HACKING THROUGH THE THICKET: A PROPOSED PATENT POOLING SOLUTION TO THE NANOTECHNOLOGY "BUILDING BLOCK" PATENT THICKET PROBLEM

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ABSTRACT

Over-patenting and the issuance of overly-broad nanotechnology "building block" patents by the United States Patent and Trademark Office have generated a densely enmeshed patent thicket that seems impossible to navigate. The nanotechnology "building block" patent thicket is preventing the commercialization of useful innovations. Collaborative effort to construct patent pools composed of the specific "building block" nanotechnology patents provides a feasible, promising, and practical means of untangling the complicated nanotechnology patent thicket. The framework for a patent pool proposal includes six critical steps. First, it is advisable that anyone seeking to implement a nanotechnology "building block" patent pool should submit a proposal for preliminary review to the Department of Justice and the Federal Trade Commission. Second, the proposal should contain a well-formulated plan of action. Third, pool participants should then analyze and evaluate which patents are complementary and essential for inclusion in the pool. Fourth, the pool participants should seek an objective independent review of the patents to ensure relevance to the pool. Fifth, the pool participants should develop a procompetitive licensing structure that is based on the Agencies' Antitrust Guidelines for the Licensing of Intellectual Property to mitigate antitrust concerns. Sixth, pool participants should collectively decide on a royalties sharing strategy for the pool.

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INTRODUCTION

Over-patenting by universities, private companies, and research institutions, combined with problems during examination of nanotechnology patents at the United States Patent and Trademark Office (USPTO), has led to the formation of a nanotechnology-based patent thicket.[1] The simultaneous existence of too many overlapping and mutually exclusive "building block" patents[2] held by too many distinct entities has created a fear of infringement litigation that is

1. A patent thicket results when too many owners hold overlapping intellectual property patents. *See* Gavin Clarkson & David DeKorte, *The Problem of Patent Thickets in Convergent Technologies*, ANNALS N.Y. ACAD. SCI. 180, 180–81 (2006).

2. At the early stages of nanotechnology development, too many patents were sought protecting essential basic building block technologies that serve as the foundation of nanotechnology research and development. These patents are collectively called "building block" patents because they were issued at the outset of nanotechnology emergence. *See* Mark A. Lemley, *Patenting Nanotechnology*, 58 STAN. L. REV. 601, 606 (2006). "Building block" patents protect fundamental research, manufacturing, and/or processing techniques upon which downstream innovation is dependent. *See generally* John C. Miller & Drew L. Harris, *The Carbon Nanotube Patent Landscape*, 3 NANOTECHNOLOGY L. & BUS. 427, 435 (2006) (defining the term "building block" as used in their scholarship on the carbon nanotube patent landscape). Miller and Harris's definition also suits the purposes of this Note.

stifling nanotechnology[3] innovation and commercialization. Many proposed solutions to the nanotechnology thicket problem have been proffered, including patent reexamination, infringement litigation, licensing, government intervention, and pooling patents in a commons. However, these proposed solutions are not economically viable, offering either prohibitively high transaction costs, or no practical means for generating revenue. Patent pooling is an ideal means for untangling the nanotechnology patent thicket because it can dissolve the barriers preventing further innovation and commercialization of nanotechnology, while still yielding revenue for the patent holders. This Note suggests a course of action to follow if a pooling of the "building block" nanotechnology patents were to occur. By preparing a nanotechnology patent pool proposal that clearly defines the scope of the patent pool, identifies the necessary patents for inclusion in the pool, and provides both a licensing structure and a royalties payment structure, those seeking to construct a nanotechnology patent pool can untangle the nanotechnology "building block" patent thicket, while mitigating potential antitrust concerns.

The purpose of this Note is to lay out an action plan to follow in the event that a pooling of the "building block" nanotechnology patents occurs. Part I of this Note offers a background summary and description of nanotechnology and defines nanotechnology patent thicket and the problems it presents. Part II, Section A illustrates how the nanotechnology patent thicket developed and explores the specific issues that arose at the USPTO when nanotechnology emerged as a field of patentable science. Part II, Section B supplies an investigation into the legal doctrines that prevent downstream research entities and start-up companies from innovating nanotechnology applications out of fear of patent infringement. An assessment of some of the proposed solutions to the nanotechnology patent thicket problem will illustrate why there is a need for a patent pooling model, despite criticism that such a model will be difficult to orchestrate.[4] Part III lays out a plan of action, describing how to create and manage the construction of a "building block" patent pool, while incorporating the *U.S. Department of Justice & Federal*

3. Nanotechnology is a broad term applied to technology that exists at the nanometer scale. *What It Is and How It Works*, U.S. NAT'L NANOTECHNOLOGY INITIATIVE, http://www.nano.gov/nanotech-101/what (last visited Mar. 24, 2012).

4. *See* Terry K. Tullis, Comment, *Application of the Government License Defense to Federally Funded Nanotechnology Research: The Case for a Limited Patent Compulsory Licensing Regime*, 53 UCLA L. REV. 279, 296–97 (2005).

Trade Commission's Antitrust Guidelines for the Licensing of Intellectual Property,[5] to avoid antitrust law concerns within the patent pool structure.

I. WHAT IS NANOTECHNOLOGY AND WHAT IS THE BIG PROBLEM?

Innovations that miniaturize technologies offer great potential for scientific advancement; and technological innovation goes hand-in-hand with business opportunity. To date, there has been limited success in the early stages of nanotechnology commercialization in areas such as cosmetics[6] and materials science,[7] yet regulatory and legal challenges still impede commercialization efforts of nanotechnology applications.[8] Moreover, the emergence of a nanotechnology patent thicket prohibitively complicates the intellectual property (IP) landscape, preventing small start-up firms and financially-strapped research universities from moving forward with business models to get their technologies into the marketplace.[9]

When nanotechnology emerged as a patentable field of science, universities, research centers, and nanotechnology companies rushed to the USPTO to procure intellectual property protection on their prospective patents in a fashion that has been described as a "patent land grab."[10] As a result of the deluge of nanotechnology patent applications, the USPTO encountered multiple challenges while examining and administering nanotechnology patents. Some of these challenges include the use of inconsistent terminology by patentees when describing their claims and USPTO examiners lacking the appropriate educational background(s) to properly evaluate the nanotechnology patents.[11]

Furthermore, nanotechnology is often highly cross-disciplinary in its applications.[12] Nanotechnology has a myriad of possible applica-

5. U.S. DEP'T OF JUSTICE & FED. TRADE COMM'N, ANTITRUST GUIDELINES FOR THE LICENSING OF INTELL. PROP. § 2.3 (1995) [hereinafter ANTITRUST GUIDELINES].

6. Jessica K. Fender, Note, *The FDA and Nano: Big Problems with Tiny Technology*, 83 CHI.-KENT L. REV. 1063, 1074 (2008).

7. Tullis, *supra* note 4, at 285.

8. *E.g.*, Raj Bawa, *Nanotechnology Patent Proliferation and the Crisis at the U.S. Patent Office*, 17 ALB. L.J. SCI. & TECH. 699, 702 (2007).

9. *See id.*

10. Raj Bawa, *Nanotechnology Patenting in the U.S.*, 1 NANOTECHNOLOGY L. & BUS. 1, 17 n.36 (2004) [hereinafter Bawa, *Nanotechnology in the US*].

11. *See* Bawa, *supra* note 8, at 727.

12. *See* David S. Almeling, Note, *Patenting Nanotechnology: Problems with the Utility Requirement*, 2004 STAN. TECH. L. REV. N1, ¶7 (2004).

tions in multiple established fields, including but not limited to textiles, electronics, and ceramics.[13] Compared to other areas of science, locating prior art in the field of nanotechnology can be very taxing,[14] because a patent examiner may conclude that the majority of the technology captured in the patent lies predominantly in a field other than nanotechnology. In an effort to centralize nanotechnology patents, the USPTO announced in October 2004 the development of a classification specifically for nanotechnology—Class 977.[15] The USPTO further narrowed the categories of nanotechnology by creating a digest of 263 specific subclassifications in November 2005.[16] Efforts by the USPTO to detail these classifications have yet to prove useful because it is virtually impossible at present to prevent overlapping and conflicting patents from being issued by different examiners at approximately the same time.[17]As a result of these challenges and difficulties, a patent thicket has formed. The IP becomes underused[18] and stymies commercialization efforts and innovation in that field.[19] This is essentially what has happened in nanotechnology. Use of such patents without permission from the patent holder is generally considered infringement,[20] which can be avoided only by either licensing the IP from the patent holder, or awaiting expiration of the patent.

To avoid infringement, innovators have traditionally had several options. For example, obtaining licenses to use the existing IP can protect against infringement. However, the high transaction costs associated with licensing all the necessary overlapping "building block" patents in the nanotechnology thicket have deterred many entities from moving forward with nanotechnology innovation.[21] Another option is for small firms to seek reexamination of those patents that are so overly broad that they are obstructing the start-up's

13. *Id.*

14. Bawa, *Nanotechnology Patenting in the US*, *supra* note 10, at 18.

15. Fender, *supra* note 6, at 1067.

16. *Id.* at 1084.

17. *See* Clarkson & DeKorte, *supra* note 1, at 183.

18. Underutilization of IP refers to the situation when too many owners hold the right to exclude others from use of a patented idea, device, or process, and then no one has an effective privilege to use that patent. *See* Tullis, *supra* note 4, at 283.

19. *See* Clarkson & DeKorte, *supra* note 1, at 180.

20. There is an exception called the experimental use defense, which permits experimentation with the patented invention of another. Typically there is no threat that the infringer will commercialize on the unauthorized use of a patentee's IP. *See* Tullis, *supra* note 4, at 300.

21. *E.g.*, Bawa, *supra* note 8, at 731.

efforts to commercialize, but litigation requires capital that small start-ups often do not have.

An alternative is to pool nanotechnology "building block" patents.[22] A carefully planned, objectively reasoned, and strategically executed nanotechnology patent pool proposal could reduce transaction costs associated with licensing multitudes of IP and allay infringement fears. The proposal would require thorough research to identify all essential complementary patents needed for inclusion in the pool; independent third party review of the selected patents to ensure that the technical and legal assessment of the patents to be included promotes innovation, efficiency, and the dissemination of technology; and careful drafting of a licensing agreement and royalty payment schedule which satisfies all parties involved, while remaining procompetitive to avoid antitrust litigation. This Note will lay a foundation upon which a complete nanotechnology "building block" patent pool could be constructed.

