much protection. On the other hand, after-arising equivalents protection may be crucial to providing the patentee with adequate patent protection.

This Article takes a critical look at after-arising equivalents protection and concludes that such protection is needed to capture after-arising technologies but should be tailored to rapidly developing cumulative technology industries. The Article reaches this conclusion by exploring in detail the two major questions, outlined above, presented by after-arising equivalents protection. The Article begins in Part I by defining the two basic components of patent scope—literal and equivalents scope. Part II of the Article recites a brief history of the doctrine of equivalents in patent law, concluding that the current emphasis of the doctrine is on after-arising equivalents protection. This current emphasis stresses the need to evaluate the merits of after-arising equivalents protection.

Part III of the Article moves into the substantive questions facing after-arising equivalents protection, looking at whether the doctrine of equivalents is actually necessary for a patentee to capture later-developed technologies. Part III examines the literal scope of the patent and the patent claim to see if they can encompass technologies developed after the patent is filed. Part III first notes that

3. Festo Corp. v. Shoketsu Kinzoku Kogyo Kabushiki Co., 234 F.3d 558, 619 (Fed. Cir. 2000) (Rader, J., concurring in part, dissenting in part), *vacated by* 535 U.S. 722 (2002).

there is claim terminology available to the inventor at the time of filing to adequately describe an after-arising technology. Inventors can write claim language to include technologies unknown at the time of drafting by using functional or generally descriptive terms so as not to "date" the claim terms. Part III indicates, however, that even when using such claim language, the temporal limitations imposed on the interpretation of claim terms prohibit such terms from literally including later technological developments. Patent doctrines, such as the patent disclosure requirements and the prohibition against the introduction of new matter after filing, prohibit expanding the literal scope of the patent with the passage of time and introducing after-arising technologies. The claim meaning is frozen as to what is understood at the patent's filing date. Part III therefore concludes that after-arising technologies can fall within a patent's scope of exclusivity only by resorting to the doctrine of equivalents.

Part IV of the Article begins to explore the normative justifications for after-arising equivalents protection. Part IV initially focuses on the classical, ex ante justification for patent protection—the incentive to invent—and the effects that after-arising equivalents protection has on this incentive. Protection for after-arising equivalents can increase the incentive to invent by providing the perception that a patent's value can be preserved in light of later-developed technologies. This increase in incentive is due to the protection's ability to extend the effective life of the patent. Part IV further notes, however, that the extension of the patent's effective life can also deter would-be subsequent inventors who are thinking about building upon already patented technologies. These potential follow-on inventors are deterred from using later-developed technologies because they fear being captured in an already patented invention's range of equivalents.

Part V takes a second look at the effects of after-arising equivalents protection on the incentive to invent. In particular, Part V considers, in response to the conflicting signals that after-arising equivalents protection sends to potential inventors, whether any tailoring of the protection can foster its incentive-maintaining effects while minimizing its deterrent effects. Part V examines in detail two possible tailoring schemes that focus protection on industries that have particular attributes. Part V first investigates tailoring protection to industries that do not experience cumulative technological development. By directing protection to non-cumulative industries, the protection's deterrent effects are minimized because there are few, if any, follow-on inventors in these types of

industries. Part V indicates, however, that such tailoring fails to increase the incentive to invent because potential inventors in these industries have little worry about being substituted by follow-on inventions. Thus, extending effective patent life by providing protection for after-arising equivalents in such industries will have minimal impact on a would-be inventor's valuation of patent protection. Part V concludes that this first tailoring scheme, on the whole, is inefficient because the addition of equivalents protection produces doctrinal complexity while providing little to no upside.

Part V then considers a second type of tailoring—focusing protection over equivalent after-arising technologies to sequentially developing industries that experience a rapid rate of technological turnover. Part V indicates that tailoring to rapidly developing cumulative industries maintains the patent system's incentive to invent. The opportunity to capture after-arising equivalents in these industries gives the potential inventor some assurance that she can maintain her market position long enough to recoup her research and development costs. Part V notes that this type of tailoring has the potential of significantly deterring follow-on inventions because protection is targeted at cumulative industries. However, as Part V explains, by focusing protection on rapidly developing industries, the deterrent effects are minimized and a self-correcting mechanism is introduced. If protection slows down the production of patentable inventions, after-arising equivalents protection is no longer afforded to the industry because of the tailoring criteria, removing any deterrent effects protection may have been creating. Part V also indicates that the disincentives are minimized by patent doctrines that allow follow-on inventors to avoid capture by a previous inventor. The subsequent developer's invention may not fall within the initial patent's range of equivalents or may be patentable in its own right, creating a patent-blocking situation that may lead to bargaining. Part V concludes by discussing how tailoring protection to rapidly developing cumulative industries may be implemented by courts in their test for the doctrine of equivalents.

I.
COMPONENTS OF PATENT SCOPE

To obtain patent protection, a patent applicant's invention must be new,[4] useful,[5] and nonobvious.[6] If these requirements are

4. 35 U.S.C. § 102 (2000) (setting forth the novelty requirement).
5. *Id.* § 101 (setting forth the utility requirement).

met, a patent is considered valid[7] and gives its owner the right to exclude others from practicing the patented invention.[8] Others cannot make, use, sell, offer for sale, or import into the United States the patented invention without the authority of the patent owner.[9] To do so is considered patent infringement.[10] The range of exclusivity given to the patentee is defined by the patent's scope,[11] which has two basic components.

A. Literal Scope

The claims set forth in a patent define the scope of its protection.[12] A patentee is required to define the scope of her invention with particularity in a patent's claims.[13] The claims set forth the area covered by the patented invention—element by element.[14]

6. *Id.* § 103 (setting forth the nonobviousness requirement); *see also* Scott R. Boalick, *Patent Quality and the Dedication Rule*, 11 J. INTELL. PROP. L. 215, 225–28 (2004) (discussing all three of these requirements of patentability, as well as others).

7. 35 U.S.C. § 282 (2000).

8. 35 U.S.C. § 271(a) (2000); Innova/Pure Water, Inc. v. Safari Water Filtration Sys., Inc., 381 F.3d 1111, 1115 (Fed. Cir. 2004) ("It is a bedrock principle of patent law that the claims of a patent define the invention to which the patentee is entitled the right to exclude.") (citing Aro Mfg., Co. v. Convertible Top Replacement Co., 365 U.S. 336, 339 (1961)).

9. 35 U.S.C. § 271(a); Bloomer v. McQuewan, 55 U.S. 539, 549 (1852) ("The franchise which the patent grants, consists altogether in the right to exclude every one from making, using, or vending the thing patented, without the permission of the patentee.").

10. *See* Markman v. Westview Instruments, Inc., 517 U.S. 370, 374 (1996) (noting that claims of "infringement" "rest on allegations that the defendant 'without authority ma[de], use[d] or [sold the] patented invention, within the United States during the term of the patent therefor . . . .'") (quoting 35 U.S.C. § 271(a)).

11. *See* Robert P. Merges & Richard R. Nelson, *On the Complex Economics of Patent Scope*, 90 COLUM. L. REV. 839, 839–40 (1990) (discussing the concept of patent scope).

12. 35 U.S.C. § 112 (2000); *see* Graver Tank & Mfg. Co. v. Linde Air Prods. Co., 339 U.S. 605, 607 (1950) (noting that the words of a patent claim provide the basis for determining whether infringement has occurred); Zenith Labs., Inc. v. Brystol-Myers Squibb Co., 19 F.3d 1418, 1424 (Fed. Cir. 1994) ("[T]he claim . . . 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).

13. 35 U.S.C. § 112 (2000) (noting that a claim must "particularly point[ ] out and distinctly claim[ ] the subject matter which the applicant regards as his invention."); White v. Dunbar, 119 U.S. 47, 52 (1886) ("The claim is a statutory requirement, prescribed for the very purpose of making the patentee define precisely what his invention is . . . .").

14. Words and phrases in a claim are referred to using the terms "element" or "limitation." *See, e.g.*, Lemelson v. United States, 752 F.2d 1538, 1551 (Fed. Cir.

The claims include a textual description of the patent's boundaries, erecting a "fence" enclosing the literal scope of protection afforded to the patentee.[15] A court determines the full breadth of this literal claim scope by interpreting the claim language.[16]

Literal infringement is the unauthorized practice of the subject matter contained within the fence defined by the claim language.[17] Literal infringement occurs when the alleged activity "reads directly, unequivocally, and word-for-word" on the claimed invention.[18] To determine whether an accused infringer's product or process literally infringes a patent claim, the claim must first be interpreted.[19] The interpreted claim is then compared to the allegedly infringing product or process to see if every claim element is met.[20] If no claim element, as interpreted, is found in the accused product, there is no literal infringement.[21] Small variations be-

1985) (using the term "element"); Sextant Avionique, S.A. v. Analog Devices, Inc., 172 F.3d 817, 826 (Fed. Cir. 1999) (using the term "limitation"). This Article will refer to claim terms and phrases as "elements."

15. *In re* Vamco Machine and Tool, Inc., 752 F.2d 1564, 1577 n.5 (Fed. Cir. 1985) (indicating that claims are similar to descriptions of lands in deeds in that claims provide the "metes and bounds" that define the area protected by the patent).

16. *See* Cyber Corp. v. FAS Techs., Inc. 138 F.3d 1448, 1454 (Fed. Cir. 1998) (en banc); John F. Duffy, *The* Festo *Decision and the Return of the Supreme Court to the Bar of Patents*, 2002 SUP. CT. REV. 273, 306 (noting that "patent claims—the formal, single-sentence statements of the invention set forth at end [sic] of the patent—provide the primary definition of the patentee's rights against infringement"); John M. Romary & Arie M. Michelsohn, *Patent Claim Interpretation After* Markman*: How the Federal Circuit Interprets Claims*, 46 AM. U. L. REV. 1887, 1888 (1997).

17. *See* Merges & Nelson, *supra* note 11, at 853 (noting that "'literal infringement' of the patent" occurs when "the challenger's product falls squarely within the boundaries of the patentee's claims").

18. SRI Int'l v. Matsushita Elec. Corp. of Am., 775 F.2d 1107, 1118 (Fed. Cir. 1985) (en banc).

19. McClain v. Ortmayer, 141 U.S. 419, 424 (1891) ("'The rights of the plaintiff depend upon the claim in his patent, according to its proper construction . . . .'") (quoting Masury v. Anderson, 16 F. Cas. 1087, 1088 (C.C.S.D.N.Y. 1873)); Markman v. Westview Instruments, Inc., 52 F.3d 967, 976 (Fed. Cir. 1995) (en banc) (noting that the literal infringement analysis requires two steps: interpreting the claims and comparing the interpreted claims to the accused device), *aff'd*, 517 U.S. 370 (1996).

20. Southwall Techs., Inc. v. Cardinal IG Co., 54 F.3d 1570, 1575 (Fed. Cir. 1995) ("To establish literal infringement, every limitation set forth in a claim must be found in an accused product, exactly.") (citing Becton Dickinson & Co. v. C.R. Bard, Inc., 922 F.2d 792, 796 (Fed. Cir. 1990)).

21. *Id.*; London v. Carson Pirie Scott & Co., 946 F.2d 1534, 1539 (Fed. Cir. 1991) (stating that if even one element of a patent's claim is missing from an accused product or process, then "[t]here can be no infringement as a matter of law").

tween the claimed invention and the accused activity can result in a finding of no literal infringement.[22]

B. Equivalents Scope

The scope of protection afforded to a patent, however, does not stop with the literal boundaries defined by the claim language. Patents also give their owner exclusivity over equivalents to the claimed invention.[23] This extra protection is added by the judicially created "doctrine of equivalents."[24] A patent's scope comprises both the literally claimed invention and a range of equivalents to the claimed invention. A patent can, therefore, be infringed in two ways—literally or under the doctrine of equivalents.[25]

A product or process infringes a patent claim under the doctrine of equivalents if it performs "substantially the same function in substantially the same way to give substantially the same result" as

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While all claim elements must be present to find literal infringement, the presence of additional elements in the accused product or process does not prevent a finding of literal infringement. A.B. Dick Co. v. Burroughs Corp., 713 F.2d 700, 703 (Fed. Cir. 1983) ("It is fundamental that one cannot avoid infringement merely by adding elements if each element recited in the claims is found in the accused device.").

22. For example, in *Chef America, Inc. v. Lamb-Weston, Inc.*, 358 F.3d 1371, 1371–72 (Fed. Cir. 2004), the patent at issue concerned a process for producing a dough product that could be microwaved and have a "'light, flaky, crispy texture,'" instead of the usual "'leathery'" or "'soggy'" texture that baking or microwaving dough products usually creates. The claim at issue required "'heating the resulting batter-coated dough to a temperature in the range of about 400° F. to 850° F.'" *Id.* at 1371. The Federal Circuit found the claims to cover the process of heating dough *to* 400 to 850 degrees Fahrenheit, rather than *at* that temperature. *Id.* at 1373–74. Lamb-Weston's dough did not reach temperatures in this range and therefore did not literally infringe. *Id.* at 1375–76.

23. Festo Corp. v. Shoketsu Kinzoku Kogyo Kabushiki Co., 535 U.S. 722, 732 (2002) ("The scope of a patent is not limited to its literal terms but instead embraces all equivalents to the claims described.") (citing Winans v. Denmead, 56 U.S. (15 How.) 330, 347 (1854)).

24. Graver Tank & Mfg. Co. v. Linde Air Prods. Co., 339 U.S. 605, 608 (1950) (discussing the evolution of the doctrine of equivalents); Duffy, *supra* note 16, at 306–07 (noting that the doctrine of equivalents "allows patent rights to extend somewhat beyond the literal bounds of the claims").

25. Boalick, *supra* note 6, at 238–39; *see also* John R. Thomas, *On Preparatory Texts and Proprietary Technologies: The Place of Prosecution Histories in Patent Claim Interpretation*, 47 UCLA L. REV. 183, 191 (1999) (discussing both the literal and equivalent scope of patents); Martin J. Adelman & Gary L. Francione, *The Doctrine of Equivalents in Patent Law: Questions that* Pennwalt *Did Not Answer*, 137 U. PENN. L. REV. 673, 679–80 (1989).

the claimed invention.[26] The scope of equivalents can also be determined by considering whether the accused product or process is "substantially different" from the claimed invention.[27] In conjunction with these two tests defining the scope of equivalents, the doctrine is also tied to the patent claim by the all-elements rule.[28] When applying either of the two tests above, the proper comparison is between the accused product or process and each claim element—not between the alleged infringement and the claim as a whole.[29] In order to fall into the patent's range of equivalents, the product or process must include an equivalent for each claim element.[30] Therefore, even if a product or process does not literally contain each claim element, it can still infringe under the doctrine of equivalents if it includes an equivalent for each claim element.[31]

26. Loctite Corp. v. Ultraseal Ltd., 781 F.2d 861, 869 (Fed. Cir. 1985), *overruled on other grounds by* Nobelpharma AB v. Implant Innovations, 141 F.3d 1059, 1068 (Fed. Cir. 1998); *see also* Warner-Jenkinson Co. v. Hilton Davis Chem. Co., 520 U.S. 17, 39–40 (1996) (noting that this "'triple identity'" test "may be suitable for analyzing mechanical devices," but may provide a "poor framework for analyzing other products or processes").