This Note suggests a six-step plan of action designed to minimize antitrust complications commonly associated with the formation of patent pools. Clear definition of the nanotechnology patent pool's scope and identification of the types of patents necessary for inclusion in a pool will be advocated in this Note to help reduce the chance of encountering antitrust difficulties. Furthermore, this Note will provide recommendations regarding the licensing structure of the pool and the type of royalty payment structure that would be best for a nanotechnology patent pool.

II. BACKGROUND FACTS AND LEGAL DOCTRINES

The U.S. National Nanotechnology Initiative (NNI) defines nanotechnology as "the understanding and control of matter at the nanoscale, at dimensions between approximately 1 and 100 nanometers, where unique phenomena enable novel applications. . . . A nanometer is one-billionth of a meter."[23] "A sheet of paper is about 100,000 nanometers thick . . . a single gold atom is about a third of a nanometer in diameter."[24] This "unique phenomena" refers to the governance of quantum mechanics over physical, biological, and

22. "A patent pool involves a single entity . . . that licenses the patents of two or more companies to third parties as a package." Carl Shapiro, *Navigating the Patent Thicket: Cross Licenses, Patent Pools, and Standard Setting*, 1 INNOVATION POL'Y & ECON. 119, 134 (2000).

23. U.S. NAT'L NANOTECHNOLOGY INITIATIVE, *supra* note 3.

24. *Size of the Nanoscale*, U.S. NAT'L NANOTECHNOLOGY INITIATIVE, http://www.nano.gov/nanotech-101/what/nano-size (last visited Mar. 24, 2012).

chemical properties at the atomic level.[25] Scientists are fascinated by the ability of nanostructures to self-assemble due to the "intrinsic dynamics of matter at the nanometer scale."[26] The potential applications for highly perfected assemblies of nanostructures are vast and promising.[27]

A. The Formation of the Nanotechnology Patent Thicket: Inextricable Tangles, Knots, and Snarls

A United States patent grants its holder a twenty-year monopoly, excluding others from making, using, selling, or offering for sale the protected invention in the United States and its territories.[28] In exchange for the monopoly, patent holders must disclose their inventions to the public, and allow the public to freely make, use, sell or offer to sell the invention after expiration of the patent.[29] Active enforcement or the impending threat of enforcement of a patentee's exclusion rights on patents can generate a patent thicket. The emergence of the nanotechnology field has presented some unique challenges regarding the patenting of its "building block" technology.

Unlike other fields of technological advancement—for example, biotechnology, computers, and software[30]—nanotechnology patents have been issued for some of "the most basic ideas in nanotechnology,"[31] such as fundamental research techniques, manufacturing tools, and fabrication methods.[32] A patent comprising characteristically "building block" claims may not hold any commercial promise on its own, but the utilization of those claims could be crucial to the downstream production of a marketable product.[33] Patents on "building block" technologies tend to stymie downstream commer-

25. Lemley, *supra* note 2, at 602.

26. Wolfgang Bacsa, *Self-Assembly and Nanostructures: Fabricating Without a Top-Down Tool*, SCITIZEN (Apr. 23, 2007, 01:27 PM), http://www.scitizen.com/nanoscience/self-assembly-and-nanostructures-fabricating-without-a-top-down-tool_a-5-527.html. For background information on bottom-up self-assembly of nanostructures, see *Fundamental Concepts*, NANOTECHNOLOGY (Sept. 4., 2008, 7:55 AM), http://infonanotechnology.blogspot.com/2008/09/fundamental-concepts.html.

27. *See* Bacsa, *supra* note 26.

28. Bawa, *supra* note 8, at 712.

29. *Id.* at 712–13.

30. Lemley, *supra* note 2, at 613 ("Whether through a policy decision, a personal belief, shortsightedness, government regulation, or invalidation of the patent, no one ended up owning the core building blocks of these [enabling] technologies during their formative years.").

31. *Id.*

32. *See id.* at 605.

33. *See id.* at 606.

cialization efforts, especially when too many overlapping patent rights exist simultaneously. Many authors agree that the USPTO has issued numerous unduly-broad "building block" nanotechnology patents to many different entities, which has generated a patent thicket, "making effective use of the technology difficult, if not impossible."[34] The dense tangle of existing IP rights prevents downstream entities from producing innovative technology because they cannot afford to license the litany of "building block" patents necessary to provide protection from infringement litigation.[35] Furthermore, it is understandable that venture capitalists would hesitate to invest in a start-up company likely to become involved in patent litigation.[36]

When applicants describe their patent claims, they are their own lexicographer. The applicant can define their claim terms and use them however they like.[37] This presents a unique challenge to patent examiners who examine nanotechnology applications. Between applications, there is no standardized or consistent use of terminology to describe the patent claims, leaving the USPTO to interpret claim construction to the best of its knowledge and ability.[38] For example, one applicant may claim "nanotubes" while another may claim "nanofibers," where in reality the two applicants are describing the same nanostructure.[39] Applicants may also put forth a new term that they claim is interchangeable or analogous with an existing term. For instance, the term "quantum dot" was introduced in U.S. Patent 6,500,622 and was claimed to be interchangeable with the term "semiconductor nanocrystal" by those patentees.[40]

34. *Id.* at 620. *See also* Thomas M. Mackey, *Nanobiotechnology, Synthetic Biology, and RNAI: Patent Portfolios for Maximal Near-Term Commercialization and Commons for Maximal Long-Term Medical Gain*, 13 MARQ. INTELL. PROP. L. REV. 123, 157 n.108 (2009).

35. *See, e.g.*, Michael A. Van Lente, Note, *Building the New World of Nanotechnology*, 38 CASE W. RES. J. INT'L L. 173, 189 (2006).

36. *See* Mackey, *supra* note 34, at 129.

37. U.S. PATENT & TRADEMARK OFFICE, U.S. DEP'T OF COMMERCE, MANUAL OF PATENT EXAMINING PROCEDURE §§ 2173.01, 2111.01 (8th ed. rev. 8, July 2010) [hereinafter MPEP], *available at* http://www.uspto.gov/web/offices/pac/mpep_e8r6_2100.pdf. The MPEP is an outline of current procedures that the patent examiners are required to follow when evaluating patent applications. The MPEP does not carry the same weight as law or "the force of the rules in Title 37 of the Code of Federal Regulations." *Id. See, e.g.*, Sean O'Neill et al., *Broad Claiming in Nanotechnology Patents: Is Litigation Inevitable?* 4 NANOTECHNOLOGY L. & BUS. 596, 598 (2007).

38. *E.g.*, Tullis, *supra* note 4, at 292.

39. Ruben Serrato et al., *The Nanotech Intellectual Property Landscape*, 2 NANOTECHNOLOGY L. & BUS. 150, 151 (2005).

40. *See* Tullis, *supra* note 4, at 292.

Not only is there confusion at the USPTO regarding nanotechnology vernacular, but some patent applicants are deliberately indirect and secretive in their claim composition. To keep competitors at a disadvantage, it has become commonplace to find patents or publications that are specifically crafted by the author to avoid discovery as relevant prior art during examination.[41] A publication on a nanotechnology-based technology may be carefully drafted using purposely ambiguous and misleading language to circumvent the use of nanotechnology terminology.[42]

The lack of standardized nanotechnology terminology, in conjunction with inadequate training of patent examiners in the field of nanotechnology, has led to a series of "building block" patents issued with overly-broad claims. Patentees perceive a need to capture the largest possible grant of IP protection with the claims of a single patent, leading applicants to draft claims that reach too far.[43] The driving notion behind this behavior is that nanotechnology has vast commercial potential, and broad patent claims will maximize protection against the other players in such a highly competitive market.[44] For example, IBM notoriously holds an overly-broad nanotechnology patent[45] in which Claim 3 states: "A hollow carbon fiber having a wall consisting essentially of a single layer of carbon atoms."[46] The use of the transitional phrase "consisting essentially of" in Claim 3 seems to imply that the scope of the claim reaches so far as to generally cover all carbon fiber nanostructures of tubular configuration.[47] The USPTO's issuance of overly-broad "building block" patents, like the IBM patent, contributes to the patent thicket problem because there is uncertainty as to the exact boundaries of the patents.

Another difficulty encountered by the USPTO involves the cross-disciplinary nature of nanotechnology. When conducting an examination of a nanotechnology patent application, it may be almost impossible for a patent examiner to locate all applicable prior art, due to this cross-disciplinary nature. "[A] basic nanotechnology patent may have implications for semiconductor design, biotechnology,

41. *See, e.g.*, Bawa, *supra* note 8, at 709.

42. *See id.*

43. Mackey, *supra* note 34, at 153–54.

44. *Id.* at 154.

45. O'Neill et al., *supra* note 37, at 603.

46. Carbon Fibers & Method for Prod., U.S. Patent No. 5,424,054 (filed May 21, 1993). It has a priority filing date of May 21, 1993. *See* O'Neill et al., *supra* note 37, at 603.

47. *Id.*

materials science, telecommunications, and textiles, even though the patent is held by a firm that works in only one of these industries."[48] At the USPTO, patents are divided into classes, based on the type of technology that is being patented. Examples include Class 438–Semiconductor device manufacturing patents,[49] Class 435–Genetic engineering,[50] and Class 977–Nanotechnology.[51] Examiners are required to investigate prior art to ensure that the patent application embodies a novel invention. An examiner, however, may not realize that a basic nanotechnology patent classified as a semiconductor device manufacturing process (Class 438) is relevant to a patent application regarding the integration of nanofibers into the manufacture of a textile (Class 28). Therefore, the examiner may miss relevant prior art, resulting in the issuance of a patent based on incomplete information.[52]

The limited availability of nanotechnology information is a major problem for examiners at the USPTO. For example, when nanotechnology patent applications first appeared at the USPTO, the "nano" prefix to the terminology was often ignored and patent applications were assigned to the most closely-related art unit based on the underlying technology of the application.[53] Examiners holding degrees in related fields of science were forced to examine the nanotechnology patent as best they could. It has always been customary for patent examiners to hold collegiate degrees in the field of science in which they examine patents. Since very few universities offer degrees in nanotechnology, many current patent examiners lack formal education in this area.[54] This lack of formal training in nanotechnology has contributed, in part, to the massive nanotechnology patent thicket that exists today.

The USPTO is trying to help patent examiners fix these problems. In fact, the USPTO has made several attempts to educate, support, and consolidate examiner efforts regarding nanotechnology. Monthly trainings on nanotechnology-related topics are offered by the

48. Lemley, *supra* note 2, at 614.

49. Adam Stephenson, *A View of the Future in Semiconductor Process: Patent Prosecution in Class 438 Under the United States Patent and Trademark Office's Final Claims and Continuations Rules*, 8 WAKE FOREST INTELL. PROP. L.J. 272, 275 (2008).

50. James W. Beard & Albert P. Halluin, *An Analysis of CIGS Solar Cell Technology*, 6 NANOTECHNOLOGY L. & BUS. 19, 23 (2009).

51. Bawa, *supra* note 8, at 708.

52. *Id.* at 709, 725.

53. Fender, *supra* note 6, at 1083.

54. *See* Bawa, *supra* note 8, at 727.

USPTO for examiners,[55] and the USPTO has also developed a nanotechnology cross-reference digest system that tracks existing nanotechnology products and prior art[56] to better organize nanotechnology patents. There has also been a push at the USPTO to reduce the number of nanotechnology examiners to approximately one hundred, to create a pool of specialized examiners with substantial nanotechnology patent examination experience.[57] While the measures taken by the USPTO may promise to ameliorate some of the patent thicket problems and increase the quality of nanotechnology patents issued in the future, they carry little benefit for the patents that already exist. The nanotechnology thicket is still as complex and enmeshed as ever.

Unique to the nanotechnology patent thicket, one of the main causes of the nanotechnology thicket stems from over-patenting of "building block" technologies by "companies, start-ups, universities and government labs working in a variety of different industries."[58] While it is not uncommon for corporate entities and small start-ups to be compelled to "demonstrate confidence" by generating extensive and impressive IP portfolios designed to attract investors and venture capitalists,[59] nanotechnology historically is the only field of enabling technology in which companies and research entities have patented fundamental scientific concepts.[60] Patenting occurred "early and often" during nanotechnology's formative years.[61] Economic competition drives patent applicants to draft overly-broad claims in order to maximize the scope of their IP; if an applicant does not claim it, the competition surely will.[62] "There is no government-mandated license, no university policy against patenting, and no

55. Fender, *supra* note 6, at 1086. *See also* Tullis, *supra* note 4, at 292 n.55 ("Through a partnership, the USPTO sought speakers who could give technical training to patent examiners in nanotechnology, and also requested suggestions for information sources for the searching of nanotechnology-specific prior art.").

56. *E.g.*, Bawa, *supra* note 8, at 706.

57. *See* Fender, *supra* note 6, at 1085–86.

58. *See* Serrato et al., *supra* note 39, at 155.

59. Bawa, *supra* note 8, at 722.

60. Mark A. Lemley describes "enabling technology" as the "technological breakthroughs that facilitate a wide range of different exploitations," meaning that a small collection of basic inventions spawned an entire industry worth of innovation. Examples include radio, television, lasers, biotechnology, integrated circuits, and computers. Lemley, *supra* note 2, at 606 n.24.

61. *Id.* at 613.

62. *See* Bawa, *supra* note 8, at 722.

question about patentable subject matter to slow the flood of patents."[63]

Universities are one of the main culprits of over-patenting because university research laboratories are among the most aggressive entities that pursue patents.[64] In 1980, the Bayh-Dole amendments to the Patent Act allowed universities and other non-profit entities to retain ownership rights of IP that resulted from government-funded research projects, so long as those entities complied with predetermined rules.[65] It is not surprising that research labs file numerous patent applications on "building block" techniques and fabrication methods, as research is driven by a very competitive "publish or perish" mentality in many university settings.[66] Seeking to collect royalties and to generate a profit from their IP, universities often negotiate complicated license agreements for the use of their fundamental technology patents. These agreements can become so involved that the transaction costs associated with licensing the IP becomes prohibitively expensive.[67] While universities are acting like market participants, the strategies they implement convolute the patent landscape of nanotechnology and compact the patent thicket even more densely.

Private companies have also manipulated the patent system and have contributed to the patent thicket in their own way. For example, Dr. Ken Barovsky, the Vice President and IP counsel for Quantum Dot Corp., has openly admitted that the company's first few nanotechnology patents were based entirely on speculation—the patent claims for quantum dots were derived from scientific literature and theory.[68]

When examining a patent application, the USPTO looks for: patentable subject matter;[69] utility;[70] novelty;[71] non-obviousness in light

63. Lemley, *supra* note 2, at 613.

64. *See id.* at 615–17.

65. Barry Newberger, Presentation Transcripts, *Intellectual Property and Nanotechnology*, 11 TEX. INTELL. PROP. L.J. 649, 655 (2003); *see also* Lemley, *supra* note 2, at 617. The Bayh-Dole Act permits the ownership of private IP rights by universities and small business entities performing research based on government funding. *See* 35 U.S.C. § 202 (2006).

66. *See* Newberger, *supra* note 65, at 655; Bawa, *supra* note 8, at 722; Lemley, *supra* note 2, at 616.

67. *See* Tullis, *supra* note 4, at 288.

68. Michael T. Burr, *The Nanotechnology Land Grab*, CORP. LEGAL TIMES, June 2004, at 32.

69. *See* 35 U.S.C. § 101 (2006). Patentable subject matter is considered "anything under the sun that is made by man." *See* Diamond v. Chakrabarty, 447 U.S. 303, 309 (1980) ("The Committee Reports accompanying the 1952 Act inform us that Congress intended statutory subject matter to 'include anything under the sun that is made by man.'" (quoting S. Rep. No. 82-

of the prior art;[72] and that the invention is sufficiently described to enable one skilled in the art to make and use the invention.[73] Unless an invention seems impossible,[74] the USPTO "presumes that an applicant's statements about utility are true," because "the inoperability standard requires that all inventions work as claimed before they can be patented."[75] There has been severe abuse of the patent system, from both the public and private sector, in relation to nanotechnology IP. While the premise behind patenting is to make one's invention public in exchange for a temporary monopoly on the invention, there seems to be an ulterior motive driving the rush to patent nanotechnology, such as squeezing out the competition by holding patents on essential nanostructure manufacture processes.[76] While patenting early and often confers an economic benefit to the patentee by limiting the competition, it all but stifles any benefit to the public because the resulting patent thicket prevents commercialization.

Downstream innovators have two main choices: either risk infringing someone else's patent or become constrained by license agreements for all of the necessary patents to prevent infringement.[77] Licensing broad patents from each patent holder is necessary to avoid infringement litigation which bears high transaction costs.[78] It is particularly cumbersome in the case of a patent thicket because the number of conflicting IP owners is so great.[79] Furthermore, uncertainty persists as to who exactly owns what in the nanotechnology IP world. Some firms will not pursue infringement litigation specifically to prevent exposing their own patents, which may be faulty

1979, at 5 (1952))). "Anything under the sun that is made by man" is limited by 35 U.S.C. § 101 (2010).

70. *See* § 101.

71. *See id.* § 102.

72. *See id.* § 103(a).

73. *See id.* § 112.

74. If an invention seems impossible, then there may be grounds for an "incredible utility" objection to the patent application. For a definition of "incredible utility," see MPEP, *supra* note 37, § 2107.02(III)(B) ("One situation where an assertion of utility would ***not*** be considered credible is where a person of ordinary skill would consider the assertion to be 'incredible in view of contemporary knowledge' and where nothing offered by the applicant would counter what contemporary knowledge might otherwise suggest . . . . 'Incredible utility' is a conclusion, not a starting point for analysis under 35 U.S.C. 101.") (emphasis added).

75. Almeling, *supra* note 12, ¶ 10.

76. Van Lente, *supra* note 35, at 201.

77. Lemley, *supra* note 2, at 622.

78. *See* Almeling, *supra* note 12, ¶ 20.

79. *See* Bawa, *supra* note 8, at 731.

or questionable in their own right because of overly-broad claim construction.[80]

There are two types of infringement for patentees to be acutely aware of: literal infringement of a patent and equivalence patent infringement. "Literal infringement occurs when the language of the claim, 'reads directly, unequivocally, and word-for-word' on the accused device."[81] Infringement by equivalence occurs when "a product or process that does not literally infringe upon the express terms of a patent claim may nonetheless be found to infringe if there is 'equivalence' between the elements of the accused product or process and the claimed elements of the patented invention."[82] A determination of equivalence should be analyzed objectively, "element-by-element."[83]

A major component of the nanotechnology patent thicket is attributable to mutually exclusive patents existing simultaneously. These are called blocking patents; the practice of one would infringe the other.[84] There are two types of patent blocking that can occur: one-way blocking and two-way blocking. In one-way blocking, the dominant patent—which has an earlier U.S. filing date than the second patent—prevents, or "blocks," the second patent from being used.[85] Even if the second patent partially blocks the dominant patent holder from pursuing certain improvements or applications, it is still considered one-way blocking.[86] Two-way blocking occurs when the patents are mutually exclusive patents existing simultaneously and both effectively block each other, leaving neither practicable without the licensing of the other.[87] As has been previously discussed, while patent examiners at the USPTO are tasked with performing thorough prior art searches during the patent application process, in the case of nanotechnology, prior art can be hidden and very difficult to locate due to inconsistencies in terminology, deliberate attempts by authors to conceal their research, and the highly cross-disciplinary nature of nanotechnology applications. The

80. Van Lente, *supra* note 35, at 201.

81. Andrew Wasson, Note, *Protecting the Next Small Thing: Nanotechnology and the Reverse Doctrine of Equivalents*, 2004 DUKE L. & TECH. REV. 10, ¶ 8 (2004) (quoting SRI Int'l v. Matsushita Elec. Corp. of Am., 775 F.2d 1107, 1118 (Fed. Cir. 1985)).