27. *See Warner-Jenkinson*, 520 U.S. at 40.

28. *Id.* at 28–29 (noting that "the doctrine of equivalents must be applied to individual elements of the claim, not to the invention as a whole"); *see also* Corning Glass Works v. Sumitomo Elec. U.S.A., Inc., 868 F.2d 1251, 1259 (Fed. Cir. 1989) (describing the all-elements rule); Pennwalt Corp. v. Durand-Wayland, Inc. 833 F.2d 931, 934–35 (Fed. Cir. 1987) (en banc) (same), *overruled in part by* Cardinal Chem. Co. v. Morton Int'l, 508 U.S. 83, 92 (1993).

29. *See Warner-Jenkinson*, 520 U.S. at 29.

30. *Id.* The scope of equivalents is also cabined by prosecution history estoppel and the public dedication rule, which estops the patentee from recapturing subject matter she either gave up during patent prosecution or disclosed in her patent but failed to literally claim. *See* Festo Corp. v. Shoketsu Kinzoku Kogyo Kabushiki Co., 535 U.S. 722, 733–35 (explaining the doctrine of prosecution history estoppel); Johnson & Johnston Assocs., Inc. v. R.E. Serv. Co., 285 F.3d 1046, 1054–55 (Fed. Cir. 2002) (en banc) (explaining the public dedication rule).

31. For example, in *Toro Co. v. White Consol. Indus., Inc.*, 266 F.3d 1367, 1368–69 (Fed. Cir. 2001) ("*Toro II*"), the claim at issue covered a convertible vacuum-blower used to vacuum or blow leaves and small debris. The claim required a "'removable air inlet cover'" that both covered the vacuum-blower's air inlet and "'increase[ed] the pressure developed by said vacuum-blower during operation as a blower.'" *Id.* at 1369 (quoting Claim 16 of the asserted patent). The accused device used two separate pieces to perform the functions of the "'removable air inlet cover'"—a cover and a separate restriction ring. *Id.*

In a previous decision, *Toro Co. v. White Conol. Indus., Inc.*, 199 F.3d 1295, 1302 (Fed. Cir. 1999) ("*Toro I*") the Federal Circuit had found that the accused device did not literally infringe because it did not contain the exact claimed singular "'removable air inlet cover'" for covering the air inlet and increasing pressure. *Toro II* at 1369. The *Toro I* court remanded to the district court for consideration of infringement under the doctrine of equivalents. The district court granted summary

The range of equivalents is also limited by the requirements for patentability.[32] The patentee cannot capture subject matter through the doctrine of equivalents that she could not have originally patented.[33]

II.
EVOLUTION OF THE DOCTRINE OF EQUIVALENTS

A. Shift from a Fairness to a Utilitarian Rationale

The doctrine of equivalents was initially created to ensure equity in patent law.[34] Courts viewed the doctrine as providing equity by ensuring fairness in patent protection.[35] The accused infringer may not have literally practiced each claim element, but notions of fairness and equity still required a finding of liability.[36] Patent claims were not considered to provide adequate protection over the patentee's claimed invention.[37] Adhering to the literal language of the claims allowed someone "to make unimportant and insubstantial changes and substitutions in the patent which, though adding nothing, would be enough to take the copied matter outside the

judgment for the defendants, holding that the accused device did not infringe Toro's patent under the doctrine of equivalents. On appeal, the *Toro II* court vacated the grant of summary judgment, stating that a reasonable fact-finder could determine that there was infringement under the doctrine of equivalents because the two-piece structure of the accused device passed the triple identity test and was insubstantially different than the claimed one-piece element. *Toro II* at 1370–72.

32. *See* Wilson Sporting Goods Co. v. David Geoffrey & Assocs., 904 F.2d 677, 684–85 (Fed. Cir. 1990).

33. *Id.* at 685.

34. *See* MICHAEL J. MUERER & CRAIG ALLEN NARD, INVENTION, REFINEMENT AND PATENT CLAIM SCOPE: A NEW PERSPECTIVE ON THE DOCTRINE OF EQUIVALENTS, (B.U. Sch. Law, Law and Econ. Working Paper Series, Working Paper No. 04-03, 2004), *available at* http://ssrn.com/abstract=533083 (providing in-depth analysis of the equitable roots of the doctrine of equivalents); Mark A. Lemley, *The Economics of Improvement in Intellectual Property Law*, 75 TEX. L. REV. 989, 1003 (1997) (hereinafter Lemley, *Economics of Improvement*); *see also* Hilton Davis Chem. Co. v. Warner-Jenkinson Co., 62 F.3d 1512, 1521 (Fed. Cir. 1995) (noting the Supreme Court and Federal Circuit opinions referring to the doctrine as equitable), *vacated by* 520 U.S. 17 (1997); Tex. Instruments Inc. v. U.S. Int'l Trade Comm'n, 988 F.2d 1165, 1173 (Fed. Cir. 1993) ("Infringement under the doctrine of equivalents has been 'judicially devised to do equity' . . . .") (quoting Loctite Corp. v. Ultraseal, Ltd., 781 F.2d 861, 870 (Fed. Cir. 1985)).

35. *See* Graver Tank & Mfg. Co. v. Linde Air Prods. Co., 339 U.S. 605, 607 (noting that the doctrine of equivalents prevents unfairly depriving a patent holder of the benefit of her invention); MUERER & NARD, *supra* note 34, at 12–13.

36. *See Graver Tank*, 339 U.S. at 607.

37. *See id.* at 607–08.

claim, and hence outside the reach of law."[38] Courts viewed an accused infringer who made these insubstantial changes as committing "fraud on a patent" or acting as an "unscrupulous copyist."[39] The doctrine of equivalents ensured such insubstantial changes did not fall outside the patent's area of exclusivity.

The Supreme Court, in its recent decisions concerning the doctrine of equivalents, has shifted away from the fairness rationale for the doctrine toward an intent-neutral rationale based on economic efficiency.[40] While the equity rhetoric is still present,[41] the basis for equivalents protection has changed. In *Warner-Jenkinson Co. v. Hilton Davis Chem. Co.*, the Court rejected the petitioner's request to base the doctrine on the principles of equity.[42] The Court specifically prohibited a "judicial exploration of the equities of a case before allowing application of the doctrine of equivalents."[43] The Court also noted that evidence of copying, by itself, did not support a finding of infringement under equivalents.[44] The "unscrupulous copyist" had taken a back seat.

In its place, the Supreme Court has focused on a utilitarian view of the doctrine of equivalents.[45] The Court's recent decision in *Festo Corp. v. Shoketsu Kinzoku Kogyo Kabushiki Co.* focuses on the doctrine's promotion of efficiency.[46] The Court's discussion of equivalents again starts by focusing on the shortcomings of the pat-

38. *Id.* at 607.

39. *Id.* at 607–08 (observing that limiting claims to their literal language "would leave room for—indeed encourage—the unscrupulous copyist to make unimportant and insubstantial changes and substitutions in the patent").

40. Festo Corp. v. Shoketsu Kinzoku Kogyo Kabushiki Co., 535 U.S. 722, 731–33 (2002); Warner-Jenkinson Co. v. Hilton Davis Chem. Co., 520 U.S. 17, 34–35 (1997); *see also* MUERER & NARD, *supra* note 34, at 19–20 (identifying the shift from the fairness theory evidenced by the Supreme Court's decisions in *Festo* and *Warner-Jenkinson*).

41. *See, e.g.*, *Festo*, 535 U.S. at 727 (noting that the doctrine of equivalents "protects its holder against efforts of copyists to evade liability for infringement by making only insubstantial changes to a patented invention").

42. 520 U.S. at 34–35.

43. *Id.* at 34.

44. *Id.* at 35–36.

45. *See* MUERER & NARD, *supra* note 34, at 19–20 (labeling the recent, utilitarian view of the doctrine of equivalents as the "friction theory"). Muerer and Nard discount the friction theory and offer their "refinement theory" on the doctrine of equivalents. *Id.* at 22–28. While the theory provides a much-needed new perspective on the doctrine of equivalents and claim drafting, the refinement theory falls outside the scope of this Article, and therefore will not be addressed.

46. 535 U.S. at 731–32.

ent claim to fully protect the patentee's invention.[47] Language, according to the Court, is an inadequate tool to completely describe the patentee's inventive activities.[48] The Court then justifies the use of the doctrine by the inability of the patentee to draft a claim to protect the full extent of her invention.[49] The Court does not focus on concepts of fairness to the patentee or unfair activities by the alleged infringer. Instead, the Court appears to identify the need to use the doctrine of equivalents to make up for the shortcomings, or, put another way, the inefficiencies, of the patent claim in properly capturing the patentee's invention.[50]

B. Current Emphasis on After-Arising Equivalents

As of late, the emphasis on the doctrine of equivalents has focused on protecting one specific type of equivalent termed an "after-arising equivalent."[51] "After-arising" equivalents protection attempts to rectify a specific inefficiency of patent claims—the inability of patent claims to capture those equivalent technologies developed after the filing date of the patent.[52] The Supreme Court, in *Warner-Jenkinson*, recognized the doctrine's ability to capture

47. *Id.* at 731 ("The language in the patent claims may not capture every nuance of the invention or describe with complete precision the range of its novelty.").

48. *Id.*; *see also* Autogiro Co. of Am. v. United States, 384 F.2d 391, 397 (Ct. Cl. 1967) ("Things are not made for the sake of words, but words for things.").

49. *Festo*, 535 U.S. at 732 ("[L]iteralism [ ] may conserve judicial resources but is not necessarily the most efficient rule.").

50. *Id.* at 731–33; *see also* MUERER & NARD, *supra* note 34, at 19–22 (detailing specific "frictions present in the claims drafting process").

51. *See* Smithkline Beecham Corp. v. Excel Pharm., Inc., 356 F.3d 1357, 1364 (Fed. Cir. 2004) (identifying an after-arising technology as "the quintessential example of an enforceable equivalent"); Glaxo Wellcome, Inc. v. Impax Labs., Inc., 356 F.3d 1348, 1354 (Fed. Cir. 2004) (same); Festo Corp. v. Shoketsu Kinzoku Kogyo Kabushiki Co., 234 F.3d 558, 619 (Fed. Cir. 2000) (Rader, J., concurring in part, dissenting in part) ("A primary justification for the doctrine of equivalents is to accommodate after-arising technology."), *vacated by* 535 U.S. 722 (2002).

52. *See Festo*, 234 F.3d at 619–20 (Rader, J., concurring in part, dissenting in part); *see also* Adelman & Francione, *supra* note 25, at 712 ("The second primary use of the doctrine of equivalents involves new developments or technologies that come into existence after the patent issues."). The first use of the doctrine that Adelman and Francione discuss is rectifying mistakes in drafting. *Id.* at 711.

The doctrine of equivalents is not, however, limited to covering only after-arising equivalents. *See* Litton Sys., Inc. v. Honeywell, Inc., 140 F.3d 1449, 1464–65 (Fed. Cir. 1998) (addressing the application of the doctrine when technology not claimed in an amended patent claim was already in existence at the time of the amendment).

such technologies.[53] Protection for after-arising equivalents also became the center of the debate surrounding prosecution history estoppel when *Festo* was before the Federal Circuit.[54] On appeal, the Supreme Court in *Festo* carved out an exception to estoppel for those "unforeseeable" equivalents—a class of equivalents that necessarily includes after-arising technologies.[55]

III.
NEED FOR DOCTRINE OF EQUIVALENTS TO CAPTURE AFTER-ARISING TECHNOLOGIES

The first step in evaluating the current emphasis of the doctrine of equivalents is to determine whether the doctrine is actually needed to capture after-arising technologies—that is, whether resort to the doctrine of equivalents is actually required to provide patentees protection over later-developed technologies. If a patent holder could draft claims that literally cover after-arising technologies, then the doctrine of equivalents would not be necessary to provide this type of protection. There would be no inefficiencies in the literal scope of patent claims that need to be overcome by the doctrine of equivalents.[56] Literal protection would be enough.

Literal protection, however, is not enough because a patent's literal claim scope cannot encompass later-developed technologies. Courts and commentators provide two explanations as to why this is the case. One reason given is that the lack of claim terminology available at the time of patent filing to describe after-arising technologies prohibits the literal capture of such subject matter. Another rationale offered is that the temporal limitations on the teachings of the patent document bar the literal claim scope from reaching later-developed technologies. The first justification for resorting to the doctrine of equivalents in this instance is not sufficient. However, the second justification, regarding the temporal constraints on the patent claims, explains the need for the doctrine in order to include after-arising technologies in a patent's scope.

53. Warner-Jenkinson Co. v. Hilton Davis Chem. Co., 520 U.S. 17, 37 (1997) (noting that equivalency is properly evaluated at the time of infringement, not at the time of patent issuance).

54. *See Festo*, 234 F.3d at 619–20 (Rader, J., concurring in part, dissenting in part); Azure, *supra* note 1, at 1181.

55. *Festo*, 535 U.S. at 738 ("There is no reason why a narrowing amendment should be deemed to relinquish equivalents unforeseeable at the time of the amendment . . . .").

56. *See id.* at 731–33 (noting that the doctrine of equivalents is meant to overcome the shortcomings of claim language to provide patent protection).

Both of these justifications are explored and analyzed in detail below.

A. Lack of Claim Terminology for After-Arising Technologies

The first reason offered by courts and commentators is that there may not be language known at the time of the patent's filing to describe a later-developed technology.[57] The after-arising technology is, by definition, not known at the patent's filing date.[58] Given this lack of knowledge, there may be no words to describe what is yet to be developed.[59] The vocabulary available at the time of the patent's filing may not be able to properly capture and detail those technologies created after the patent claim's drafting.

Judge Rader provides an example of such a situation in his concurrence-in-part and dissent-in-part in the Federal Circuit's en banc decision in *Festo* in 2000:

> A primary justification for the doctrine of equivalents is to accommodate after-arising technology. Without a doctrine of equivalents, any claim drafted in current technological terms could be easily circumvented after the advent of an advance in technology. A claim using the terms "anode" and "cathode" from tube technology would lack the "collectors" and "emitters" of transistor technology that emerged in 1948. Thus, without a doctrine of equivalents, infringers in 1949 would have unfettered license to appropriate all patented technology using the out-dated terms "cathode" and "anode".[60]

57. *See, e.g.*, Al-Site Corp. v. VSI Int'l, Inc., 174 F.3d 1308, 1320 n.2 (Fed. Cir. 1999) ("Patent policy supports application of the doctrine of equivalents to a claim element expressed in means-plus-function form in the case of 'after-arising' technology because a patent draftsman has no way to anticipate and account for later developed substitutes for a claim element."); Adelman & Francione, *supra* note 25, at 712.

58. "The courts have defined after-arising technology as technological developments known after issuance of a patent." Azure, *supra* note 1, at 1153.