82. Warner-Jenkinson Co. v. Hilton Davis Chem. Co., 520 U.S. 17, 21 (1997).

83. *Id.* at 40.

84. Richard J. Gilbert, *Antitrust for Patent Pools: A Century of Policy Evolution*, 2004 STAN. TECH. L. REV. 3, 6 (2004).

85. *Id.*

86. *Id.* at 7.

87. *Id.* at 6, 26.

USPTO is disconnected from any infringement litigation that might result from the issuance of a patent: it does not assist a patentee in enforcing a patent, nor does it keep track of infringement cases post-issuance.[88] These factors have led to the issuance of mutually exclusive patents existing simultaneously, resulting in patent blocking.

B. Disentangling the Nanotechnology Patent Thicket: Legal, Business, and Creative Solutions

The challenges presented by the nanotechnology patent thicket predicament are numerous and complex. Many authors and scholars have proposed potential solutions to the problem. Some are firmly rooted in established legal doctrine such as patent reexamination, infringement litigation, or licensing schemes.[89] Others are more creative in their approach, suggesting government intervention or practical policy changes.[90] While many of these theoretical solutions are feasible and pose unique advantages, careful analysis reveals that they are also riddled with disadvantages and caveats which render them less effective and less desirable than initially anticipated.

1. Reexamination

Reexamination of a patent suspected of being unduly broad is a pre-litigation strategy for hacking through the nanotechnology patent thicket. Any third party or inventor may request a patent reexamination at any point during the life of the patent and for up to six years after the patent's expiration,[91] under the statute of limitations provided in 35 U.S.C. § 286.[92]

88. *See* Bawa, *supra* note 8, at 715–16. Furthermore, the patent holder brings infringement litigation at his or her own expense. *See id.* at 716.

89. For an explanation of patent reexamination, see Hal Jay Bohner & Robert E. Krebs, *Pre-litigation Strategies: Patent Reexamination*, FINDLAW, http://library.findlaw.com/2004/May/11/133411.html (last visited Mar. 24, 2012). For an explanation of infringement litigation, see Jean O. Lanjouw & Mark Schankerman, *Characteristics of Patent Litigation: A Window on Competition*, 32 RAND J. ECON. 129, 130 (2001). For an explanation of licensing schemes, see Lemley, *supra* note 2, at 623–27.

90. *See, e.g.*, Tullis, *supra* note 4, at 308.

91. *See* MPEP, *supra* note 37, § 2204; *see also* 37 C.F.R. § 1.501(a) (2010) (third party or inventor can request reexamination "any time during the period of enforceability of a patent").

92. *See* MPEP, *supra* note 37, § 2204. Under the statute of limitations, any third party or inventor has an additional six years—following the expiration of the patent—in which to bring an infringement suit. 35 U.S.C. § 286 (2006).

There are two types of reexaminations: *ex parte* proceedings and *inter partes* proceedings.[93] In either proceeding, a patent's patentability is reevaluated when a substantial new question of patentability based on any prior art—printed publication or patent—is brought to the attention of the USPTO.[94] Yet, reexamination proceedings may not be the ideal method for solving the nanotechnology patent thicket problem. Not only is filing for a patent reexamination labor intensive for the challenging party,[95] it is also expensive, especially if one is requesting reexamination for multiple patents.[96] Furthermore, reexamination provides the patent holder with an opportunity to add or amend claims, so that the challenged patent can better navigate around the prior art presented in the proceedings, or make clearer the boundaries of the claims so as to block a prior art patent.[97] Another disadvantage to reexamination as a pre-litigation strategy for handling the patent thicket involves the counterproductive estoppel associated with an *inter partes* reexamination, which, with little exception, prevents the patent from being challenged in court.[98]

2. *Infringement litigation*

Naturally, patent litigation is another approach for steering through the nanotechnology patent thicket. In patent infringement litigation, a patent owner seeks monetary damages, injunctive relief, or both against further infringement.[99] Once nanotechnology

93. For *ex parte* reexamination see 35 U.S.C. §§ 301–307 and 37 C.F.R. §§ 1.510–1.570. For *inter partes* reexamination see 35 U.S.C. §§ 311–318 (2006). *See generally* J. Peter Paredes, *Written Description Requirement in Nanotechnology: Clearing a Patent Thicket?*, 88 J. PAT. & TRADEMARK OFF. SOC'Y 489, 510 (2006) (describing reexamination as a potential procedure for challenging the validity of an issued patent).

94. *See* MPEP, *supra* note 37, § 2214.

95. A party requesting reexamination must provide a statement identifying each substantial new question of patentability and each claim for which reexamination is requested, and explain in detail the relevance of any prior art (publications or patents) provided by the party requesting the reexamination. The requesting party must provide copies of all prior art relevant to the reexamination, as well as a complete copy of the patent to be reexamined. Also, the party requesting reexamination must ensure that the request for reexamination is served on the patent owner. *See* MPEP, *supra* note 37, § 2214.

96. According to the USPTO's Fee Schedule effective September 26, 2011, a request for *inter partes* reexamination costs $8800.00 and a request for *ex parte* reexamination costs $2520.00. Current Fee Schedule, UNITED STATES PATENT AND TRADEMARK OFFICE, http://www.uspto.gov/web/offices/ac/qs/ope/fee092611.htm (last visited Mar. 24, 2012).

97. Bohner & Krebs, *supra* note 89.

98. *Id.*

99. 35 U.S.C. § 271 (2006).

evolves into a financially lucrative endeavor, patent litigation will be a useful tool for assessing who actually owns what intellectual property. Presently, however, the costliness of patent litigation is a deterrent from this course of action.[100] Fear of litigation discourages competition. Lawsuits can either make or break competitors, particularly in cases of broadly claimed or fundamental IP.[101] The outcome of a suit could determine whether a firm will be able to continue in the business, because its competitor will be out of business.[102]

3. *Licensing schemes*

Licensing of "building block" nanotechnology patents is another plausible solution to the patent thicket problem because licenses can be very diverse in their implementation. Licenses can be either exclusive or non-exclusive. An exclusive license agreement allows only one entity to license the patent or invention.[103] A company looking to exclusively license "building block" patented technology will tend to "generate more lucrative business opportunities and higher revenues,"[104] since the exclusivity of the license allows it to directly benefit from any future commercialization of products derived from the exclusive license. On the other hand, a non-exclusive license allows for multiple companies to use the licensed technology, thus increasing competition.[105] One benefit of a non-exclusive license is that it has lower licensing and royalty fees, which results in the final cost of the product to the consumer being lower.[106] In addition, licenses can be restrictive in terms of geographic location, or "field-of-use,"[107] meaning the licensee can only practice the licensed IP in certain applications (i.e., therapeutic applications, veterinary applications,

100. *See* Bawa, *supra* note 8, at 729–30.

101. *See* Joel I. Klein, Acting Assistant Att'y Gen., Antitrust Div., U.S. Dep't of Justice, Address before the American Intellectual Property Law Association: Cross-Licensing and Antitrust Law (May 2, 1997), *available at* http://www.justice.gov/atr/public/speeches/1118.htm (explaining the anticompetitive effects of cross-licensing between competitors).

102. *Id.*

103. Behfar Bastani et al., *Technology Transfer in Nanotechnology: Licensing Intellectual Property from Universities to Industry*, 1 NANOTECHNOLOGY L. & BUS. 166, 169 (2004).

104. *Id.* at 169–70.

105. *Id.* at 169.

106. *See id.* at 170.

107. Shapiro, *supra* note 22, at 127.

etc.).[108] Once a licensee has been granted a license, it may freely practice the patent without the repercussions of infringement.[109]

Cross-licensing occurs between two or more parties with symmetrical interests: a firm needs its competitor's patent just as badly as its competitor needs its patent.[110] Cross-licensing has been used with limited success. For example, the semiconductor industry has experienced success with cross-licensing because it consists primarily of a limited number of firms that produce similar products and hold similar IP portfolios.[111] Critics contend that competing firms tend to use cross-licensing to limit competition and avoid litigation, which directly harms public interest by reducing the amount of competition in the marketplace.[112] Some of the anticompetitive effects from cross-licensing include artificially inflated prices, reduction in output to simulate characteristics of a monopoly market or a collusive duopoly market, and a reduction in innovation of that particular technology.[113] However, each of these anticompetitive effects can be managed to mitigate antitrust proclivities.

Furthermore, the potential for larger firms to collude in efforts to muscle out smaller firms is ever present: larger firms could create economic barriers to entry in nanotechnology. One barrier to entry would involve larger firms initiating hold-ups of smaller firms.[114] Larger firms could also practice double marginalization,[115] where two firms (or two divisions of the same firm) both mark up their license price above their own costs—passing those costs on to the small firm licensees. Another barrier is the prohibitively high transaction costs that arise once more than two parties are involved in the cross-licensing.[116] The overall problem with cross-licensing in the nanotechnology patent thicket is that "the inefficiencies stifle the

108. *See* Bastani et al., *supra* note 103, at 172.

109. *See* Shapiro, *supra* note 22, at 127.

110. Lemley, *supra* note 2, at 623–24.

111. Serrato et al., *supra* note 39, at 155.

112. Bawa, *supra* note 8, at 1.

113. Klein, *supra* note 101.

114. A hold-up is where one party (party A) engages in opportunistic behavior by taking advantage of the other party (party B) particularly after party B has already made a specific investment that is a sunk cost in its nature. *See* Joseph Farrell et al., *Standard Setting, Patents, and Hold-Up*, 74 ANTITRUST L.J. 603, 603–04 (2007). For an example of a hold-up, see MICHAEL R. BAYE, MANAGERIAL ECONOMICS AND BUSINESS STRATEGY 209–10 (7th ed. 2010).

115. Firms will typically price an output at a price that makes up for any cost of the output to the firm. For an example of double marginalization, see BAYE, *supra* note 114, at 418–19.