59. For example, last year's annual update of Merriam-Webster's Collegiate Dictionary includes the word "MP3," defined as "a computer file or the audio file format." *They're in the Book*, DALLAS MORNING NEWS, Aug. 1, 2004, at 13A (noting that the term "MP3" first appeared in 1996). Such terms as "MP3" were not part of the English vocabulary twenty years ago because there was no MP3 audio file format twenty years ago. *See* Karlheinz Brandenburg & Gerhard Stoll, *The ISO-MPEG-1 Audio: A Generic Standard for Coding of High-Quality Digital Audio*, 42 J. AUDIO ENG'G SOC'Y 780 (1994).

60. Festo Corp. v. Shoketsu Kinzoku Kogyo Kabushiki Co., 234 F.3d 558, 619 (Fed. Cir. 2000) (en banc) (Rader, J., concurring in part, dissenting in part), *vacated by* 535 U.S. 722 (2002); *see also* Adelman, *supra* note 1, at 1023.

The problem with this reasoning, as aptly pointed out by Michael J. Muerer and Craig Allen Nard,[61] is that after-arising equivalents can be captured by earlier drafted claims if the patentee drafts her claims in functional terms. The situation set forth above could have been prevented by the patentee of the earlier, vacuum tube-based technology patent. By referring to technology of the time by name, the claim dates itself. Instead of using claim terms such as "anode" and "cathode," the patentee could simply claim the then-present tube technology in general, descriptive terms. For example, in a vacuum tube, electrons collect at the tube's "anode" electrode and emit from the tube's "cathode" electrode.[62] In transistors, a later-developed technology in the hypothetical, an "emitter" performs similar functions to those of an anode while a "collector" performs similar functions to those of a "cathode."[63] A claim that could cover both technologies would use terminology such as "electron collector" and "electron emitter."[64] While the patentee is necessarily referring to anodes and cathodes by using these phrases, the claim is not directly tied to the language of the time. The claim, by using "electron collector" and "electron emitter," would cover both vacuum tube and transistor technology.[65] Furthermore, means-plus-function claim language could be used to describe technologies in functional terms, so as not to date the claim language.[66] Means-plus-function claims cover both the structure

61. MUERER & NARD, *supra* note 34, at 45.

62. *See* WEBSTER'S NINTH NEW COLLEGIATE DICTIONARY 88, 216 (1983) (defining "anode" as "the electron-collecting electrode of an electron tube" and "cathode" as "the electron-emitting electrode of an electron tube").

63. *See* STANLEY G. BURNS & PAUL R. BOND, PRINCIPLES OF ELECTRONIC CIRCUITS 102–06 (1987).

64. Muerer and Nard use the example of a claim describing a type of tennis racket that can cover a later-developed racket material, such as graphite, by using "general terms." MUERER & NARD, *supra* note 34, at 27.

65. This analysis does not address the other barriers to drafting claims with language that includes future technologies. There are still the issues presented by the technology at issue, the invention at issue, general lack of foreseeability, time limitations, and lack of unlimited funds that would permit such perfect drafting. *See* Glynn S. Lunney, Jr., *Patent Law, the Federal Circuit, and the Supreme Court: A Quiet Revolution*, 11 SUP. CT. ECON. REV. 1, 38 (2004) ("In applying for a patent, an applicant must attempt to guess how the market will develop and then draft a patent that covers *all* of the forms competition may take—a hard exercise generally made more difficult by the patent attorney's inevitable focus on the precise form of the invention before her."); Toshiko Takenaka, *Doctrine of Equivalents After* Hilton Davis*: A Comparative Law Analysis*, 22 RUTGERS COMPUTER & TECH. L.J. 479, 506 (1996) (noting some of the difficulties in drafting patent claims).

66. *See* 35 U.S.C. § 112 (governing the drafting of means-plus-function claims).

described in the specification to perform the claimed function, as well as their equivalents, allowing the patentee to draft her claims in complete, functional terms.[67]

B. Temporal Limitation on Claims Capturing After-Arising Technologies

The real limitation on claim language's ability to capture after-arising equivalents is that claim language is interpreted as a person skilled in the art understands it at the time the patent is filed. The teachings of the whole patent are frozen as of the filing date of the patent.[68] The specification is interpreted as it is understood at the time of filing.[69] A similar requirement applies to the patent claims.[70] The claims can be drafted to literally describe technology not yet known, as demonstrated above. But the claims technically cannot capture the later-developed technologies because to do so would require the claims to be interpreted as they are understood at some time after the filing date. "In fact, the quintessential example of an enforceable equivalent, after-arising technology, would always be unclaimable new matter" for the patent as filed.[71]

The Federal Circuit's decision in *Schering Corp. v. Amgen, Inc.*[72] provides a good example of this temporal constraint on a claim's

67. *See* Odetics, Inc. v. Storage Tech. Corp., 185 F.3d 1259, 1266–67 (Fed. Cir. 1999) (explaining the scope requirements for means-plus-function claims).

68. *See* Metabolite Labs., Inc. v. Lab. Corp. of Am. Holdings, 370 F.3d 1354, 1366 (Fed. Cir. 2004) (stating the same for the written description requirement); Hybritech Inc. v. Monoclonal Antibodies, Inc., 802 F.2d 1367, 1384 (Fed. Cir. 1986) (noting that enablement is determined as of the filing date of the patent application).

69. *See Hybritech*, 802 F.2d at 1384; *In re* Wertheim, 541 F.2d 257, 262 (C.C.P.A. 1976).

70. *See* ResQNet.com, Inc. v. Lansa, Inc., 346 F.3d 1374, 1378 (Fed. Cir. 2003) (noting that the correct meaning to use during claim construction is the accustomed meaning of persons with ordinary skill in the relevant field at the time of the invention); ACTV, Inc. v. Walt Disney Co., 346 F.3d 1082, 1088 (Fed. Cir. 2003).

71. Glaxo Wellcome, Inc. v. Impax Labs, Inc., 356 F.3d 1348, 1354 (Fed. Cir. 2004) (noting that "the doctrine of equivalents," in turn, "compensates for the patentee's inability to claim unforeseeable new matter").

A patent cannot contain new matter, and patent claims directed to new matter lose their original filing date. *See* 35 U.S.C. § 132(a) (2000) (prohibiting new matter in patents); Vas-Cath Inc. v. Mahurkar, 935 F.2d 1555, 1562–63 (Fed. Cir. 1991) (indicating that for patent claims to enjoy the original patent's filing date, and presumed date of invention, the claims must be supported by the original application's specification, as understood by those skilled in the art at the application's filing date).

72. 222 F.3d 1347 (Fed. Cir. 2000).

literal meaning. The patent at issue in *Schering* described certain human polypeptides known as interferons. The claims in the case recited both a recombinant DNA molecule's encoding for a leukocyte interferon and that recombinant DNA molecule's use.[73] The claims identified this leukocyte interferon by the term "IFN-α" because the term "IFN-α" "more specifically identified a particular polypeptide by its physical properties—molecular weight, binding affinity for highly specific antibodies, and amino acid sequence."[74] The court faced the question of whether the claim language "IFN-α" encompassed all IFN-α subtypes, including those developed after the patent was filed.[75]

The court concluded that the claim term "IFN-α" could only be given its meaning "at the time of [the] application."[76] The reasoning for this decision was twofold. First, claims are generally given the meaning that a person skilled in the art at the time of the invention would assign to them.[77] Second, claims can only be given the meaning supported by the patent's specification, which is also interpreted as of the time of filing. In *Schering*, the specification described only a specific single interferon polypeptide, not all of the subtypes of IFN-α.[78] The patent was unable to describe such subtypes because they had yet to be discovered as of the patent's filing.[79] Because, as of the patent's filing, "neither [the inventor] nor others skilled in the art knew of the existence of, let alone the identity of, the specific polypeptides now identified as subtypes of IFN-α, those subtypes cannot be within the scope of the claims."[80]

While not addressing the question of after-arising equivalents directly, the Federal Circuit in *Schering* explains how a claim cannot literally cover later-developed technologies. In *Schering*, the other subtypes of IFN-α were not discovered until after the patent was filed, a classic case of after-arising technology. These subtypes were also identified as IFN-α, therefore technically falling under the claim term "IFN-α." But the claim term must be interpreted as it was understood at the patent's filing and as it is supported by the

73. *Id.* at 1349–51.

74. *Id.* at 1352.

75. *Id.* at 1351.

76. *Id.* at 1353.

77. *Id.*

78. *Id.*

79. *Id.* at 1352–53 (noting that an article published in NATURE, July 10, 1980, at 110, first acknowledged the possibility of different IFN-α subtypes five months after the patent's filing).

80. *Id.* at 1353–54.

patent's specification.[81] These two requirements prevent a patentee, regardless of how the claims are drafted, from capturing after-arising technologies within the patent's literal scope. These requirements apply as well to claims drafted in means-plus-function form. Such claims must also be interpreted to include only those structures known at the time of the patent's filing.[82] Accordingly, "[a]n 'after-arising equivalent' infringes, if at all, under the doctrine of equivalents."[83]

This rule of law is not without its detractors. Some have argued, using the decision of *In re Hogan*[84] as supporting authority, that patent claims can literally encompass later-developed technologies.[85] There is language in *Hogan* that suggests that claims in pioneering inventions should gain exclusivity over later-developed technologies.[86] However, as the Federal Circuit has since explained, *Hogan* "simply held that one could not use a later-existing state of the art to invalidate a patent that was enabled for what it claimed at the time of filing."[87] The court in *Hogan* did not specifically hold that claim language can literally include after-arising technologies. In fact, the weight of Federal Circuit authority indicates the opposite, as discussed above and exemplified by the *Schering* decision.[88] Thus, recent case law has emphasized the temporal

81. *See* Plant Genetic Sys., N.V. v. DeKalb Genetics Corp., 315 F.3d 1335, 1339–42 (Fed. Cir. 2003) (limiting the claims to the specification's teachings, as understood at the time of the patent's filing).

82. Al-Site Corp. v. VSI Int'l, Inc., 174 F.3d 1308, 1320–21 (Fed. Cir. 1999).

83. *Id.* at 1320.

84. 559 F.2d 595 (C.C.P.A. 1977). *Hogan* was a decision by the Court of Customs and Patent Appeals—one of the Federal Circuit's predecessor courts. The Federal Circuit is bound by earlier decisions of this court. *See* South Corp. v. United States, 690 F.2d 1368, 1369 (Fed. Cir. 1982).

85. *See* Robert P. Merges, *Rent Control in the Patent District: Observations on the Grady-Alexander Thesis*, 78 VA. L. REV. 359, 379–80 n.73 (1992); *see also* ROBERT P. MERGES & JOHN F. DUFFY, PATENT LAW AND POLICY: CASES AND MATERIALS 299–300 (3d ed. 2002). This theory is termed "temporal disparity" or "temporal paradox."

Mark Lemley concludes that the current case law varies the time frame in which claim terms are construed, depending on the reason for claim construction. *See* MARK A. LEMLEY, THE CHANGING MEANING OF PATENT CLAIM TERMS 6–14 (Stanford Pub. Law & Legal Theory Working Paper Series, Research Paper No. 107, 2005), *available at* http://ssrn.com/abstract=677645.

86. *See Hogan*, 559 F.2d at 606–07.

87. *Plant Genetic*, 315 F.3d at 1340.

88. *See also* Chiron Corp. v. Genetech, Inc., 363 F.3d 1247, 1262–63 (Fed. Cir. 2004) (Bryson, J., concurring) (noting that claims cannot be construed "broadly enough to encompass technology that is not developed until later and was not enabled by the original application").

limitation on literal claim meaning, prohibiting the literal capture of later-developed technologies.

IV.
AFTER-ARISING EQUIVALENTS PROTECTION AND THE INCENTIVE TO INVENT

Having established above the need to resort to the doctrine of equivalents in order to actually capture later-developed technologies, the next question presented is a normative one—whether providing such protection is, on the whole, beneficial. The following section will start the exploration of this normative question, specifically looking at how after-arising equivalents protection impacts the ex ante incentive to invent that patent law is attempting to create.

After-arising equivalents protection has the ability to extend the perceived effective life of a patent by giving the patent holder exclusivity over implementations of her invention with later-developed technologies. By extending the patent's perceived effective life, after-arising equivalents protection, in turn, increases the incentive to invent. However, this analysis does not take into account the impact of after-arising equivalents protection on follow-on inventors—individuals whose inventions build upon the inventive activities of others. As the effective life of a patent is extended, the potential of deterring those would-be inventors who would improve upon the already patented invention by using later-developed technologies increases. Both the incentive and disincentive effects of after-arising equivalents protection will be explored in more detail below, with specific attention to the impact on both initial and follow-on inventors.

A. Incentive to Invent and the Would-Be Inventor's Perception

The United States patent laws are designed to "promote the Progress of Science and useful Arts."[89] To fulfill this goal, patent

89. U.S. CONST., art. I, § 8, cl. 8; *see also* 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.'") (quoting U.S. CONST., art. I, § 8, cl. 8).

There are non-utilitarian justifications for patent law, such as the reward theory. *See, e.g.*, Adam Mossoff, *Rethinking the Development of Patents: An Intellectual History, 1550–1800*, 52 HASTINGS L.J. 1255 (2001); A. Samuel Oddi, *Un-Unified Economic Theories of Patents—The Not-Quite-Holy Grail*, 71 NOTRE DAME L. REV. 267, 275–77 (1996).

law is classically viewed as providing an incentive to invent.[90] The incentive to invent is created by the limited exclusive protection that patent law provides over the invention.[91] The creation of inventions requires the expenditure of resources, including the time of the inventor and the costs of research and development.[92] A would-be inventor will not attempt to invent unless she can reasonably anticipate recouping her investment costs.[93] Inventions, which are basically ideas, are "public goods" that are easily copied and can be used by anyone without depletion or depriving others of the idea's use.[94] Without the ability to control the invention, the inventor could not demand the price for her invention needed to recoup

90. *See* Kewanee Oil Co. v. Bicron Corp., 416 U.S. 470, 480 (1974) ("The patent laws promote this progress by offering a right of exclusion for a limited period as an incentive to inventors to risk the often enormous costs in terms of time, research, and development."); Mark A. Lemley, *Ex Ante versus Ex Post Justifications for Intellectual Property*, 71 U. CHI. L. REV. 129, 129–30 (2004) (hereinafter, Lemley, *Ex Ante*) (referring to the incentive to invent as the "ex ante justification" for intellectual property law); Lemley, *Economics of Improvement*, *supra* note 34, at 993 ("Intellectual property is fundamentally about incentives to invent and create.").

Patent law is also viewed as providing certain incentives after invention, such as those identified in the prospect theory and commercialization theory. See Edmund W. Kitch, *The Nature and Function of the Patent System*, 20 J.L. & ECON. 265, 276–78 (1977) (describing the prospect theory of patents); Mark F. Grady & Jay I. Alexander, *Patent Law and Rent Dissipation*, 78 VA. L. REV. 305 (1992) (refining the prospect theory by focusing on rent dissipation in patent law); F. Scott Kieff, *Property Rights and Property Rules for Commercializing Inventions*, 85 MINN. L. REV. 697 (2001) (articulating the commercialization theory of patent law). Examining after-arising equivalents protection under these ex post justification for patent law is beyond the scope of this Article.

91. Lemley, *Economics of Improvement*, *supra* note 34, at 995–96 (noting that by giving inventors "control over the use and distribution of their ideas," intellectual property law "encourage[s] them to invest efficiently in the production of new ideas and works of authorship").

92. *See id.* at 994.

93. *See id.*

94. Joseph Scott Miller, *Building a Better Bounty: Litigation-Stage Rewards for Defeating Patents*, 19 BERKELEY TECH. L.J. 667, 681–82 (2004) (discussing the "free rider problem" that the public-good nature of invention creates and how it "undercut[s] the incentive to invent"); Katherine J. Strandburg, *What Does the Public Get? Experimental Use and the Patent Bargain*, 2004 WIS. L. REV. 81, 104–05 (2004) ("The production of patentable inventions is understood to be different from other commercial activity because the investment in new ideas, unlike the investment in capital equipment or materials, is assumed to be appropriable by competitors at very little expense."); Dan L. Burk & Mark A. Lemley, *Policy Levers in Patent Law*, 89 VA. L. REV. 1575, 1605 (2003) (indicating that "information is a public good for which consumption is nonrivalrous—that is, one person's use of the information does not deprive others of the ability to use it").

her costs and turn a profit.[95] Patent law gives the potential inventor some assurance that she can recover her sunk costs.[96] Patent law provides this assurance by giving the inventor control over her invention.[97] Without patent protection, inventions with social value that exceeds their social costs would not be made because such inventions would be unprofitable.[98] Patent protection, therefore, encourages potential inventors to develop ideas that are novel, useful, and nonobvious.[99]

The incentive to invent is maintained by the would-be inventor's perception that she will get adequate protection to recoup costs.[100] The incentive-to-invent rationale for patent protection fo-

95. Lemley, *Economics of Improvement*, *supra* note 34, at 994–95; *see also* Gideon Parchomovsky & Peter Siegelman, *Towards an Integrated Theory of Intellectual Property*, 88 VA. L. REV. 1455, 1466–67 (2002) (stating that "absent legal protection, competitors would copy such works without incurring the initial costs of producing them . . . [and, therefore,] [u]nauthorized reproduction would drive down the market price to the cost of copying, original authors and inventors would not be able to recover their expenditures on authorship and R&D, and, as a result, too few inventions and expressive works would be created").

96. *See* Lemley, *Economics of Improvement*, *supra* 34, at 995–96. Notably, patent law can only provide a perception that the patentee will be able to recover costs. *See* Lemley, *Ex Ante*, *supra* note 90, at 129–30; WESLEY M. COHEN, RICHARD R. NELSON, AND JOHN P. WALSH, PROTECTING THEIR INTELLECTUAL ASSETS: APPROPRIABILITY CONDITIONS AND WHY U.S. MANUFACTURING FIRMS PATENT (OR NOT) 3 n.4 (Nat'l Bureau of Econ. Research Working Paper No. 7552, 2000), *at* http://www.nber.org/papers/w7552 (noting that it is the "expectation" that patent law facilitates the generation of "ex post rents" that provides the incentive to invent). Other market conditions can prevent the patentee from actually recouping her investment costs, such as no demand for the patented product.

97. *See* Lemley, *Economics of Improvement*, *supra* note 34, at 995–96.

98. *See* Lunney, *supra* note 65, at 39.

99. There are, however, other incentives that promote inventions. *See, e.g.*, *id.* at 39 ("[E]ven in the absence of exclusive rights to the intangible information component of an innovative product, the private market, operating against a background of property rights in tangible things, will generate some incentive for innovation."); Michael Abramowicz, *Perfecting Patent Prizes*, 56 VAND. L. REV. 115 (2003) (discussing a reward, or prize, system to prompt inventing). In fact, companies traditionally rely upon other factors to protect their inventions. *See* COHEN ET AL., *supra* note 96, at 6, 8–9.

Patent law-based incentives to invent are still necessary, however, to ensure that inventions are created where the "social value exceeds their social costs" but are "unprofitable based upon the rents available from tangible property rights alone." Lunney, *supra* note 65, at 39.

100. *See* Lemley, *Ex Ante*, *supra* note 90, at 129–30; COHEN ET AL., *supra* note 96, at 3 n.4 (noting that it is the "expectation" of patent law facilitating the generation of "ex post rents" that provides the incentive to invent); Joseph S. Cianfrani, *An Economic Analysis of the Doctrine of Equivalents*, 1 VA. J.L. & TECH. 1, 45 (1997), *at* http://www.vjolt.net/vol1/issue/vol1_art1.html ("The potential patentee will the-

cuses on influencing pre-invention activity. This ex ante aspect of patent protection attempts to create an environment conducive to invention. To ensure that the incentive to invent is produced, patent laws must be evaluated with respect to how they affect a potential inventor's perception of the post-invention climate, as opposed to assessing whether the ex post effects occur exactly as planned.[101]

B. Maintaining the Incentive by Extending the Perceived Patent Life

A patent's life is limited in two ways—by the patent's scope and the patent's statutory life.[102] Patent law includes a statutory limitation on a patent's lifetime, requiring the patent to expire twenty years after its filing.[103] However, in most cases, the patent de facto expires well before its twenty years are up. Other products or processes may enter the market during a patent's statutory life that act as substitutes for the patented invention.[104] If these replace-

oretically evaluate the costs and benefits of the patent system along with the costs and expected benefits to the research.").

101. Although what actually happens after invention, and whether the protection is truly adequate, can also influence future behavior by the patentee and other observers. *See* Bronwyn H. Hall & Rosemarie Ham Ziedonis, *The Patent Paradox Revisited: An Empirical Study of Patenting in the U.S. Semiconductor Industry, 1979–1995*, 32 RAND J. ECON. 101, 109 (2001) (noting that the $1 billion damage award and injunction in the Polaroid/Kodak suit in 1986 reshaped companies' views on patenting).

102. Ted O'Donoghue et al., *Patent Breadth, Patent Life, and the Pace of Technological Progress*, 7 J. ECON. & MGMT. STRATEGY 1, 2–4 (1998) (introducing the concept of "effective patent life" composed of both the patent breadth and statutory patent life); Merges & Nelson, *supra* note 11, at 839 (discussing how important patent scope is to the "economic significance" of a patent).

103. *See* 35 U.S.C. § 154(a)(2) (2000) (noting that the patent "grant shall be for a term beginning on the date on which the patent issues and ending 20 years from the date on which the application for the patent was filed in the United States"). The term detailed in § 154(a)(2) can be adjusted due to delays created by the United States Patent Office during prosecution. See 35 U.S.C. § 154(b) (2000).

104. Products or processes that can replace the product or process embodying the patentee's invention in the market are considered substitutes. *See, e.g.*, O'Donoghue et al., *supra* note 102, at 2. Patents do not automatically confer monopoly power. The patent holder does not automatically enjoy market power in the relevant market for products or processes that satisfy the same consumer demand. *See* Walker Process Equip., Inc. v. Food Mach. & Chem. Corp., 382 U.S. 172, 177–78 (1965) (noting that "[t]here may be effective substitutes for the [patented] device which do not infringe the patent"); William A. Drennan, *Changing the Invention Economics by Encouraging Corporate Inventors to Sell Patents*, 58 U. MIAMI L. REV. 1045, 1158 (2004); Lemley, *Economics of Improvement*, *supra* note 34, at 996 n.26. Patents, however, give the patentee the power to exclude others from selling products falling within the patent's scope. *Id.* Thus, necessarily, there will be

ment products or processes do not fall within the patent's scope, they effectively force the patent to expire by requiring the patent holder to compete with replacement products or processes to recover her investment costs.[105] Non-infringing substitutes impinge on the market power that the patent holder enjoys in the area of the patented technology.[106] While the patent has not technically expired, it has effectively expired because the exclusivity that the patent provides is now worthless in the marketplace.[107]

The breadth of the patent's scope of exclusivity can prevent an early expiration. As discussed above, a patent gives its owner exclusivity in two ways—through its literal scope and its equivalents scope.[108] The larger the area of exclusivity provided by the patent, the larger the universe of products or processes the patentee can control.[109] Put another way, the broader the patent scope, the more protection the patent holder receives and the more competing products she can exclude.[110] A patent's breadth defines the universe of products or activities that cannot replace the patented

some "substitute" products that the patentee can exclude and others she cannot. The key point is that the broader the patent's scope, the more substitute products the patentee has power over. *See* Suzanne Scotchmer, *Standing on the Shoulders of Giants: Cumulative Research and the Patent Law*, 5 J. ECON. PERSP. 29, 30 (1991) (noting how the "breadth of patent protection is a key consideration in the incentive to innovate").

105. The patent holder no longer enjoys an exclusive market, preventing her from dictating the market price. *See* Lemley, *Economics of Improvement*, *supra* note 34, at 996.

The patent holder may never enjoy such an ability because of competition conditions in the industry or the inability for the invention to give her cost advantages over other competitors. *See id.* at 996 n.26; F.M. SCHERER & DAVID ROSS, INDUSTRIAL MARKET STRUCTURE AND ECONOMIC PERFORMANCE 444 (3d ed. 1990).

106. *See, e.g.*, Rite-Hite Corp. v. Kelley Co., 56 F.3d 1538, 1548–49 (Fed. Cir. 1995) (en banc) (discussing the negative effect on the patentee's profits from the presence of acceptable non-infringing substitutes in the market).

107. *See* O'Donoghue et al., *supra* note 102, at 2 (discussing effective patent life as the time "until a patented product is replaced in the market").

108. *See supra* notes 11–33 and accompanying text (discussing the literal and equivalents scope of a patent).

109. Ted O'Donoghue, *A Patentability Requirement for Sequential Innovation*, 29 RAND J. ECON. 654, 657 (1998) ("[P]atent breadth specifies a set of products that no other firm can produce without permission from the patentholder . . . ."); Scotchmer, *supra* note 104, at 30; Merges & Nelson, *supra* note 11, at 839–40 (indicating that "the broader the scope, the larger the number of competing products and processes that will infringe the patent").

110. *See* Merges & Nelson, *supra* note 11, at 839.

technology during the patent's statutory lifetime.[111] Patent breadth plays a crucial role in defining the effective life of a patent.[112]

The patent's effective life—the statutory period of patent protection limited by the patent's scope—is the foundation of the incentive to invent.[113] The perceived effective protection a patent will give an inventor creates the incentive to invent.[114] A potential inventor looks at the patent system and determines whether it will give her enough protection,[115] for a sufficient period of time,[116] to make inventing worth her time and money.[117] She wants a period of exclusivity so that she has time over which she can recoup her investment and enjoy some profits.[118] She also wants an area of exclusivity so that her patented product or process is not replaced over this time period by a substitute or improvement that she cannot exclude.[119] A potential inventor's perception of the strength of both of these components—statutory life and patent breadth—must be favorable to create a climate conducive to invention.[120]

111. *See* Drennan, *supra* note 104, at 1108 (noting how a patent "grants a pure monopoly in the market for the patented product").

112. *See* O'Donoghue et al., *supra* note 102, at 2 (citing other references supporting the proposition that patent breadth impacts "effective patent life").

113. *Id.* at 3–4; *see also* Jerry R. Green & Suzanne Scotchmer, *On the Division of Profit in Sequential Innovation*, 26 RAND J. ECON. 20, 21 (1995) ("Incentives to innovate are protected overall by granting a sufficient patent life.").

114. Perception of protection is key to the incentive to invent because, under this ex ante rationale, "the goal of intellectual property is to influence behavior that occurs before the right comes into being." Lemley, *Ex Ante*, *supra* note 90, at 129–30. The potential inventor's behavior is influenced, before the actual invention and resulting patent are created, by her perception of the protection the patent system will give her. At this early point in the inventing process, no concrete rights can be evaluated.

115. *See* Green & Scotchmer, *supra* note 113, at 21 (noting that patent breadth "determines how profit is divided in each period of the patent").

116. *See id.* (indicating that patent length "determines the total profit that is collected").

117. *See* O'Donoghue, *supra* note 109, at 669 (noting that "effective patent life" is "the length of time for which an innovator earns a share of market profits").

118. *See, e.g.*, Lemley, *Economics of Improvement*, *supra* note 34, at 994–96.

119. *See, e.g.*, *id.*; Scotchmer, *supra* note 104, at 33 ("The first innovator's incentive to invest becomes . . . weaker under narrow patent protection if the second generation product is a substitute for the first."); COHEN ET AL., *supra* note 96, at 8 n.17.

120. *See* RONALD J. MANN, THE MYTH OF THE SOFTWARE PATENT THICKET: AN EMPIRICAL INVESTIGATION OF THE RELATIONSHIP BETWEEN INTELLECTUAL PROPERTY AND INNOVATION IN SOFTWARE FIRMS 6–7, 39 (Univ. of Tex. Sch. of Law, Law and Economics Working Paper No. 022, Feb. 2004), *at* http://ssrn.com/abstract=510103 (noting that the most important facet of a software patent is to

The introduction of after-arising technologies can cut short a patent's effective life. Later-developed technologies do not reduce a patent's statutory life.[121] After-arising technologies can, however, limit a patent's effective life if they act as replacements for the patented technology that the patentee cannot control.[122] By using these later-developed technologies, competitors can bring to the market products or processes that effectively compete with the patented technology. Competition from new technologies may be particularly feared because of the potential increase in quality or decrease in cost that the later-developed technology may bring. If replacement after-arising technologies do not fall within the patent's scope, the patent's exclusivity is compromised, hampering the patentee's ability to recoup her research and development costs.[123] Therefore, a patent's ability to "survive" technological developments depends on the breadth of its patent protection.

Extending a patent's scope to include after-arising equivalents will maintain the patent's effective life in the face of such developments.[124] As discussed above, the patentee cannot capture these later technological developments within the patent's literal claim scope.[125] Equivalents protection is her only hope for excluding these new technologies with a previously issued patent.[126] After-arising equivalents protection gives the patentee the ability to capture newly developed technology that is insubstantially different

"carve out for the firm a space in which it can innovate without competition"); O'Donoghue et al., *supra* note 102, at 2–4, 24–25.

Some may argue that since later-developed technologies are unknown, they cannot effect a would-be inventor's decision to invent. *See* MUERER & NARD, *supra* note 34, at 45–46. However, as Muerer and Nard note, it is not the knowledge of the specific after-arising technology that creates the fear of inadequate protection in potential inventors. *Id.* at 46. The knowledge that such later developments are possible and that the would-be inventor may not be able to exclude such developments is what can hamper the incentive to invent.

121. *See generally* 35 U.S.C. § 154 (fixing the patent's statutory lifetime to the patent's effective filing date and the amount of delays during prosecution).

122. *See* O'Donoghue et al., *supra* note 102, at 2–4 (noting how the introduction of replacements for the patented product reduces effective patent life).

123. *See id.* at 24 (discussing the negative impact competition from substitutes has on innovation because of its effects on the profitability of research and development).