116. Clarkson & DeKorte, *supra* note 1, at 188.

ability of innovators to use necessary scientific techniques and tools in order to continue researching and developing nanoproducts."[117]

4. *Government intervention*

Nanotechnology research of "building block" technology has largely been publically funded.[118] In 2009, the United States contributed $1.53 billion in federal dollars to nanotechnology initiatives.[119] Under the Bayh-Dole Act, the government has the power to compel licensing of technology developed from public funding on reasonable terms, yet it has never exercised this power.[120] Some scholars have proposed that an appropriate course of action would be for the government to exercise mandatory licensing of federally funded technology, guaranteeing accessibility of basic research techniques and tools of nanotechnology to researchers and innovators.[121] Mark A. Lemley, the Director of the Stanford Program in Law, Science, and Technology, has suggested government-imposed restrictions on basic "building block" patent holders' ability to use exclusive licenses that restrict downstream innovation of nanotechnology applications.[122] The driving force behind this suggestion is that the "[k]nowledge, enclosed by exclusive intellectual property rights, might go unused because of the transactions costs [associated with] negotiating the necessary agreements among a multitude of owners, with divergent interests, and incompatible expectations about the values of their intellectual property."[123] If the government were to exercise its authority granted by the march-in rights of the Bayh-Dole Act,[124] it could mandate non-exclusive licensing of nanotechnology "building block" patents.

117. Tullis, *supra* note 4, at 297.

118. Entities such as the National Nanotechnology Initiative (a federal multi-agency construction designed to promote U.S. leadership in the research and development of nanoscale phenomena and technology), the Department of Education, the National Science Foundation, the National Institute of Health, and the Department of Defense have all used federal funds for nanotech research and development. *See* OBSERVATORYNANO, PUBLIC FUNDING OF NANOTECHNOLOGY 19 (2012), *available at* http://www.observatorynano.eu/project/filesystem/files/PublicFundingofNanotechnologies_March2012.pdf.

119. *Id.* at 4.

120. *See* 35 U.S.C. § 203(a) (2006); Lemley, *supra* note 2, at 628.

121. Lemley, *supra* note 2, at 628.

122. *Id.*

123. Bryan Bruns, *Open Sourcing Nanotechnology Research and Development: Issues and Opportunities*, 12 NANOTECHNOLOGY 198, 199 (2001).

124. Two rights are retained by the government under the Bayh-Dole Act: (1) march-in rights, which are intended to prevent anticompetitive nonuse of patents such as patent hoard-

Terry K. Tullis[125] has advocated for a government license defense to the infringement of federally funded research that results in IP. The government license defense specifically addresses infringement (committed by federally funded infringers) of IP derived from public funding.[126] By slightly amending the Bayh-Dole Act to permit any researcher, performing federally funded research, to exercise the government defense license under the premise that the researcher is conducting research on behalf of the United States, Tullis argues that "[a] well-formulated government license defense would provide a means for overcoming the innovation-impeding effects of absolute exclusion rights by assessing infringement along a spectrum of use."[127] By employing a sliding scale, the amount an infringer would pay in royalty fees would be based upon the degree of commercial infringement that has occurred.[128] Therefore, "[i]f a court were to excuse an act of infringement under the government license defense, infringing contractors would have the chance to neutralize infringement liability by paying reasonable royalties."[129] This course of action, while well reasoned, implies that an actor should infringe first and ask how much he owes in royalties after the fact. In practice, it is unlikely that actors would be willing to infringe when they know they will be sued for royalties.

5. *Commons*

A proper solution to the nanotechnology "building block" patent thicket problem should dissolve the barriers preventing further research, development, and potential commercialization of nanotechnology. One method for untangling the patent thicket involves implementing a commons. Scientific and technological commons are socially driven efforts to achieve cooperation among various parties, where no individual party exercises exclusive IP rights on the sci-

ing or patent blocking, allow the government to require a federally funded patentee to grant a reasonable license to a responsible applicant, and (2) government license rights, which are "royalty-free license[s] to practice any patented technology funded by the government." *See* Tullis, *supra* note 4, at 305–06 (referring to § 202(c)(4) of the Bayh-Dole Act).

125. Terry K. Tullis is an associate at Knobbe Martens Olson & Bear LLP, an IP law firm. He specializes in patents and IP due diligence. KNOBBE MARTENS, http://www.kmob.com/terry-tullis (last visited Mar. 24, 2012).

126. Tullis, *supra* note 4, at 306, 308.

127. *Id.* at 308.

128. *See id.*

129. *Id.*

ence or technologies in question.[130] One scholar advocates that scientific and technological commons are the ideal mechanism for untangling the nanotechnology "building block" patent thicket, because a commons-based strategy protects foundational research tools and manufacturing processes from individual ownership and grants broad access to technologies that are incorporated in the commons.[131] Commons are designed to be pools of "building block" technology or science that are free for anyone to use; that is, no one directly receives monetary compensation when a "building block" technology is used by another.[132]

While commons-based strategies have worked in developing other areas of modern science, such as open source code for the development of free software,[133] in the case of nanotechnology, implementation of a commons would be problematic for several reasons. First, a plethora of "building block" nanotechnology patents already exists.[134] Second, a large portion of nanotechnology "building block" patents have issued to research labs, such as universities, which work exclusively in research and development of scientific foundations.[135] Universities hold a disproportionate share of nanotechnology-related patents: universities hold almost 12% of all nanotechnology patents, where normally universities only hold 1% of all patents in general.[136] Implementation of a commons-based solution to the patent thicket problem would cause universities and research entities to suffer an economic disadvantage compared to corporations because other than exercising the IP licensing of their work, these entities lack a means to capitalize on their discoveries. Corporate entities, on the other hand, are in the business of commercializing their products to generate capital[137] and need not rely on income resulting from the licensing of IP.

Mackey contends that implementing a commons will not cause universities too much financial hardship because they have many

130. *See* Yochai Benkler, *Commons-Based Strategy and the Problems of Patents*, 305 SCI. 1110, 1110–11 (2004), *available at* http://www.sciencemag.org/content/305/5687/1110.full.pdf.

131. *See* Mackey, *supra* note 34, at 190-91.

132. Benkler, *supra* note 130, at 1110.

133. *See id.*

134. Kshitij Aditeya Singh, *Intellectual Property in the Nanotechnology Economy*, NANOFORUM, *available at* http://www.nanoforum.org/dateien/temp/Article%20on%20Intellectual%20Property%20-%2012%20JAN.pdf?05032011233715.

135. *Id.*

136. Lemley, *supra* note 2, at 615.

137. *Id.* at 616.

other ways to market themselves.[138] While the income generated from IP held by universities only amounts to approximately 3–5% of a university's total budget at best,[139] implementing a nanotechnology "building block" commons now would have a larger impact on universities than just causing a hiccup in their finances. Imposing a commons would unfairly strip universities of their nanotechnology IP and would dislodge the competitive nature of scholastic achievement and vision. It also seems that universities that develop foundational research techniques in nanotechnology and obtain patents on such techniques have a propensity to continue that research in efforts to obtain new IP rights for the innovations that result from furthering their research.[140] If the monetary incentive ascribed to patenting technology is removed from the equation, universities would lose motivation to continue innovating.

6. *Patent pooling*

The development of a patent-pooling model could untangle the thicket by providing an economic incentive for "building block" patent holders to cooperate. It has been demonstrated throughout history that "certain organizations have occasionally responded [to patent thickets] by constructing patent pools or organizational structures where multiple firms collectively aggregate patent rights into a package for licensing . . . ."[141] In fact, in 2010 the United States Court of Appeals for the Federal Circuit held packaged licensing models to be permissible so long as they do not suppress alternative technology that is, or is likely to become, commercially successful.[142] Structurally, patent pools are easy to understand. Access to the pooled patents is granted in exchange for a fee.[143] A license is either granted directly from the patentee to the licensee or through a joint venture designed specifically to manage the pool.[144] Operation of a patent pool is generally acceptable, so long as the pool does not stifle com-

138. *See* Mackey, *supra* note 34, at 196–97.

139. Bastani et al., *supra* note 103, at 167.

140. *See* Lanjouw & Schankerman, *supra* note 89, at 130.

141. Clarkson & DeKorte, *supra* note 1, at 181.

142. Princo Corp. v. Int'l Trade Comm'n, 616 F.3d 1318 (Fed. Cir. 2010). This case focuses on the patent misuse defense. Patent misuse is a non-statutory defense to patent infringement claims that is applicable to licensing agreements that suppress alternative technology. *Id.* at 1321. "[T]here is no misuse unless the accused infringer shows that the technology was, or would probably have become, commercially viable . . . ." *Id.* at 1343 (Dyk, J., dissenting).

143. *See* Van Lente, *supra* note 35, at 204; Klein, *supra* note 101.

144. *See* Klein, *supra* note 101, at n.3.

petition and does not lead to the collusion of multiple firms in a way that violates the antitrust provisions of the Sherman Act.[145] Even the USPTO has suggested that a patent pool is a likely solution to the nanotechnology patent thicket problem.[146]

There are concerns regarding the development of a patent pooling model for nanotechnology "building block" patents. It has been contended that there is little need for a pool of nanotechnology "building block" patents because there have only been a limited number of transactions involving nanotechnology.[147] The patent thicket itself is largely to blame for the lack of nanotechnology transactions. Uncertainty overshadows the transactions involving nanotechnology: who actually holds a valid patent? If the firm moves forward with this innovation, will a lawsuit result due to broad IP claims that are ultimately determined to be faulty? The technology and the patents are still unproven, which could trigger instability in the construction of a nanotechnology patent pool because, "[a]s researchers and developers explore numerous potential nanotechnologies, hedging bets becomes expensive."[148] The patents in the pool must be "essential patents"; they must be valid, complementary, absolutely necessary, and have no possible substitute.[149] Economist Carl Shapiro[150] cautions that the "inclusion of truly *complementary* patents in a patent pool is desirable and procompetitive, but assembly of *substitute* or rival patents in a pool can eliminate competition and lead to elevated license fees."[151]

Logically, a licensee has no need to license two patents when one is a substitute for, or a rival to,[152] the other. Only time will tell which patents in the pool will be truly essential or fundamental to commercialization efforts downstream, and which patents will eventual-

145. *See* FLOYD L. VAUGHAN, THE UNITED STATES PATENT SYSTEM: LEGAL AND ECONOMIC CONFLICTS IN AMERICAN PATENT HISTORY 39–68 (1956); Van Lente, *supra* note 35, at 204.

146. Clarkson & DeKorte, *supra* note 1, at 188.

147. Tullis, *supra* note 4, at 296.

148. *Id.* at 297.

149. François Lévêque & Yann Ménière, *Economics of Patent Pools*, MICROECONOMIX ECON. ANALYSIS APPLIED TO LAW 2 (2007), *available at* http://www.microeconomix.com/publications/doc_details/67-economics-of-patent-pools-.html.

150. Carl Shapiro is the Transamerica Professor of Business Strategy at the Haas School of Business, and Professor of Economics in the Economics Department, at the University of California at Berkeley. He earned his Ph.D. in Economics at M.I.T. in 1981, taught at Princeton University during the 1980s, and has been on the Berkeley faculty since 1990. CARL SHAPIRO, FACULTY & RESEARCH, UNIVERSITY OF CALIFORNIA, BERKELEY, http://faculty.haas.berkeley.edu/shapiro/ (last visited Mar. 30, 2012).

151. Shapiro, *supra* note 22, at 134.

152. *Id.*

ly prove to be of little economic worth, as there is no way to judge conclusively the value of a patent until commercialization of nanotechnology has had a chance to take off. This uncertainty of potential patent value may cause patent holders unconvinced of what will prove to be essential IP to feel compelled to hold out on participation in the pool, and instead vie to hold-up the pool members by forcing them to license their technology independently.[153] There is also fear of a collective action problem when implementing a nanotechnology patent pool.[154] In order for the nanotechnology patent pool to form, a collective agreement must be negotiated to satisfy all the entities involved, as well as to avoid potential "anticompetitive consequences, even when [the] agreement is among firms that are not actual competitors."[155]

Furthermore, the asymmetrical differences between the agendas of universities that are patenting their nanotechnology research and commercial entities who are trying to develop marketable products may, at first glance, appear problematic for the development of a patent pool.[156] Identifying a common goal between the two parties' goals, however, may help illustrate how the two fronts are unified. Collectively, academia and industry are both motivated to generate additional revenue sources, providing a foundation upon which a nanotechnology patent pooling model can be constructed. Academics strive to protect the IP incorporated in their research, which often represents significant investitures of human capital—time, energy, etc.—because any revenue generated from licensing the IP can then be reinvested in future research. This result aligns with the traditional academic values of promoting education and discovery. As a contributor to and a user of the pool, universities add to the exchange of ideas and directly benefit from access to new avenues of technological development that they may expound upon with future research. Along a parallel vein, the commercial sector typically secures IP to protect its product development, which frequently results from large capital expenditures.[157] As a pool member, companies will gain access to a collection of IP that can enhance its business by opening up new areas for commercial expansion.

153. Lévêque & Ménière, *supra* note 149, at 3.
154. Gilbert, *supra* note 84, at 25–26.
155. *Id.*
156. *See* Tullis, *supra* note 4, at 297.
157. Bastani et al., *supra* note 103, at 169.

Patent pools achieve economies of scale[158] that mitigate transaction costs associated with licensing individual patents from independent patent holders. This form of centralized licensing is a major incentive to participating in a patent pool, because there is an overall reduction in costs associated with accessing the pool.[159] When licensing is decentralized, various inefficiencies creep into the arrangement, putting an additional burden on the licensee.[160] For example, separate licenses lead to higher transaction costs for both the licensor (who has to obtain multiple licenses) and the patent holder (who has to monitor and enforce all licensing contracts).[161] Rather than enduring individual negotiation costs for each individual licensing agreement, a pool participant can purchase a single all-access license to the entire pool.[162] In essence, a patent pool is a one-stop shopping experience, where the licensee can obtain all the related complementary IP necessary to practice innovation within the relevant industry.[163] The general consensus is that patent pools comprised primarily of complementary patents are welfare enhancing.[164]

What follows is a skeletal framework upon which a complete patent pooling model, designed to circumnavigate antitrust difficulties involved with untangling the nanotechnology "building block" patent thicket, can be developed. Suggestions on the definition of a pool's scope and advisement concerning identification of technically essential complementary patents for inclusion in a pool will be established. Recommendations regarding ways to circumnavigate antitrust difficulties with a carefully crafted licensing structure and identification of which royalty payment structure would be best for a nanotechnology patent pool will be explained.

158. "Economies of scale" is a phrase that is used to describe the reduction in cost-per-unit as more units are produced. BAYE, *supra* note 114, at 185–86. In the case of a patent pool, the total cost of obtaining a pool license is less costly than acquiring all the different licenses in the pool individually. *See* Lévêque & Ménière, *supra* note 149, at 1.

159. Lévêque & Ménière, *supra* note 149, at 1.

160. *Id.*

161. *Id.*

162. Bruns, *supra* note 123, at 202.

163. Shapiro, *supra* note 22, at 134.

164. *See* Josh Lerner & Jean Tirole, *Efficient Patent Pools* 4 (Nat'l Bureau of Econ. Research, Working Paper No. 9175, 2002) (providing a graphic illustration of patent pool efficiency).

III. NOT INEXTRICABLE: PATENT POOLS COULD SOLVE THE NANOTECHNOLOGY PATENT THICKET DILEMMA

The details of a complete nanotechnology "building block" patent pool proposal are impossible to furnish without adequate resources to identify *all* the necessary complementary patents for inclusion in the pool, independent third-party review of the selected patents, and technical and legal assessment of the patents to be included in the pool. It is feasible, however, to offer a few suggestions regarding the types of patents that should be included in a nanotechnology pool proposal. Additionally, it is possible to recommend a general licensing structure and royalty payment structure that will allay antitrust concerns and still disentangle the nanotechnology "building block" patent thicket, despite a lack of detail regarding which entities will participate in the pool and to what extent each firm will contribute to the pool.

A. Constructing a Patent Pool

There are two stages involved in the formulation of a patent pooling model. The first stage requires determination of which complementary patents are essential for inclusion in the pool to promote innovation and efficiency, and which patents should be excluded because of their anticompetitive tendencies. Extensive research, objective determination, and "review[] for essentiality by an independent patent expert"[165] are all expensive endeavors but generally are considered by the United States Department of Justice ("DOJ") and the Federal Trade Commission ("FTC")[166] to be good practices for mitigating antitrust concerns when building a patent pool.

The second stage of creating a patent pool involves determining the terms of the licensing agreement for the patents in the pool. The pool licensing agreement should clearly set forth the terms of the agreement, any licensing restrictions, and a royalty payment schedule. It is important to make an adequate determination of essential patents for inclusion in the pool because "including an extraneous patent can affect the other members' share of total licensing earnings."[167] There are many different types of licensing agreements, and

165. Anne Layne-Farrar & Josh Lerner, *To Join or Not to Join: Examining Patent Pool Participation and Rent Sharing Rules* 9 (LECG Consulting and Harvard University, Working Paper, 2008), http://ssrn.com/abstract=945189 (last visited Apr. 22, 2012).

166. These two entities will also be collectively referred to as "the Agencies."

167. Layne-Farrar & Lerner, *supra* note 165, at 9.

care should be taken when deciding which scheme is best for disentangling the patent thicket, promoting of innovation, and disseminating technology. It is important to acknowledge antitrust laws because ignoring them could result in the dissolution of the patent pool.

The DOJ and the FTC are the two federal agencies charged with antitrust policy enforcement.[168] They monitor and launch investigations into enterprises which appear to engage in anticompetitive business practices that are harmful to consumers.[169] These agencies also provide preliminary antitrust evaluations of patent pool proposals upon request.[170] Patent pools are one particular mechanism that businesses have historically and strategically used *and* abused for their economic benefit. The Agencies approach patent pool proposals with caution, yet they have been known to approve proposals where competitive safeguards are clearly set forth to protect the patent pool from partaking in anticompetitive behavior.[171]

Some examples of competitive safeguards that the Agencies have approved as procompetitive include the following:

- Limitation of the potential patent portfolio to only those patents that are technically essential to the pool's construction and not competitive between each other;
- Clear identification of patents proposed as part of the package licenses, as well as the demonstrated licensability of those patents;
- Issuance of worldwide and non-exclusive licenses when the pool is enacted to demonstrate procompetitive behavior;
- Conditional royalty payment and licensee liability dependent on actual use of the patents in the pool;
- No prohibition by the license agreement on licensees' creation and use of alternative technologies if they so choose; and
- Required reciprocated granting-back of non-exclusive, non-discriminatory licenses for innovations produced by the licensee that are built upon IP that was obtained through licensing the pool.[172]

168. *See* ANTITRUST GUIDELINES, *supra* note 5, § 1.0.
169. *Id.* § 3.1.
170. Clarkson & DeKorte, *supra* note 1, at 194.
171. Gilbert, *supra* note 84, at 1–2.
172. *Id.*

One example of a successful patent pool is the MPEG-2 standardized technology patent pool. MPEG-2 technology was the second, and ultimately successful, generation of the MPEG technology, becoming a popular technology standard used "for digitally coded representation of moving pictures, audio, and their combination in compressed formats."[173] It is considered the "gold standard" for patent pooling models involving standardized technologies.[174]

The collaborative effort to adopt a standardized compression technology was crucial to the success of MPEG-2 technology. Nine entities[175] performed an extensive study to identify all of the potentially relevant and complementary IP held collectively among them and throughout the world that would be essential for inclusion in the pool.[176] The firms also determined which technology patents were substitutive and excluded them from the MPEG-2 pool.[177] Next, the licensing agent MPEG LA was formed and performed the same objective analysis (completed by an unaffiliated third party) as verification that the designated patents actually did belong in the pool.[178] The success of the MPEG-2 pool has been attributed to MPEG LA's use of an independent expert for objective verification of which patents were necessary to comply with the MPEG-2 standard.[179]

Patent pools founded to further the adoption of standardized technology, like the MPEG-2 pool, find greater success avoiding antitrust complications when the common goal is to promote the development of a standard and not to immediately generate profits.[180] Patent pools formed with the primary objective of profit maximization tend to run into antitrust complications.[181] For instance, the FTC challenged a patent pool created by Summit Technology, Inc. and Visx, Inc. in 1998, claiming the two firms' use of the pool was deliberately anticompetitive.[182] The two firms' each held patents on laser technology used during laser-eye surgery (Visx's excimer laser and

173. Clarkson & DeKorte, *supra* note 1, at 191.

174. *Id.* at 194.