124. O'Donoghue, *supra* note 109, at 669 (indicating that effective patent life is extended if "future innovators will infringe" the patent).

125. *See supra* notes 68–88 and accompanying text (discussing the inability for patent claims to literally cover after-arising equivalents).

126. *See supra* notes 68–88 and accompanying text.

from the claimed technology.[127] The patent's breadth expands as new, equivalent technologies are created, preventing such new technology from replacing the patented product or process without the patentee's permission.[128] Protection over after-arising equivalents acts as insurance for the inventor. Insubstantial technological changes may not negatively affect the patentee's control over the patented technology because of this added patent protection.

By giving the patentee protection over after-arising equivalents, patent law can maintain the incentive to invent.[129] The doctrine of equivalents, in general, is viewed as maintaining the incentive to invent.[130] As the breadth of protection increases, the incentive to invent, particularly the incentive to invent a more costly invention, increases.[131] Allowing for protection for after-arising equivalents

127. *See supra* notes 23–33 and accompanying text (discussing the scope of protection gained under the doctrine of equivalents).

128. *See supra* notes 23–33 and accompanying text.

129. *See, e.g.*, O'Donoghue et al., *supra* note 102, at 25 (concluding that, by providing "leading breadth" protection over competing products of a higher quality than the patented invention, the incentive to innovate is maintained).

In fact, after-arising equivalents protection arguably addresses one of the main concerns those in the industry have with patents—the ability for competitors to easily design around them. *See* COHEN ET AL., *supra* note 96, at 14–15 (noting that the most cited concern about the effectiveness of patents is the ability for others to design around the disclosed invention).

130. *See* Lunney, *supra* note 65, at 75 ("To the extent that patents play an important role in innovation, narrowing the doctrine of equivalents is likely to reduce the incentives for, and hence the resources invested in, innovation."); Ryan Thomas Grace, *Losing the Forest Among the Trees in the* Festo *Saga—Rationalizing the Doctrine of Equivalents and Prosecution History Estoppel in View of the Historical Justifications for Patent Protection*, 11 J. INTELL. PROP. L. 275, 278 (2004) (noting how any reduction in the scope of the doctrine of equivalents reduces the incentive to invent); Kenneth D. Bassinger, *Allocating Linguistic Uncertainty in Patent Claims: The Proper Role of Prosecution History Estoppel*, 49 LOY. L. REV. 339, 402 (2003) (same); John W. Schlicher, *The Law, History, and Policy of Prosecution History Estoppel in Patent Actions in the U.S. Supreme Court*—Festo (Part II), 84 J. PAT. & TRADEMARK OFF. SOC'Y 692, 698 (2002) (discussing the role of the doctrine of equivalents in maintaining the incentive to invent); Cianfrani, *supra* note 100, at 45 ("Should the patent system be weakened by elimination of the doctrine of equivalents, the patentee's reward will be reduced by the *ex ante* decrease in value of the patent protection to the patentee."); Gary Dukarich, *Patentability of Dedicated Information Processors and Infringement Protection of Inventions That Use Them*, 29 JURIMETRICS J. 135, 170 (1989) ("The literal infringement and doctrine of equivalents tests have long served well in protecting and preserving incentives for those who create useful inventions."). *But see, e.g.*, Joshua D. Sarnoff, *Abolishing the Doctrine of Equivalents and Claiming the Future after* Festo, 19 BERKELEY TECH. L.J. 1157, 1205–08 (2004) (arguing that the doctrine of equivalents hampers the incentive to invent).

131. *See* Lunney, *supra* note 65, at 39–43, 64.

addresses a specific concern of would-be inventors. A potential inventor need not worry about patent protection vanishing in light of insubstantial technological developments. The presence of after-arising equivalents protection in patent law creates the perception that patent scope adapts to changes in technology. This perceived adaptation of patent scope translates into a perception that a patent's effective life will be limited by only its statutory life[132] or conditions outside of the patent system's control.[133] The patentee is able to control the patented invention even when it is implemented with after-arising technologies. The potential inventor will know that while she cannot exclude those developments that are substantially different from the claimed invention, anything less will fall into the patent's breadth because the patent can capture after-arising equivalents.[134]

Consider the facts in *Hughes Aircraft Co. v. United States* as a working example of how protection of after-arising equivalents can maintain the incentive to invent.[135] The technology at issue in *Hughes* concerned a control system for space satellites.[136] The patent, owned by Hughes, taught the use of sensors on the satellite that sent information on its position to a ground crew who would analyze the information and send signals back to the satellite.[137] With these signals from the ground, the satellite could adjust its orientation.[138] The claims required that the satellite be configured to both send information to the ground crew for processing and receive information from the ground crew to correct its position.[139]

132. *See* O'Donoghue et al., *supra* note 102, at 24–25.

133. Such conditions can be a complete shift in consumer preference away from the type of technology covered by the patent before the patent's statutory life expires.

134. *See* O'Donoghue, *supra* note 109, at 667 (noting, "When there is a long sequence of innovations, firms tend to underinvest without protection from future innovators"). There is a serious question whether potential inventors know of this protection for after-arising equivalents and understand the import of such protection. There is evidence, however, that companies pay attention to the extent of patent protection. *See* COHEN ET AL., *supra* note 96, at 27 (noting that "successful suits in electronics" have spurred both offensive and defensive patenting).

135. 717 F.2d 1351 (Fed. Cir. 1983).

136. *Id.* at 1352–53.

137. *Id.* at 1360 (specifically the patented satellite control system transmitted sun pulses received by the satellite to earth, "enabling the ground crew to simulate the rotation of the satellite and to calculate the satellite's spin rate, sun angle, and ISA position, *i.e.*, the measure of where the satellite is in its spin cycle at any instant of time," and, in return, transmit "firing signals to the jet, causing it to fire immediately and to produce precession").

138. *Id.*

139. *Id.* at 1355.

The accused United States satellite used an on-board computer to compute its current position and then reorient itself.[140] The allegedly infringing satellite did not use a ground crew to control its orientation.[141] This change in design from the patented invention was driven in part by the developments in computer technology and processing power after the Hughes's patent was filed.[142] The government satellite used after-arising technology in its design, allowing it to improve upon Hughes's initial design. The Federal Circuit concluded that the accused satellite did not literally infringe because it did not send or receive control information from a ground crew.[143] However, the court found infringement under the doctrine of equivalents, finding the on-board computer of the accused satellite equivalent to the claimed use of ground control.[144]

With these facts, consider the decisions Hughes faced before it even developed the patented satellite control system. Hughes, when setting out to design its satellite control system, presumably considered the protections patent law would provide for any invention it created.[145] Hughes knew that if it invested its time and money in developing the control system, patent law would provide it with exclusivity over the invention for a fixed period of time.[146] Hughes was concerned, however, as to whether this exclusivity

140. *Id.* at 1360–61 (the accused spacecraft transmits the sun pulses "to a computer on board the spacecraft rather than to the ground").

141. *Id.*

142. *Id.* at 1364 (noting that the accused device "employed a modern day computer").

143. *Id.* at 1360–61.

144. *Id.* at 1364–66.

145. *See, e.g.*, Cianfrani, *supra* note 100, at 45 ("Since a patentee's incentives stem in large part from the protection he will receive from a patent, a potential patentee's incentives will be reduced somewhat from a regime in which the doctrine of equivalents is present to protect them.").

This presumption is, admittedly, a big one. Many commentators have noted, empirically in some cases, that patent protection plays little to no role in the invention decision-making process. *See* COHEN ET AL., *supra* note 96, at 3–4, 9–10. However, there is some evidence to the contrary. *See, e.g.*, MANN, *supra* note 120, at 6–7, 39–42; COHEN ET AL., *supra* note 96, at 25 (noting that there has been "a modest increase in reported effectiveness, suggesting that patents may now be playing a more central role in the appropriability strategies of larger firms").

146. Again, this assumes they have some knowledge about patent law. One of the potential fallacies of the incentive to invent theory of patent law is that it assumes possible inventors are aware of the protections patent law provides. *See supra* note 134.

It is also worth noting that the patent at issue in *Hughes* was controlled by the previous statutory period of protection—seventeen years from the date of issue. *See* 35 U.S.C. § 154(c)(1) (2000).

would be effective enough to allow it to price its satellite control system above the marginal cost of reproduction for a long enough period of time to recoup its costs and justify engaging in the process of inventing.[147] Its concerns included, in addition to the ability to control imitations of its invention, whether someone would produce a variation on its invention that would drive its price close to marginal costs.[148]

The facts in *Hughes* provide a real example of this scenario occurring, through the government's use of a satellite control system using new computer processing technology unavailable when Hughes invented.[149] If the potential inventor perceives that she can exclude such later developments that are considered equivalents to her invention, her belief that patent protection will be effective in allowing her to recoup costs increases. Without such protection, her perception of the effectiveness of patent protection is much different, because she knows that the value of her invention can be severely impacted by the introduction of a new technological substitute for one component of her invention, as illustrated by the facts of *Hughes*.[150] Protection for after-arising equivalents gives the potential inventor additional peace of mind that patent protection will be effective for a sufficient period of time. This peace of mind preserves the incentive to invent.

C. Decreasing the Incentive by Deterring Follow-On Inventions

The above analysis focused on maintaining the incentive to invent for a single invention. Protection for after-arising equivalents provides an incentive for this single invention because such protection ensures a longer effective patent life.[151] However, this single invention model fails to take into account that most inventions build upon earlier inventions.[152] An invention does not exist in a vacuum.[153] The potential inventor's perceptions are influenced by what has already been invented and, more importantly, the protec-

147. *See* Lemley, *Economics of Improvement*, *supra* note 34, at 996 (discussing the need for intellectual property law to allow such pricing to facilitate invention).

148. *See* O'Donoghue et al., *supra* note 102, at 24–25 (discussing the merits of providing the patent holder protection against competing products of inferior and superior quality with respect to the invention).

149. In fact, the developer of the government's satellite control system looked to the Hughes's invention for guidance, taking more from the Hughes design than from the newer designs available. *Hughes*, 717 F.2d at 1364.

150. *Id.* at 1364–66.

151. *See supra* notes 12–33 and accompanying text.

152. Merges & Nelson, *supra* note 11, at 842–43.

153. *Id.* at 870.

tion afforded to these already existing inventions.[154] Patent law must consider the impact of maintaining the incentive for one inventor on the incentives for potential inventors to follow—those who will be building from, or improving upon, the initial invention.[155] The impact on the incentive to create follow-on inventions must especially be considered in the case of after-arising equivalents. After-arising equivalents are, by definition, subsequent inventions using new technology with an existing patented invention.[156]

The concept of cumulative innovation concerns not only the initial invention, but subsequent inventions that build off of the initial invention.[157] These subsequent inventions can take the form of variations that simply substitute for the initial invention.[158] They can also take the form of variations that improve upon the initial invention.[159] The crucial factor for these types of inventions is that they start with the initial invention and either modify it or use it as an ingredient in another product or process, creating a subsequent invention. The development is cumulative, with the next inventor using the previous invention as a starting block.

154. *Id.* 843, 875–76 (noting that overly broad rights "will preempt too many competitive development efforts"). In contrast, under most ex post patent theories, such as the prospect theory, the initial inventor's control over subsequent developments forms the basic justification for patent protection. *See* Kitch, *supra* note 90, at 276.

155. Merges & Nelson, *supra* note 11, at 842–43 (considering the effects of patent scope in general on subsequent improvements).

156. After-arising equivalents may not be patentable inventions. That is, they may not meet the test for patent protection. *See* Lemley, *Economics of Improvement*, *supra* note 34, at 1007–08 (discussing "minor improvers" whose inventions do not "translate[ ] into a minimum social contribution to obtain a patent").

157. Burk & Lemley, *supra* note 94, at 1607–08 (discussing the patent theory of cumulative innovation); Green & Scotchmer, *supra* note 113, at 20 (noting that "[k]nowledge and technical progress are cumulative in the sense that products are often the result of several steps of invention, modification, and improvement").

158. Merges & Nelson, *supra* note 11, at 870. In fact, even in a cumulative development environment, the initial inventor needs an adequate incentive to invent to ensure the "entire line of technology" is not "stymie[d]." *See* Green & Scotchmer, *supra* note 113, at 20.

159. *See* Merges & Nelson, *supra* note 11, at 870. For the purposes of this section of the Article, all types of subsequent inventions will be considered. Merges & Nelson and Lemley focus their analysis to providing incentives for actual improvers, as opposed to all subsequent developers who modify the initial invention. Merges & Nelson, *supra* note 11, at 870; Lemley, *Economics of Improvement*, *supra* note 34, at 1000.

In the cumulative development environment, there are multiple inventors' incentives that need to be taken into account.[160] The initial would-be inventor needs incentives to create her invention.[161] However, once the initial invention is protected, concerns should turn to the incentives for would-be subsequent inventors. The worries for the subsequent inventor are twofold. First, the subsequent inventor has the same concern as the initial inventor—that, without protection, others will easily copy her invention, preventing her from recouping her research and development costs. Second, concerns that are unique to the subsequent inventor arise regarding the initial inventor's ability to control the second inventor's creation.[162] While patent protection quells the first concern, as it does with the initial inventor, patent protection may have the opposite effect with respect to the second concern. Since the subsequent invention will build off of the initial invention, the second potential inventor will likely worry that the first inventor's patent rights may block the second inventor's ability to market and profit from her invention.[163] The stronger a potential inventor perceives the first inventor's rights to be, the more likely the subsequent potential inventor will be deterred from trying to develop variations or improvements to the initial invention.[164] The second would-be inventor may see the initial patent as an immovable roadblock, thus deterring any follow-on invention.

Expanding patent protection through the doctrine of equivalents in general can discourage the creation of substitutes for and improvements on patented inventions.[165] The amount of current protection on a given patent can affect the incentives for potential inventors to evolve already patented technology.[166] The

160. Merges & Nelson, *supra* note 11, at 843 (considering these multiple incentives with regards to patent scope).

161. *See supra* notes 89–101 and accompanying text.

162. *See* Scotchmer, *supra* note 104, at 38 ("Before investing in a second generation technology, the researcher must evaluate the probability that the new technology will not infringe the prior patent."); Merges & Nelson, *supra* note 11, at 916.

163. Merges and Nelson discuss the fear a subsequent inventor may have of getting "enmeshed in litigation." Merges & Nelson, *supra* note 11, at 916.

164. *Id.* at 875–76.

165. *See id.* at 915 ("When a broad patent is granted or expanded via the doctrine of equivalents, its scope diminishes incentives for others to stay in the invention game, compared again with a patent whose claims are trimmed more closely to the inventor's actual results.").