175. These nine entities include Fujitsu, General Instrument, Lucent, Matsushita, Mitsubishi, Philips, Scientific-Atlanta, Sony, and Columbia University. *See* Shapiro, *supra* note 22, at 134.

176. Clarkson & DeKorte, *supra* note 1, at 192.

177. Shapiro, *supra* note 22, at 134.

178. *Id.* at 134–35.

179. *See id.* at 135.

180. *Id.* at 140.

181. *See, e.g.*, Clarkson & DeKorte, *supra* note 1, at 193.

182. *See id.*

Summit Technologies' laser refractive surgery devices) and methodology patents protecting their procedures for correcting nearsightedness and astigmatism,[183] which they found to be rival patents to each other's technology. Hence, the firms were stuck in a two-way blocking patent thicket where each party held a substitute patent that blocked the other from practicing its IP.[184] In order to clear their mutual blocking patent thicket problem, Visx and Summit Technologies developed Pillar Point Partners—an entity to manage their patent pool—and pooled the rival patents into one licensing package where users of either laser surgery device (excimer or refractive laser technology) would have to pay for use.[185] Visx and Summit Technologies benefited handsomely because this arrangement suppressed price competition between the two products[186] and resulted in shared proceeds any time either of the two lasers was used.[187] This was an abuse of the patent pooling mechanism. Visx and Summit settled with the FTC after agreeing to dissolve the pool.[188]

In 1995, the Agencies laid out their general antitrust enforcement policy in the "Antitrust Guidelines for the Licensing of Intellectual Property."[189] While the Guidelines are not law, they are designed to help individuals predict whether the Agencies will raise antitrust concerns regarding their business practices.[190] Therefore, a nanotechnology "building block" patent pool that is tailored to the Agencies' Antitrust Guidelines can potentially survive antitrust scrutiny by carving out a collective standardizing entity designed to disentangle the nanotechnology patent thicket and promote innovation and consumer welfare. There are several elements set forth in the Guidelines to be mindful of when proposing the construction of such a patent pool. These elements include the relationships of the licensing parties that are involved and what, if any, restrictions will be incorporated into the pool's licensing scheme.

Classification and consideration of the relationships between the licensing parties is important because the relationship status of the

183. *See id.*

184. *See* Lévêque & Ménière, *supra* note 149, at 2; *see also* Shapiro, *supra* note 22, at 135; Clarkson & DeKorte, *supra* note 1, at 195.

185. Shapiro, *supra* note 22, at 135.

186. *See, e.g.*, Lévêque & Ménière, *supra* note 149, at 2.

187. Shapiro, *supra* note 22, at 135.

188. Clarkson & DeKorte, *supra* note 1, at 195.

189. *See* ANTITRUST GUIDELINES, *supra* note 5, § 1.0.

190. *See id.* § 1.0.

licensor and the licensee(s) may raise antitrust concerns, if certain licensing restrictions are proposed in the nanotechnology patent pool licensing agreement.[191] A horizontal relationship between the licensor and licensee(s) exists when, in the absence of the licensing agreement, the two parties would have likely been potential competitors in the relevant market.[192] On the other hand, a vertical relationship exists with "activities that are in a complementary relationship"; that is, one firm is a consumer of a technology supplied by the other and the two firms are not competitors in that particular market.[193] When there is a vertical relationship between the licensor and the licensee(s), the Agencies will look for potentially harmful anticompetitive effects resulting from that vertical relationship on any horizontal relationships observed at either the level of the licensor or the licensees.[194]

Some licensing restrictions promote competition, while others do not. Field-of-use, geographical, and exclusionary licensing restrictions[195] can be procompetitive and allow a licensor to exploit its IP in an efficient and effective manner.[196] If restraints are put on the licensing agreement, then it is desirable for those restraints to align the parties' interests through common incentives or reduction of transaction costs.[197] The Agencies have also designated several types of licensing agreement restraints as *per se* unlawful because they are anticompetitive in character.[198] These include, but are not limited to, blatant price-fixing, agreements to reduce output, division of the customer market among horizontal competitors, and "certain group boycotts and resale price maintenance."[199] The Agencies have developed an antitrust "safety zone" where licensors and licensees (not collectively comprising more than 20% of each relevant market significantly affected by the restraint) can carefully craft reasonable[200] restraints that are not facially anticompetitive.[201] Restrictions that fall

191. *See id.* § 4.1.2.

192. *See id.* § 3.3.

193. *See id.*

194. *See id.* § 4.1.1.

195. Caution should be used when using exclusionary license restrictions as, "[g]enerally, an exclusive license may raise antitrust concerns only if the licensees themselves, or the licensor and its licensees, are in a horizontal relationship." *Id.* § 4.1.2.

196. *See id.* § 2.3.

197. *See id.*

198. *Id.* § 3.4.

199. *Id.*; *see also id.* § 5.1.

200. *See id.* § 4.3.

201. *See id.*

within the safety zone will not be challenged because licensing agreements that promote the "efficiency-enhancing integration of economic activity . . . facilitate[s] the combination of the licensor's intellectual property with complementary factors of production owned by the licensee."[202]

B. Procompetitive Advisements for a Nanotechnology Patent Pool Proposal

When implementing a nanotechnology "building block" patent pool, the primary goal should be to open up access to foundational technologies and research techniques necessary to further innovation and unfreeze commercialization efforts. With that in mind, it is highly advisable that the entities who band together to build a pool strategically develop a patent pool proposal designed to promote competition in the nanotechnology industry and avoid antitrust scrutiny, and request a preliminary antitrust evaluation from the Agencies before moving forward. The proposal should include a definition of the scope of the pool, identification of all the technically essential complementary patents for inclusion and the patent-holding parties involved a licensing scheme to be employed, and a payment structure describing the division of rents for access to the IP in the pool.

Clearly defining the scope of a proposed patent pool demonstrates to the Agencies a need for collaboration to transverse the nanotechnology patent thicket that is thwarting commercialization efforts. "Nanotechnology" is an overarching term that refers to the whole of the five main subdivisions of nanotechnology based on the nanostructure at the core of the technology.[203] These subdivisions include dendrimers, carbon nanotubes ("CNTs"), nanowires, quantum dots, and fullerenes.[204] Mirroring the narrow technological scope of the successful MPEG-2 pool model, the nanotechnology "building block" patent pool should similarly be broken down into smaller pools based on the physical properties of the core nanostructures, further narrowed by relevance to a specific market or field of science. For example, a pool composed of CNT and nanowire building block patents is essential to the fabrication of nanoscale electronic circuitry. A second example would be a pool composed of essen-

202. *Id.* § 3.4.
203. Serrato et al., *supra* note 39, at 150.
204. *Id.*

tial quantum dot and CNT capsule building block patents for the development of nanoscale drug delivery systems. Or, a nanotechnology pool could be composed of only one nanostructure type, such as a CNT patent pool[205] for applications in energy or cosmetics.[206] Inclusion of dendrimer "building block" patents in a pooling proposal would require careful deliberation since nanotechnology dendrimers have been predominately patented by a single firm called Dendritic Nanotechnologies, Inc.[207] Dendritic's IP dominance would probably raise antitrust concerns, specifically market share dominance with the Agencies if these patents were included in a patent pool. Narrowing the scope of a pool keeps the pool technologically relevant and keeps the pools a manageable size.

In the event that a pooling of the building block nanotechnology patents occurs, choosing the technologically essential complementary patents for inclusion in the pool is a crucial first step to minimizing the chances of running afoul with antitrust laws. The pool should mirror certain aspects of the successful MPEG-2 pooling model, including the incorporation of competitive safeguards into the licensing agreement, creation of a licensing agent entity, and the employment of a third party, to serve as an independent reviewer of the essential patents chosen for inclusion in the nanotechnology patent pool portfolio. Participation in the nanotechnology patent pool would be entirely voluntary. Nanotechnology "building block" patent holders have invested large amounts of money and human capital into obtaining patents on their nanotechnology discoveries and inventions, which the nanotechnology patent thicket has essentially rendered as sunk costs, creating an economic incentive for patent holders to collaborate in order to recoup some of those costs by joining the pool voluntarily. As pool participants, members will benefit from reduced transaction costs and license negotiation costs, and will also gain access to a multitude of relevant IP that will enable them to introduce new marketable products. The nanotechnology industry is currently profit stagnant (with the exception of some

205. John Miller and Drew Harris proposed a "Nanotube Patent Forum," which is very similar in construction and purpose to a patent pool. They indicated specific parties that should be involved (including "key patent holders such as IBM, NEC, Hyperion, Intel, Rice University, GE, Carbon Nanotechnologies, Nantero, Unidym, and Stanford University") and also advocated for open discussion regarding royalty payment structures between these parties. *See* Miller & Harris, *supra* note 2, at 452–54.

206. Serrato et al., *supra* note 39, at 151.

207. *Id.* at 150.

carbon nanotube products).[208] Given the opportunity to take proactive steps towards profitable ends, it is very likely that nanotechnology patent holders will voluntarily submit to a patent pool model.[209]

Once the pool members have determined which patents are to be included in the pool, they "must agree on . . . the terms of licensing."[210] The Antitrust Guidelines for the Licensing of Intellectual Property provide some insight into how a pool's licensing structure can be tailored to promote procompetitive benefits, and what aspects of the licensing structure can be manipulated to satisfy anticompetitive agendas. With the nanotechnology patent thicket as enmeshed as it is, those seeking a way through should exercise great care and objective judgment when designing the licensing structure of their proposed pool. Packaged licensing of the "building block" patents could remedy the nanotechnology patent thicket debacle. This proposed licensing arrangement is a competitive safeguard and is ideal for maximizing pool efficiencies[211] by "integrating complementary technologies, reducing transaction costs, clearing blocking positions, and avoiding costly infringement litigation."[212] By packaging technologically-related pool IP into one non-exclusive, non-discriminatory license, licensees will obtain access to all of the necessary IP and not have to worry about infringement; a non-exclusive licensing strategy stimulates innovation and enables competition.[213] Yet not everyone seeks access to an entire pool of patents. A nanotechnology patent pool proposal should also permit independent licensing, where a licensee has the option to negotiate the terms of an independent license with the individual patent owner of interest.[214] A proposal for a nanotechnology patent pool should therefore prescribe a "mixed bundle"[215] licensing arrangement because it facilitates increased competition and innovation.

Recommendations on effective restraints, determinations about when to grant back new innovative IP, renegotiations, and contin-

208. For examples of profitable carbon nanotube applications, see Miller & Harris, *supra* note 2, at 429–32.

209. *But see* Layne-Farrar & Lerner, *supra* note 165, at 24 (presenting empirical findings that between one-half to two-thirds of the eligible firms choose not to join a patent pool voluntarily).

210. *Id.* at 10.

211. ANTITRUST GUIDELINES, *supra* note 5, § 5.3.

212. *Id.* § 5.5.

213. *Id.* § 4.1.2.

214. *See* Layne-Farrar & Lerner, *supra* note 165, at 10.

215. "Mixed bundling" describes licensing structures that include a packaged license offer as well as the option for independent licensing opportunities. *See id.* at 10 n.18.

gency exit plan strategies may help those engineering a licensing structure stay within the antitrust "safety zone." Examples of anti-competitive restrictions to avoid when drafting a licensing agreement include vertical restraints that hinder downstream attempts at commercialization, such as price fixing or not permitting the use of unpatented substitutes in place of licensed technologies,[216] and exclusive territory restrictions that are not in the best interests of consumers.[217]

The terms of a pool's "grant-back" policy are usually laid out in the licensing agreement. After accessing the wealth of IP stored in a pool, firms may produce patent-worthy innovations that are essential for inclusion back into the pool, which they may then use as leverage to holdup the pool for higher royalties.[218] Grant-back policies prevent this type of hold-up by requiring non-exclusive, non-discriminatory grant-back licensing of innovations produced as a result of access to the pool.[219] Instituting a grant-back policy where the share of royalties and the packaged licensing fee are adjusted with each new technically essential, innovative contribution to the pool would generate an economic incentive to develop pool-related innovations.[220] At the nanotechnology building block level, however, it is likely that there will be many pool-unrelated innovations that fall outside the scope of what is technically essential for grant back to the pool. Keeping the licensing agreement free of restrictions as to what licensees can and cannot do with their innovative IP that falls outside the scope of a nanotechnology pool will encourage the sprawl of novel nanotechnology applications and will pave the way to new business opportunities.

Which nanotechnology patent holders will come out furthest ahead in the race to commercial success is still to be determined. That being the case, in addition to the minor adjustments to the licensing fee and royalties share resulting from the grant back of new innovative IP to the pool, participants may appreciate the opportunity to renegotiate the terms of their license agreement after a set

216. Gilbert, *supra* note 84, at ¶ 91.

217. ANTITRUST GUIDELINES, *supra* note 5, § 4.1.2; *see also* Gilbert, *supra* note 84, at ¶ 97 n.84.

218. Layne-Farrar & Lerner, *supra* note 165, at 10.

219. Gilbert, *supra* note 84, at ¶ 2.

220. *See* Josh Lerner et al., *The Design of Patent Pools: The Determinants of Licensing Rules*, 38 RAND J. ECON. 610, 613, 622–24 (2005) (providing empirical evidence that patent pools comprised of complementary IP should: (1) allow members to engage in independent licensing, and (2) implement a grant-back policy). S*ee also* Layne-Farrar & Lerner, *supra* note 165, at 10 n.19.

period of time. Permitting renegotiations of the licensing terms every few years could help foster successful long-term relationships between the licensing parties.[221] While renegotiations of a pool's packaged license may seem daunting and cumbersome to orchestrate, as the number of pool members may be high, renegotiation may be imperative to the long-term survival of the pool. Renegotiation may be necessary as circumstances and situations change over time.

Another appropriate consideration here is that since participation in a nanotechnology "building block" patent pool would be completely voluntary, it may be practical to devise a set of rules governing the exit of a pool member, if withdrawal from the pool must occur.[222] Preparing precautionary contingencies in the licensing agreement may entice members to join the patent pool who otherwise would not because of the inflexibility of the licensing agreement. Situations could potentially arise where exit from the pool may be necessary and fair to the other members in the pool. For example, a "building block" patent that once seemed essential to a patent pool may prove to be useless and should be removed from the pool because a useless patent should not be earning royalties.

Determining the price of a pool's licensing fee will require input from all pool members. "While independent licenses are typically priced in bilateral negotiations" between the potential licensee and the individual patent holder, the pool members as a collective whole must agree on the pricing of the pool license and how to divide the royalties generated from licensed access to the pool.[223] Because licensing fees are based on the particular IP contained in the pool, the fees typically range "from a few thousand to a few hundreds of thousands of dollars."[224] Similarly, royalty rates vary widely. For instance, 1% of any net profits earned on the sale of products that resulted from the use of pool patents may be paid back to the pool members.[225] In other situations, where a patent has direct, significant, or immediate commercialization potential, a royalty rate of up to 10% of net sales on the marketed product is not unheard of.[226]

221. *See generally* Bastani et al., *supra* note 103, at 171 (noting specifically how Stanford University is known for explicitly asking to renegotiate licensing terms every two or three years).

222. *See* Layne-Farrar & Lerner, *supra* note 165, at 7.

223. *Id.* at 10.

224. Bastani et al., *supra* note 103, at 170.

225. *See id.*

226. *See id.*

There are three main types of profit-sharing strategies with distinct advantages and disadvantages.[227] Participants in a nanotechnology "building block" patent pool could opt for royalty-free licensing, meaning licensees that achieve commercialization as a result of access to the pool are *not* required to payback a percentage of the net profits to the pool. As a result, royalty-free licensing is not very commonly employed.[228] In the case of a nanotechnology "building block" patent pool, a royalty-free structure will fundamentally not work because it destroys a large portion of the economic incentive to voluntarily join the pool.

Another possible royalty distribution structure involves numerically proportional division of rents, where each member "receive[s] a share of the aggregate earnings based on the number of patents [it] contribute[s] to the pool."[229] In practice, this royalty structure is very common.[230] In fact, the MPEG-2 patent pool model provides a working example of this royalty payment structure. Royalties are allocated proportionally based on the "patent holder's share of all the essential, pooled patents applicable in the country in which the product is made."[231] However, a problem tends to arise in this royalty structure when a small number of patents prove to be highly valuable over time.[232] Therefore, a third type of rent division proportionally bases royalty payments on the value contribution of each patent to the pool, making some contributors entitled to a larger share of the earnings.[233]

Initially, a royalty structure based on numerically proportional rules should be used with nanotechnology patent pools, provided there is an option to collectively reassess the royalty structure after a few years. This proposal would likely suit the fiscal interests of those participating in a nanotechnology patent pool since, at the outset, an economic incentive is needed to drive collaborative efforts to form a pool and eliminate the progress-hindering patent thicket. Once cleared, innovation will assess the true value of the patents in the pool, revealing which technologies are essential to the development of nanotechnologies. At some point in the future, the royalty

227. *See* Layne-Farrar & Lerner, *supra* note 165, at 10.

228. Only one (Bluetooth technology) out of nine modern patent pools has royalty-free licensing. *See id.*

229. *Id.*

230. *See* Lévêque & Ménière, *supra* note 149, at 3.

231. Farrell et al., *supra* note 114, at 643 n.150.

232. *See id.*

233. *See* Layne-Farrar & Lerner, *supra* note 165, at 12.

structure can be reevaluated by pool members and converted to a value-based royalty structure.

CONCLUSION

Over-patenting and the issuance of overly-broad nanotechnology "building block" patents by the USPTO have generated a densely enmeshed patent thicket that seems impossible to navigate. Nanotechnology is touted as having immense potential, yet IP commercialization efforts are frozen by the existence of this jumble of fundamental nanotechnology IP. Because the nanotechnology "building block" patent thicket is preventing the commercialization of useful innovations, a viable solution to circumvent barriers to the market must be introduced. Collaborative effort to construct patent pools comprised of the specific "building block" nanotechnology patents provides a feasible, promising, and practical means of untangling the complicated nanotechnology patent thicket.

The successful design of a nanotechnology "building block" patent pool proposal can be achieved with careful planning and objective reasoning. Because a patent pool proposal requires affirmation of *all* the essential patents to a specific pool—which cannot be determined without thorough research, assessment, and independent review—the specific details for a nanotechnology "building block" patent pool proposal cannot be constructed at this time. However, a potential pool proposal framework can be described and implemented in the event that a pooling of the "building block" nanotechnology patents occurs.

The framework for a patent pool proposal includes six critical steps. First, it is highly advisable that anyone seeking to implement a nanotechnology "building block" patent pool should submit a proposal for preliminary review to the Agencies. This review by the Agencies will help identify any potential antitrust complications that could arise as a result of pooling essential complementary patents necessary to alleviate a nanotechnology patent thicket. Second, the proposal should contain a well-formulated plan of action. This includes a clear definition of the scope of the pool. Defining the scope will keep the pool technologically relevant and small in size. Voluntary participation in the pool is likely, because nanotechnology "building block" patent holders have amassed sunk costs that could potentially be recouped by collaborating to form a pool. Third, pool participants should then analyze and evaluate which patents are complementary and essential for inclusion in the pool.

Fourth, the pool participants should seek an objective independent review of the patents to ensure relevance to the pool. Fifth, the pool participants should develop a procompetitive licensing structure that is based on the Agencies' Antitrust Guidelines for the Licensing of Intellectual Property to mitigate antitrust concerns. Sixth, pool participants should collectively decide on a royalties sharing strategy for the pool.

This nanotechnology patent pooling model is designed to navigate antitrust difficulties commonly encountered by patent pools. By integrating the Antitrust Guidelines into this nanotechnology patent pool framework, those seeking to construct a procompetitive patent pool proposal, intended to remain well within the antitrust "safety zone," can use this model as a guide to their pool engineering process. Furthermore, this model is also designed to entice nanotechnology "building block" patent holders to participate in the pool by providing economic incentive to voluntarily join. Pool contributors are presented with an opportunity to recoup some of their sunken research and development costs through licensing fees and royalty payments. With objective implementation, this nanotechnology patent pool framework could effectively disentangle the nanotechnology patent thicket, thus enabling the innovation and commercialization of new nanotechnology applications.