166. *See* Burk & Lemley, *supra* note 94, at 1607–10 (discussing the concept of "cumulative innovation" and the effects patent protection has on such innovation); Clarisa Long, *Patents and Cumulative Innovation*, 2 WASH. U. J.L. & POL'Y 229,

broader the protection, the more likely the patent holder can control substitutes and improvements to her patent.[167] Perceiving the possibility of control by the current patentee, potential follow-on inventors may choose not to invent.[168]

After-arising equivalents protection has a higher chance, compared with other areas of equivalents protection, of creating a disincentive to potential follow-on inventors.[169] Protection for after-arising equivalents is targeted at subsequent inventions. By definition, after-arising equivalents embody the use of later-developed technologies in insubstantial variations on the patented invention.[170] These types of equivalents fit into the cumulative development model by using a new technology in an already created invention.[171] And protection for after-arising equivalents gives the

237–45 (2000) (discussing whether strong patent protection "enervate[s] the incentives for downstream research" in different biotechnology fields); Lemley, *Economics of Improvement*, *supra* note 34, at 1005–07; Scotchmer, *supra* note 95, at 32, 35 (noting that protection for an initial invention "can lead to deficient incentives to develop second generation products" based on the initial invention because the follow-on developer "must transfer some of the innovation's revenue to the first innovator by licensing"); Merges & Nelson, *supra* note 11, at 884.

Notably, even broad literal patent scope can reduce the incentive to invent improvements to a patent invention. *See* Merges & Nelson, *supra* note 11, at 908–09 (discussing the tailoring of patent scope in general, irrespective of the patent scope's literal and equivalent components).

167. *See* Lemley, *Economics of Improvement*, *supra* note 34, at 1005–07; O'Donoghue, *supra* note 109, at 672 ("The more backloaded are payoffs, the smaller is the reward to successful innovation."); Merges & Nelson, *supra* note 11, at 884.

168. *See* Lemley, *Economics of Improvement*, *supra* note 34, 997–99.

The doctrine of equivalents can also deter further innovation through the uncertainty it casts on a patent's scope. *See* Warner-Jenkinson Co. v. Hilton Davis Chem. Co., 520 U.S. 17, 28–29 (1996); Gen. Elec. Co. v. Wabash Appliance Corp., 304 U.S. 364, 369 (1938) ("The limits of a patent must be known for the protection of the patentee, the encouragement of the inventive genius of others and the assurance that the subject of the patent will be dedicated ultimately to the public.").

169. Even absent such protection, fundamental aspects of patent law protection can decrease the incentives for the subsequent inventors. The literal scope of a patent may at least partially dominate later developments by restricting the new technology from using some of the initial patent's legacy aspects, creating a blocking patent situation. *See, e.g.*, Robert Merges, *Intellectual Property Rights and Bargaining Breakdown: The Case of Blocking Patents*, 62 TENN. L. REV. 75 (1994).

170. *See, e.g.*, Festo Corp. v. Shoketsu Kinzoku Kogyo Kabushiki Co., 234 F.3d 558, 619–20 (Fed. Cir. 2000) (en banc) (Rader, J., concurring in part, dissenting in part) (discussing after-arising equivalents), *vacated by* 535 U.S. 722 (2002).

171. *See, e.g.*, BEI Techs., Inc. v. Matsushita Elec. Indus. Co., 268 F. Supp. 2d 782, 800–02 (E.D. Mich. 2003) (discussing a potential after-arising equivalent to a claimed angular rate sensor that used tuning fork comprised of two later-developed bonded crystal materials in contrast to the claimed single crystal material).

initial inventor the ability to exclude, and therefore control, these subsequent developments. This ability to control after-arising equivalents has negative effects on the incentives of would-be subsequent inventors in the cumulative innovation environment.[172] A potential subsequent inventor may be hesitant to invest in a particular invention for fear of not being able to recoup her costs because an earlier patentee may block, and at least demand royalties for, the practice of her patented invention.[173]

The cumulative nature of technological development makes the disincentive aspect of after-arising equivalents protection applicable to almost every invention in the development chain.[174] Unless the invention is a pioneering invention or does not use after-arising technology,[175] the invention is building off of someone else's work and potentially falling within the after-arising equivalents scope of an earlier patented invention.[176] So every potential inventor who uses new technologies will have concerns that she may not be able to exploit her invention, even if the new invention is patented. She may be dominated by an existing patent and the patent's protection for after-arising equivalents. Almost every inventor is following another's technological development, and protection for after-arising equivalents deters these follow-on inventions.

The facts in *Hughes* can again be used as a starting point to demonstrate the effect protection for after-arising equivalents has on incentives to invent. Any potential inventor looking to improve upon or change Hughes's satellite control system would think twice about investing in research and development of such changes be-

172. *See* Burk & Lemley, *supra* note 94, at 1607–10; Merges & Nelson, *supra* note 11, at 876–79.

173. *See* Burk & Lemley, *supra* note 94, at 1607–10; Merges & Nelson, *supra* note 11, at 876–79.

174. *See* O'Donoghue, *supra* note 109, at 655 (noting that each inventor is both an initial inventor and subsequent inventor in the long sequence of technological development in most industries).

175. The term "pioneer invention," "although used somewhat loosely, 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 has gone before." Westinghouse v. Boyden Power Brake Co., 170 U.S. 537, 561 (1898); *see also* John R. Thomas, *The Question Concerning Patent Law and Pioneer Inventions*, 10 HIGH TECH. L. J. 35, 45–52 (1995) (discussing pioneer invention doctrine).

176. *See* Lemley, *Economics of Improvement*, *supra* note 34, at 1010 (noting that every invention is an improvement at some level, even pioneers).

cause of the after-arising equivalents protection Hughes enjoys.[177] Such improvements can be captured by Hughes, just as the improved satellite design used by the government was found infringing. The initial inventor, with this protection, can acquire the benefits of subsequent developments using new technologies—diminishing the incentive for those potentially following on.[178] The government did pursue improving upon the Hughes design. However, the result of *Hughes*, which demonstrates the increased control over subsequent developments that after-arising equivalents protection provides, likely made potential subsequent developers of the Hughes technology think twice about investing in such research.

Subsequent inventors using after-arising technologies can, however, avoid being captured by an initial inventor's patent. The most obvious way to avoid such capture is for the subsequent invention to be substantially different from the initial patented invention.[179] That is, the subsequent invention should be a "radical improvement"[180] over the initial invention. If the next step in the cumulative development is a giant leap over the initial invention, the subsequent invention will not infringe because it falls outside the range of equivalents.[181]

Even if the user of an after-arising technology does not create a radical improvement, her improvement may still be significant enough to qualify for patent protection.[182] The subsequent inventor therefore can obtain a patent and, as a result, block the initial inventor from practicing the initial invention with the later-devel-

177. This, obviously, assumes that the follow-on inventor is aware of Hughes's patents or the possibility of such patents.

178. *See* Lemley, *Economics of Improvement*, *supra* note 34, at 1005 (discussing the *Hughes* case).

179. The subsequent development is not an equivalent because it fails the applicable test—either the function, way, result test or the insubstantial differences test. *See Warner-Jenkinson*, 520 U.S. at 40.

180. This terminology is taken directly from Lemley's analysis of different types of potentially infringing improvers. Lemley, *Economics of Improvement*, *supra* note 34, at 1010–13.

181. *See Warner-Jenkinson*, 520 U.S. at 40. The "reverse doctrine of equivalents" does not apply to radical improvements that use after-arising equivalents, because such improvements cannot literally infringe the patent's claims, *see supra* notes 17–27 and accompanying text, and the reverse doctrine only applies to questions of literal infringement, *see* SRI Int'l v. Matsushita Elec. Corp., 775 F.2d 1107, 1118 (Fed. Cir. 1985) (en banc).

182. That is, if the subsequent development meets the threshold tests for utility, novelty, and obviousness. *See generally* 35 U.S.C. §§ 101–103 (describing the conditions for patentability).

oped technology encompassed by the subsequent inventor's patent.[183] Creation of these "significant improvements"[184] generates a blocking-patents situation in which both the initial inventor and the subsequent inventor cannot practice the subsequent invention without license from the other inventor.[185] So, using the facts in *Hughes*, if the government's use of an on-board computer was considered nonobvious over the Hughes's invention, the government could have obtained a patent and blocked Hughes from making and selling on-board satellite control systems.[186] If both parties wanted to practice the improved satellite control system, they would both need licenses from each other—Hughes from the United States to use on-board control and the United States from Hughes to use the base invention.

The means for subsequent inventors to avoid capture from initial inventors set forth above do not, however, completely eliminate the impact on the incentive for subsequent inventors to invent. Initially, the uncertainty of the range of equivalents can deter potential inventors from pursuing radical improvements.[187] The exact scope of the after-arising equivalents afforded to a patent is tough to define, particularly when the range of equivalents is ever-changing as new technologies are developed.[188] A potential subsequent inventor cannot determine before she sets out to invent whether the invention she will create will not fall within the range of

183. Lemley, *Economics of Improvement*, *supra* note 34, at 1008–10; Merges & Nelson, *supra* note 11, at 860–62.

184. This terminology is also taken directly from Lemley's analysis on improvements. *See* Lemley, *Economics of Improvement*, *supra* note 34, at 1009–10 ("The original patent owner can prevent the improver from using his patented technology, but the improver can also prevent the original patent owner from using the improvement.").

185. For example, the initial inventor develops and patents a widget with element X. A second inventor, starting with the initial inventor's widget, creates an improved widget having element X and element Y. The improvement is patentable, and the second inventor gets a patent on a widget with elements X and Y. The second inventor's patent is dominated by the initial inventor's patent because the second invention uses element X—subject matter the initial inventor has exclusivity over. The initial inventor cannot practice the improvement using both element X and Y because the second inventor has exclusivity over that subject matter. Thus, in order to practice the improvement—widget with elements X and Y—both the initial inventor and the second inventor need licenses from the other.

186. *See Hughes*, 717 F.2d at 1360–61, 1364–66.

187. *See* Adelman & Francione, *supra* note 25, at 682–83 (discussing the "serious consequences" of the uncertainty created by the doctrine of equivalents).

188. *Id.*

equivalents.[189] Such a prediction is plagued with uncertainties—the scope of equivalents and the attributes of the not-yet-created invention. Second, for the subsequent inventor who creates a significant improvement, there is fear that the initial inventor will not bargain and cross-license.[190] Third, there is always the possibility that the potential subsequent inventor may create something that does not even rise to the level of patentability—her invention may be a "minor improvement."[191] In this situation, she cannot avoid infringement by being substantially different or create a blocking-patents situation by having a patent of her own.[192]

The central concern is how after-arising equivalents protection affects the perceptions of a potential subsequent inventor. The stronger such protection, the less favorable the follow-on invention climate looks to potential inventors. Just as after-arising equivalents protection has the potential to maintain, or increase, the incentive to invent, it has equal potential to deter invention.

V.
TAILORING AFTER-ARISING EQUIVALENTS PROTECTION

After-arising equivalents protection can both maintain the incentive to invent, by ensuring an adequate effective patent life, and decrease the incentive to invent, by blocking a subsequent inventor's entrance into the market. As a result, it is unclear whether this type of protection will really stimulate invention or in fact damper it. This part of the Article takes a second look at after-arising equivalents protection to see if some tailoring of the protection can maximize its incentive-creating ability and minimize its disincentive-creating ability.[193] This section will look at whether after-arising

189. *Id.* (noting that this uncertainty can "frustrate[ ] and chill[ ] the activities of . . . other inventors, who must be concerned about whether their efforts will be met by an infringement suit based on the amorphous doctrine of equivalents").

190. Merges & Nelson, *supra* note 11, at 865 (noting that the original patentee may "use her patent as a 'holdup' right, in an attempt to garner as much of the value of the improvement as possible").

191. Again, this terminology is taken from Lemley's analysis. *See* Lemley, *Economics of Improvement*, note 34, at 1007–08 (discussing the "minor improver").

192. *Id.* This may be of no concern, considering the subsequent invention does not rise to the level of patent protection. Society may see no benefit in providing incentives for such inventions. *Id.*

193. The tailoring of patent scope in general has been discussed before. *See* Merges & Nelson, *supra* note 11, at 843–44; *see also* Robert M. Hunt, *Patentability, Industry Structure, and Innovation*, 52 J. INDUS. ECON. 401, 415–16 (2004) (discussing the tailoring of the standards of patentability to the particular characteristics of

equivalents protection can be tuned with respect to certain attributes of particular technological industries. Two possible tailoring schemes are investigated—one tailoring protection to non-cumulative technology industries and the second tailoring protection to rapidly developing cumulative technology industries. The first tailoring scheme, while not deterring follow-on inventions, fails to effectively increase the incentive to invent because potential inventors in non-cumulative technology industries worry little about after-arising technologies. Such tailoring is, on the whole, inefficient. In contrast, targeting industries that are cumulative and rapidly developing focuses protection efficiently on contexts in which would-be inventors have the highest concern that their invention will quickly be replaced by later-developed technologies.

As Robert P. Merges and Richard R. Nelson observed, inventions and the circumstances surrounding their creation and use are not the same for every industry.[194] Taking these differences into account, one may be able to tailor after-arising equivalents protection to industries where its protection results in a true incentive to invent. The tailoring of after-arising equivalents protection is particularly possible because such protection is a judicially created doctrine whose exact formulation is dictated by the courts.[195] The doctrine of equivalents, in and of itself, is a tailoring regime, providing protection only if the accused device is similar to the claimed invention.[196] Furthermore, the test for determining whether an invention constitutes an after-arising equivalent leaves room for judi-

different industries). Merges and Nelson present a theory of tailored incentives. *Id.*; Burk & Lemley, *supra* note 94, at 1607–08. Lunney has also discussed the tailoring of patent doctrines, such as obviousness and the doctrine of equivalents. See Lunney, *supra* note 65, at 5–7.

194. *See* Merges & Nelson, *supra* note 11, at 843. Many others have observed the same fact—that invention and inventors are different from industry to industry. Burk & Lemley, *supra* note 94, at 1581–89 (discussing the industry-specific nature of invention).

195. Graver Tank & Mfg. Co. v. Linde Air Prods. Co., 339 U.S. 605, 608 (1950); Lunney, *supra* note 65, at 70–72 (noting that "[t]he discretion available under the doctrine of equivalents is therefore likely to prove far more effective at identifying competitive substitutes and, for that reason, far more useful in tailoring individually optimal patent protection"); Burk & Lemley, *supra* note 94, at 1641, 1674 (noting the "inherent nature of discretion in patent law").

196. The doctrine's equitable roots are evidence of the doctrine tailoring its application to the facts of each patent case. *See, e.g.*, Festo Corp. v. Shoketsu Kinzoku Kogyo Kabushiki Co., 234 F.3d 558, 593 (Fed. Cir. 2000) (Plager, J., concurring), *vacated by* 535 U.S. 722 (2002) (discussing the equitable nature of the doctrine of equivalents).

cial discretion.[197] Courts could simply fold in any tailoring criteria to the current test for the doctrine of equivalents.

Tailoring patent doctrine to the particulars of a technological industry is nothing new. As Dan L. Burk and Mark A. Lemley detail, there already exist many "policy levers" in patent law that take into account the specific attributes of different technological industries.[198] Policy levers take the form of patent legislation and judicially created doctrine.[199] These policy levers ensure that patent law furthers its goals by adjusting doctrine in response to circumstances surrounding the area of technology and the patent law at issue. By tailoring after-arising equivalents protection with regard to certain industry characteristics, the protection can also be a policy lever—tuning patent protection to further the incentive to invent.[200]

A. Tailoring Protection to Non-Cumulative Technology Industries

One tailoring option is to limit after-arising equivalents protection to only those industries where new technologies do not build upon earlier inventions. Protection can be limited to those industries where development is taken in discrete steps. By focusing after-arising equivalents protection on these "non-cumulative" technologies, the deterrence effects of such protection are minimized. In industries where few inventions build off already existing inventions, after-arising equivalents protection is less likely to block future developments. In discretely developing industries, the nature of the industry makes would-be inventors less concerned about the scope of existing patent protection.[201]

Merges and Nelson discuss narrowing patent scope in general for industries where invention is cumulative.[202] Cumulative technology industries are those in which many inventions are modifica-

197. *Warner-Jenkinson*, 520 U.S. at 40 (discussing the discretion courts have in formulating the exact test for equivalents).

198. Burk & Lemley, *supra* note 94, at 1641–58 (detailing existing policy levers). There are objections to the use of policy levers. See *id.* at 1668–70. In the case of after-arising equivalents protection, tailoring is needed to maintain the incentive to invent without deterring subsequent inventions. *See infra* Part V.A–B.

199. Burk & Lemley, *supra* note 94, at 1630.

200. Burk and Lemley mention the doctrine of equivalents as a potential policy lever, but do not explore it. *Id.* at 1641.

201. Merges & Nelson, *supra* note 11, at 880–81. Others have discussed similar approaches. *See* Julie E. Cohen & Mark A. Lemley, *Patent Scope and Innovation in the Software Industry*, 89 CAL. L. REV. 1, 40–42 (2001) (discussing the prevalence of reuse in software development).

202. Merges & Nelson, *supra* note 11, at 916.

tions of or improvements to current technologies.[203] These industries do most of their technical advancement in incremental, cumulative steps, building upon existing inventions to generate new technology. A good example of a cumulative technology industry is the software industry.[204] Computer software can be developed by reusing existing coding techniques and previous pieces of code.[205] In addition, the computer industry in general, including the hardware and semiconductor industries, traditionally develops incrementally with new technologies that are commonly modifications of and improvements to existing technology.[206] Technological progress in these industries is cumulative and relies on the work of many different inventors.

Merges and Nelson advocate narrowing patent protection in these industries because broader protection can deter future invention.[207] The broader the patent scope, the greater the universe of subsequent inventions an existing patentee can capture and control.[208] In response, potential inventors may forgo building on the existing technology out of fear that the existing patent holders can seize any new technology and the accompanying profits.[209] To prevent such deterrence, Merges and Nelson suggest narrowing patent scope in these industries.[210] The cumulative nature of such industries makes it more likely that future inventors will be affected by the breadth of existing patents.[211]

The same reasoning holds true when considering after-arising equivalents protection. One major way to build on existing inventions is to modify the invention using a later-developed technol-

203. Burk & Lemley, *supra* note 94, at 1619–20; Scotchmer, *supra* note 104, at 29; Merges & Nelson, *supra* note 11, at 880–81.

204. Burk & Lemley, *supra* note 94, at 1620–23 (describing the rationale for cumulative innovation in the software industry); Cohen & Lemley, *supra* note 201, at 40–42. Another current example of a cumulative innovation industry is the biotechnology industry. *See* Arti K. Rai, *Fostering Cumulative Innovation in the Biopharmaceutical Industry: The Role of Patents and Antitrust*, 16 BERKELEY TECH. L. J. 813, 816–18 (2001).

205. Mark A. Lemley & David W. O'Brien, *Encouraging Software Reuse*, 49 STAN. L. REV. 255, 265 (1997).

206. Burk & Lemley, *supra* note 94, at 1694 (discussing how semiconductors chips are "composite device, comprised of multiple inventions, each of which may be covered by a separate patent"); Merges & Nelson, *supra* note 11, at 881.

207. Merges & Nelson, *supra* note 11, at 882, 916.

208. *Id.* at 882.

209. *Id.* at 916.

210. *Id.*

211. *See* Burk & Lemley, *supra* note 94, at 1620–23 (agreeing that such tailored protection is needed to ensure development in the software industry).

ogy.[212] The ability of a patent holder to capture such modification to her invention, via the doctrine of equivalents, can deter the potential improver. The capture of modifications by existing patent holders creates a disincentive to develop or use new technologies in combination with already existing technologies.[213] Such modification using after-arising technologies will fall under current patent protection if they are equivalent.[214] The potential improver, seeing this as a possibility, will be dissuaded from pursuing such developments.[215] An improver can get bogged down in litigation with a patent holder exerting her after-arising equivalents protection.[216]

Therefore, tailoring to non-cumulative technology industries removes after-arising equivalents protection from those industries in which there is activity that can be deterred. By tailoring after-arising equivalents protection away from cumulative industries, subsequent inventors are not deterred from pursuing modification to existing technologies. Potential inventors, knowing that no after-arising equivalents protection exists, are free to pursue further developments using later-developed technologies without the fear that current patentees can capture their inventions. After-arising equivalents protection is taken away from the industry where it can have the most negative impact on the incentive to invent.

This same tailoring, however, also takes away equivalents protection that is likely to increase the incentive to invent.[217] Industries with cumulative product development are the very industries where after-arising equivalents protection matters to a would-be inventor. Follow-on inventions cut a patent's effective life short by replacing the patented product or process.[218] After-arising equivalents protection extends effective patent life by providing the patentee with control over these later-developed improvements.[219] Cumulative technology industries are the very industries in which after-arising equivalents can have a positive impact on the incentive to invent.

212. *See, e.g.*, *Hughes*, 717 F.2d at 1360–63 (discussing how the government's design modified Hughes's satellite control design to take advantage of new computing power).

213. Merges & Nelson, *supra* note 11, at 916.

214. *See* Adelman & Francione, *supra* note 25, at 712.

215. *See* Merges & Nelson, *supra* note 11, at 916.

216. *See id.*

217. *See* O'Donoghue, *supra* note 109, at 667–69 (noting that in industries where "there is a long sequence of innovations, firms tend to underinvest without protection from future innovators").

218. See *supra* notes 121–28 and accompanying text.

219. *See* Merges & Nelson, *supra* note 11, at 916.

The opposite of the above analysis applies to non-cumulative technology industries. There is no need to narrow protection in non-cumulative industries in order to minimize the deterrent effect of after-arising equivalents protection.[220] Technologies in these industries develop in discrete steps, with inventions having little to no relation to previous inventions in the industry.[221] Non-cumulative industries develop an invention, and this invention "does not point the way to wide ranging subsequent technical advances."[222] Examples of non-cumulative industries given by Merges and Nelson are the consumer goods packaging industry and the toy industry.[223] Broad protection in non-cumulative industries does not typically produce deleterious effects.[224] Since potential inventors in these industries do not look to old technologies to build upon, their concerns regarding existing patents are low.[225] The likelihood of existing patents blocking the commercialization of their new invention is small because the new invention is not based on existing technology.[226] Put simply, a new invention in a non-cumulative industry is rarely within the range of equivalents of an existing patent.

Again, for similar reasons, after-arising equivalents protection in non-cumulative industries is less likely to deter invention. A would-be inventor in such industries is unlikely to use a new technology with an existing patented invention. New developments, even if they use new technologies, will not fall within the equivalents scope of issued patents. Each invention is discrete in these industries, falling outside the realm of any potential equivalents protection.[227] Actors in such industries are not concerned about being blocked by existing patents because of the industry's discrete nature.

After-arising equivalents protection could, therefore, be tailored to non-cumulative technology industries.[228] Tailoring protection to non-cumulative technology industries directs protection

220. *Id.* at 881.
221. *Id.*
222. *Id.* at 880.
223. *Id.* at 880–81.
224. *Id.*
225. *Id.*
226. *Id.*
227. The doctrine of equivalents provides protection for only those products or processes that either are insubstantially different from the claimed invention or meet the function, way, result test. *See Warner-Jenkinson*, 517 U.S. at 40.
228. Basically, this is a specialized application of the tailoring incentives discussed by Merges and Nelson. *See* Merges & Nelson, *supra* note 11, at 916.

where it has the least negative impact. After-arising equivalents protection can deter the use of new technologies with existing inventions.[229] In non-cumulative technology industries, the potential for a new inventor to use later-developed technologies with an already patented technology is low. As such, the disincentive aspects of after-arising equivalents protection in non-cumulative industries are minimal. There is no subsequent development activity to deter because such development is rare.

Tailoring after-arising equivalents protection to non-cumulative technology industries, however, also minimizes the incentives created by this protection. Potential inventors in non-cumulative technology industries do not worry about any reduction in effective patent life from replacement technologies. In discrete invention industries, after-arising equivalents protection does not extend the effective life of the patent. There are no subsequent inventions the broadened patent scope can capture. New developments do not fall along the inventive path of the initial patent in non-cumulative technology industries.[230] The reason after-arising equivalents protection is harmless to the incentives for future inventors is the same reason such protection does little for earlier inventors. New developments in non-cumulative technology industries are, in most cases, not equivalents. They lie outside the earlier invention's technological area, unable to be captured by after-arising protection. After-arising equivalents protection in these industries does not increase the incentive to invent because such protection addresses a non-concern of potential inventors and provides inventors in this industry with little additional actual protection.

Thus, tailoring protection to non-cumulative industries is inefficient. While this tailored protection introduces little harm to the incentive to invent, it provides little benefit because of the nature of the industries targeted. And this minimal benefit comes at the cost of, at the very least, an increase in doctrinal complexity. The introduction of the doctrine of equivalents into patent protection for these industries introduces certain costs, mainly as a result of the doctrine's inherent uncertainty.[231] In fact, instead of adding a layer of patent protection for non-cumulative technology industries that provides minimal additional incentives, it might be far better to simply forgo after-arising equivalents protection for these types of industries all together. If after-arising equivalents protection is

229. *See supra* notes 151–73 and accompanying text.

230. Merges & Nelson, *supra* note 11, at 881.

231. *See, e.g.*, *supra* note 163.

rarely needed in a certain type of industry, the simplest solution is to not provide such protection for those industries.

The benefits of after-arising equivalents protection are, therefore, squandered by tailoring protection to non-cumulative technology industries. In contrast, after-arising equivalents protection actually impacts the patent's effective life in cumulative industries. A would-be inventor in a cumulative technology industry has real concern about a later-developed technology cutting her patent protection short. After-arising equivalents protection has far greater import to potential inventors in industries that experience cumulative development.

B. Tailoring Protection to Rapidly Developing Cumulative Technology Industries

Another option is to tailor after-arising equivalents protection to cumulative technology industries that experience a rapid rate of development. That is, after-arising equivalents protection can be tailored to those cumulative industries in which the hit rate of technological change is very high.[232] If the rate of development in a cumulative industry reaches a certain threshold, after-arising protection takes effect. This tailored protection is similar to providing the opposite of the tailored protection discussed above. However, the protection is available solely to industries in which technological progress is both cumulative and rapid. Such tailoring maximizes the incentive-maintaining aspects of after-arising protection because it focuses on industries in which effective patent life is likely to be cut short by later technological developments.

Rapidly developing industries are industries in which technologies come to market quickly and often. The developments in such industries are not necessarily patentable developments—they include those "minimal improvements" that are not new, useful, or nonobvious.[233] And if the industry is a cumulative technology in-

232. The tailoring of patent protection when the hit rate of ideas is high has been discussed before. *See* O'Donoghue et al., *supra* note 102, at 25 (recommending such protection). However, this discussion does not focus on using the doctrine of equivalents as a vehicle for providing the tailored protection. *See id.* (noting that "one must ask what the patent authorities must observe in order to implement such a policy").

233. If the industry was one in which the fast pace of technological change included only patentable advances, then the need for after-arising equivalents protection would, potentially, not be needed. However, the problem with making that assumption is that it is impossible to determine, for certain, that after-arising equivalents protection did not create the incentive for such patentable jumps in technology. Taking protection away from such industries could stall such inventive

dustry, then the rapid pace of development forces quick turnover of products or processes in the market within the same inventive path. New, subsequent technologies compete with, and potentially replace, earlier patented technologies. The quicker subsequent technologies are developed, the sooner already-patented products or processes are challenged in the marketplace.[234]

An example of a "rapidly advancing 'cumulative' technolog[y]" industry is the semiconductor industry.[235] The semiconductor industry experiences a quick rate of technological progress.[236] The development process in this industry is relatively fast, and sped up, in part, by the use of automation and computer-aided design to create and test new designs.[237] In turn, this short development time allows technological change to occur more frequently. These exogenous forces, outside the patent system, cause semiconductor development to occur at a rapid pace.[238] This development includes all types of advances, including those minor advances that are not patentable inventions. The semiconductor industry is not only subject to rapid change but also cumulative. Most new products or processes build upon already existing technologies, usually developed by other parties.[239] New chip designs and fabrication techniques commonly emerge from existing technologies.

The biopharmaceutical industry, in contrast, experiences a very low rate of technological advancement. The development timeline for a new biotechnology product, such as a pharmaceuti-

advancements. Therefore, the tailoring discussed here applies to all industries that experience cumulative, rapid technological development, even if the developments are only of a patentable nature. However, obviously, the need for after-arising equivalents protection is higher in those industries experiencing non-patentable advancements—that is a higher quantity as opposed to quality of technological progress. There, after-arising equivalents protection can "correct" such industries by providing the incentive to invent patentable subject matter.

234. *See* O' Donoghue et al., *supra* note 102, at 25 (discussing the concept of high "hit rate of ideas" in the context of "how quickly an innovator would lose his market position in the absence of [ ] protection").

235. Hall & Ziedonis, *supra* note 101, at 102. Another rapidly advancing, cumulative technology industry is the software industry. *See* Burk & Lemley, *supra* note 94, at 1620–23.

236. Hall & Ziedonis, *supra* note 101, at 102 (noting the "rapid pace of technological change" in the industry).

237. *Id.* at 105–07 (noting the rise of automation, and other changes, that have sped up the research and development process).

238. *Id.* at 105.

239. *Id.* at 102 ("[A]ny new product or process is likely to overlap with technologies previously or simultaneously developed by external parties."); Merges & Nelson, *supra* note 11, at 881.

cal, is extremely long.[240] In addition, the regulatory process governing the introduction of new pharmaceuticals slows development.[241] As a result, the time between technologies in the biopharmaceutical industry can be fairly lengthy. This slow development rate occurs even though the industry's technological progress is cumulative in nature, with new developments building upon previous ones.[242]

Cumulative industries with a high hit rate of new technologies are the very industries that need after-arising equivalents protection to maintain the incentive to invent. As discussed above, after-arising equivalents protection is a concern only in cumulative technology industries.[243] In non-cumulative industries, potential inventors have little worry that any invention they develop will be substituted by the use of a new technology in the same inventive path. In contrast, a potential inventor in a cumulative industry will have significant concern that any invention she produces will be modified or improved upon by another in the industry.[244] The subsequent development may potentially replace the initial inventor's product or process in the marketplace. After-arising equivalents protection gives potential inventors some peace of mind that they can capture equivalent modification of their patented products or processes that use later-developed technology.[245] Such protection makes inventions with a high social value—patentable invention—more likely to be developed because the invention has a higher likelihood of being profitable.[246]

240. Burk & Lemley, *supra* note 94, at 1676 & n.383 (noting that it can take between twelve and fifteen years from beginning of research to market) (citing Pharm. Research and Mfrs. of Am., Why do Description Drugs Cost so Much . . . (June 2000), http://www.phrma.org/publications/publications/brochure/questions/).

241. Burk & Lemley, *supra* note 94, at 1676. While this process is streamlined somewhat for generic drug manufacturers, "regulatory hurdles" are also imposed on these follow-on developers. See 21 U.S.C. § 355(j)(2)(A)(i) (2000); Bayer AG v. Elan Pharm. Research Corp., 212 F.3d 1241, 1244–45, 1249–50 (Fed. Cir. 2000) (describing the abbreviated new drug application ("ANDA") process); Burk & Lemley, *supra* note 94, at 1677.

242. *See* Rai, *supra* note 204, at 816–18.

243. *See supra* notes 202–31 and accompanying text.

244. *See supra* notes 202–31 and accompanying text.

245. *See supra* notes 102–34, 202–31 and accompanying text; *see also* MANN, *supra* note 120, at 42, 47 (noting the concern of most software companies that "a competitor might appropriate any useful invention at any time" and that this concern "makes patents and their breadth an item of interest to inventors").

246. *See* Lunney, *supra* note 65, at 39–43.

The concerns for a potential inventor rest on an additional factor, however. Her worries lie not just with cumulative developments, but also with the possibility that such developments will come quickly. Potential inventors are focused on effective patent life—broad enough protection for a long enough period of time that allows them to recoup their costs.[247] Cumulative developments are a concern, because they can cut this effective patent life short. But cumulative developments are a concern only if they are created before the initial inventor has had time to recoup her research and development costs.[248] Therefore, the more rapid the cumulative development in an industry, the more fearful a potential inventor will be that her period of exclusivity will be cut short before she can recover costs. The perception by individuals in such industries is that any invention they create will almost immediately face a potential replacement in the marketplace. If the cumulative industry's turnover in technology is slow, a potential inventor has less apprehension. She will be replaced eventually with a subsequent development, but this replacement will come later rather than sooner, after she has had a chance to recover her sunk costs. The higher the rate of technological progress in a cumulative industry, the more concern a potential inventor has about after-arising technologies and their ability to replace her patented product or process too soon. Accordingly, referring to the semiconductor industry example, protection for after-arising equivalents afforded a patent in this area preserves the patent's effective life by expanding its scope.[249] A would-be chip-design or fabrication-process inventor perceives this protection as beneficial because there is a higher likelihood she will recover her sunk costs and she is, therefore, incentivized to invent.[250]

247. *See supra* notes 90–101 and accompanying text.

248. The ability to recoup research and development costs creates the incentive to invent. *See* Lemley, *Economics of Improvement*, *supra* note 34, at 994–96.

249. *See, e.g.*, O'Donoghue et al., *supra* note 102, at 2–3 (explaining how patent scope is a component of effective patent life); *see also* Hughes, 717 F.2d at 1364–66 (finding infringement by an after-arising equivalent in the computer industry).

250. *See* Cohen & Lemley, *supra* note 201, at 47 ("Arguably, allowing software patentees to capture the value of improvements many generations removed from the initial invention simply preserves incentives to innovate in the face of rapid technological change."); Lemley, *Economics of Improvement*, *supra* note 34, at 994–96 (noting that the ability to recoup research and development costs creates the incentive to invent).

After-arising equivalents protection and patent law are providing an incentive to invent patentable inventions—inventions that are new, useful, and nonobvious. Thus, while the semiconductor industry experiences a high hit rate of new technol-

Contrast the semiconductor industry climate with that of the biopharmaceutical industry. In the biopharmaceutical industry, the rate of development is low.[251] There is, thus, little fear that a patented invention will be replaced before the patent's statutory life expires. To maintain the patent's effective life, no expansion of patent scope is required. After-arising equivalents protection is, therefore, not needed in most cases to maintain the incentive to invent. And this is true even with the cumulative nature of the biopharmaceutical industry. The use of new technologies, while potentially falling into the original patent's path of invention, comes infrequently because of the slow rate of technological progress. Protection against after-arising equivalents is not as much of a concern for potential biopharmaceutical inventors. The protection does not play a role in the recouping of research and development costs.

Tailoring protection to rapidly progressing cumulative industries, while increasing the incentive to invent, still has the potential to deter follow-on innovation. By focusing on cumulative industries with a high rate of advancement, the incentive-creating aspects of protection are emphasized. But such protection, even when narrowed to industries with these characteristics, may still discourage follow-on inventors by extending the effective patent life of existing patents.[252] Current patent holders, with this type of protection, may be able to control generations of technological development of the initial invention.[253] Seeing existing patentees' possible coverage of later-developed technologies, potential subsequent developers may choose to forgo melding new developments with existing technologies. Consequently, such protection targeted to quickly advancing cumulative industries could deter the creation of new generations of technology.

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ogies, these new technologies are not necessarily of inventive quality. And this high hit rate can discourage the investment in technologies of the patentable level—leaving after-arising equivalents protection as a tool to encourage such investments. O'Donoghue, *supra* note 109, at 655–56 (noting that companies target different levels of invention, with the patentability requirements steering companies to a higher level of invention).

251. *See supra* notes 240–42 and accompanying text.

252. *See* Merges & Nelson, *supra* note 11, at 916.

253. *See, e.g.*, Burk & Lemley, *supra* note 94, at 1622–23 (discussing retarding effects of broad patent protection in the software industry—an industry that experiences "rapid, incremental innovation"); Cohen & Lemley, *supra* note 201, at 39–50. Cohen and Lemley further note that the incremental nature of the software industry may increase the likelihood that triers of fact would find that subsequent developments are equivalents. *Id.* at 41.

This type of tailoring creates the reverse of the tradeoffs experienced when focusing protection on non-cumulative industries. Here, after-arising equivalents protection is directed to those industries in which protection has a higher likelihood of increasing the incentive to invent. However, the protection is directed toward cumulative industries—environments where after-arising protection has a real potential of deterring subsequent invention. This deterrence can negate any advances in incentives generated by after-arising equivalents protection, particularly because in cumulative industries every potential inventor is a follow-on inventor, building upon an existing technology.

The negative deterrent effects of this type of tailoring are minimized, however, by the following mechanisms. First, under the tailoring scheme under discussion, after-arising equivalents protection is not directed to all cumulative industries, but only to those experiencing rapid technological development. Targeting protection to this additional level of specificity helps to minimize the number of industries that may experience the deterring effects of protection. Directing protection to rapidly progressing industries also ensures that protection is aimed at those industries where later-developed technologies are more likely to have an early, and therefore more noticeable effect, on the patent's effective life. Protection is tailored to those industries where those who are developing new inventions have the greatest concerns of patent protection being cut short. Thus, by tailoring protection to this second level—rapidly developing industries—the incentive-increasing effects of protection will, at the very least, be high enough to offset any deterrence to the creation of new inventions.

An additional benefit of basing the application of after-arising equivalents protection on an industry's rate of progress is that such tailoring provides an internal check to minimize the deterrent effects of protection. Protection is given only if the subject industry experiences a high rate of technological change. If that rate of development is low, no after-arising equivalents protection is given. If it is high, protection is afforded. Thus, if after-arising equivalents protection significantly slows the rate of advancement down, by deterring follow-on developers, and stalls any inventive development, the protection will be removed. The industry will no longer be at a high rate, and therefore after-arising equivalents protection will not be needed to ensure an adequate effective patent life. Once the rate returns to its high levels, after-arising equivalents protection

kicks back in, to maintain the incentive to invent.[254] By tailoring protection to the rate of technological progress, protection is only afforded if it is needed to provide the incentive to invent. If the protection starts to retard advancement in the industry, the protection stops because the rate slows down. That is, by tailoring protection in this way, a dynamic adjustment is put in place to prevent after-arising equivalents protection from causing too much harm by deterring follow-on inventions and, as a result, slowing the rate of technological progress. Admittedly, there can be incremental harm to the incentive to invent before this self-correcting mechanism becomes effective. Adjustments to protection may be slow, particularly when application of the tailoring scheme is implemented by the courts. These potential harms are, however, only incremental. And the possibility of a self-correcting mechanism—tailoring to rapidly progressing industries—will signal to potential inventors that protection is narrowly targeted and attempting to avoid deterrence of follow-on inventions.

In addition, a potential follow-on inventor has tools to avoid being captured by an existing patentee. As mentioned earlier, these tools cannot eliminate the negative impact that after-arising equivalents protection has on the incentive to invent.[255] However, they can minimize the deterring effects. If the subsequent invention is a "radical improvement," in that it is not an equivalent, the subsequent inventor can avoid being enjoined. The new invention may be found non-infringing because it is not equivalent to the already-patented invention, falling outside the after-arising equivalents protection.[256] The subsequent invention may also be a "substantial improvement," in that it is patentable but still falls within the equivalents scope of the initial invention. The follow-on inventor, can, in this instance, use her patent to block the existing patentee from practicing her development, forcing a bargaining sit-

254. Potentially, after-arising equivalents protection may harm the incentive for follow-on inventions in an industry to such an extent that the rate of invention will never rise again. This is, however, unlikely because the rate of invention in such industries can be tied to exogenous forces outside of patent law. *See supra* notes 235–42 and accompanying text. Thus, patent law is not simply trying to keep these industries progressing technologically, but attempting to provide incentives for those patentable jumps in technology, particularly those which would not be created absent some exclusivity to facilitate cost recovery. *See* Lunney, *supra* note 65, at 39, 74–75.

255. *See supra* notes 187–92 and accompanying text.

256. *See supra* note 179 (discussing the test to determine whether an allegedly infringing product or process infringes under the doctrine of equivalents).

uation.[257] While a substantial improvement can be captured by an existing patentee, the ability to patent the improvement allows the subsequent inventor to block the initial patentee from practicing the new invention.

As stated earlier, these "outs" are not certain, but they do provide a subsequent developer with the potential of avoiding capture by an existing patentee. In addition, the availability of these two favorable situations to the would-be subsequent inventor provides incentives for her to create more than minimal improvements, further advancing social welfare. Also, the ability to either avoid infringement or create a blocking situation is only available to the subsequent inventor. An initial inventor gains nothing from these situations, unless she is also trying to avoid capture from an earlier inventor. These doctrines, therefore, have little import in non-cumulative industries, where capture by an earlier inventor is unlikely because of the nature of the industry, and not because of resort to the legal doctrines of "radical improvement" and "substantial improvement."

The increased incentive from after-arising equivalents protection that the follow-on inventor will enjoy further minimizes the deterrent effects of this tailored protection. In contrast, there are no similar mechanisms to provide the incentive to invent when tailoring protection to non-cumulative industries. Tailoring protection to non-cumulative industries, while minimizing the deterrent effects of protection, leaves nothing to provide an incentive to invent for those inventors affected by after-arising technologies.[258] The patent doctrine meant to provide incentives to would-be inventors is patent protection—both literal and equivalent.[259] If an industry is truly non-cumulative, providing more than literal protection for an invention—particularly providing protection over after-arising equivalents—is of little import to would-be inventors.

Tailoring protection to cumulative, rapidly developing industries may create some disincentive to pursue follow-on inventions, but there are self-correcting mechanisms and specific doctrines, dis-

257. *See supra* notes 182–86 and accompanying text (noting the blocking patent situation).

258. *See supra* notes 230–31 and accompanying text. This can be a significant problem, because lowering the incentive to invent on the front end can prevent a would-be inventor from ever creating, stalling the cumulative invention process. See O'Donoghue, *supra* note 109, at 654–55; Green & Scotchmer, *supra* note 113, at 20–21, 25–26 (noting that to maintain the incentive to invent for the initial inventor, effective patent life must actually facilitate the recovery of more than research and development costs).

259. *See supra* notes 89–101, 129 and accompanying text.

cussed above, at play that minimize the extent of these disincentives. And tailoring to industries with a high rate of development maintains the incentive to invent on the front end. Thus, when all is considered, tailoring to rapidly developing, cumulative industries provides more of an incentive to invent, on balance, than tailoring to non-cumulative industries.

Two final concerns regarding tailoring protection to rapidly developing cumulative industries still need to be addressed. One lingering concern is that an increase in the incentive to invent is not needed in such industries because they are already experiencing rapid technological progress. Such a concern, however, overlooks the goal of the incentives patent law is attempting to create—to encourage inventions of patentable quality. Even if an area of technology is experiencing quick technological turnover, the new technologies being created may not be new and nonobvious in light of what has already been created. The incentives that patent law introduces attempt to encourage the development of patentable, socially valuable inventions.[260] By providing after-arising equivalents protection to industries that are already experiencing technological progress, patent law is providing incentives focused on the quality of the inventions produced, not the quantity.

A second, very real concern focuses on how such tailoring can actually be implemented. Tailoring that is linked to the specific attributes of the patent's industry is admittedly difficult to put into practice, particularly when the implementation will most likely be done by courts on a case-by-case basis and the attributes of a given industry may change over time. The basic test for the doctrine of equivalents, however, already requires courts to engage in some tailoring of protection—providing protection over only those allegedly infringing devices that are considered equivalent under the relevant test.[261] The tailoring suggested in this Article can be folded into the current equivalents test, with the court requiring the patentee to bear the burden of proving that the patent sits in an industry experiencing rapid and cumulative technological development. This would simply be an additional burden of proof on the patentee, on top of the traditional equivalents test. The patentee would provide information about the industry—how new inventions are developed and how often development occurs. The accused infringer could then contest the patentee's assertions, in the

260. *See, e.g.*, Lunney, *supra* note 65, at 39.

261. *See supra* notes 47–50, 195–97 and accompanying text (discussing the discretion already inherent in the current formulation of the doctrine of equivalents).

same way she already contests offerings of proof on the basic equivalents question. Courts are already asked to "identify[ ] competitive substitutes" for the patented invention under the current formulation of the doctrine of equivalents.[262] The tailoring suggested would further specify the identification courts make under the current doctrine of equivalents standard.

CONCLUSION

The ability to provide protection over after-arising equivalents has recently been put forward by many as the main justification for the doctrine of equivalents. Thus, there is a real need to look not only at the doctrine of equivalents in general, but also at this specific type of protection for after-arising technologies. This Article has started the discussion by addressing the technical need for such protection and the implications of such protection under the incentive-to-invent rationale for patent law. The tailoring of after-arising equivalents protection is clearly needed. Focusing such protection to cumulative industries that experience a high rate of technological turn over maximizes the incentive-creating aspects of this protection. Many other issues regarding after-arising equivalents, however, still need to be explored, including how such protection plays out under other justifications and rationales for patent protection, particularly those that focus on the ex post effects of patent protection.

262. Lunney, *supra* note 65, at 70–72.