



NOTE

Patenting Nanotechnology: Problems with the Utility Requirement

DAVID S. ALMELING*

CITE AS: 2004 STAN. TECH. L. REV. N1

http://stlr.stanford.edu/STLR/Articles/04_STLR_N1

INTRODUCTION

¶1 Nanotechnology is a buzzword, which makes an exact definition tricky. But most experts agree that nanotechnology refers to technology at the nanometer scale, which is one billionth of a meter.¹ To put this in perspective, one nanometer is about 100,000 times as thin as a human hair.² But nanotechnology is more than just its small size. It also involves a new way to pursue technology. Before nanotechnology, the technological process was top-down: whittling a block of material to make a desired object.³ Nanotechnology, in contrast, is bottom-up: aggregating individual atoms and molecules to make a desired object.⁴

¶2 Some commentators promise that nanotechnology will make us all "healthy and wealthy," ending myriad diseases "and even old age."⁵ Others take a more cautious tone. ⁶ Who is right? No one knows. But this uncertainty has not stopped inventors from filing patent applications with the Patent and Trademark Office (PTO). Between 1997 and 2002, the number of nanotechnology patents grew by 600%.⁷ As of December

* J.D., 2004, Duke University School of Law; B.A., 2001, University of Florida. [Mr. Almeling is clerking during the 2004-2005 term for the Hon. Gerald Bard Tjoflat, U.S. Court of Appeals for the Eleventh Circuit. He thanks Professor Arti K. Rai for her invaluable comments on earlier drafts. He also thanks Sarah E. Citrin, Kristina C. Evans, and Timothy M. Pomarole for their editing assistance and thoughtful comments on earlier drafts. He stresses, of course, that all errors are his alone.]

¹ See COMM. FOR THE REVIEW OF THE NAT'L NANOTECHNOLOGY INITIATIVE, NAT'L RESEARCH COUNCIL, SMALL WONDERS, ENDLESS FRONTIERS: A REVIEW OF THE NATIONAL NANOTECHNOLOGY INITIATIVE 4 (2002) [hereinafter SMALL WONDERS] ("Nanoscale science and technology, often spoken of as 'nanoscience' or 'nanotechnology,' are simply science and engineering carried out on the nanometer scale, that is, 10⁻⁹ meters."); Tina Masciangioli & Wei-Xian Zhang, *Environmental Technologies at the Nanoscale*, ENVTL. SCI. & TECH., Mar. 1, 2003, at 103A ("Nanotechnology refers broadly to using materials and structures with nanoscale dimensions, usually ranging from 1 to 100 nanometers (nm)."); Barry Newberger, *Intellectual Property and Nanotechnology*, 11 TEX. INTELL. PROP. L.J. 649, 650 (2003) ("In my opinion, a more practical definition is the application of science at the nanoscale."). This Note defines nanotechnology in a similar manner: any technology at the nanometer scale, even if that technology is larger than 100 nanometers.

² Barnaby J. Feder, *Nanotechnology Is Set for a Capital Infusion*, INT'L HERALD TRIB., Dec. 22, 2003, at 9.

³ MICHAEL WILSON ET AL., NANOTECHNOLOGY: BASIC SCIENCE AND EMERGING TECHNOLOGIES 26 (2002).

⁴ *Id.*

⁵ Puneet Gupta, *Recent Trends in Nanotechnology*, in KELLOGG ON TECHNOLOGY & INNOVATION 261 (Ranjay Gulati et al. eds., 2003) (quoting comments of Ralph Merkle, a principle fellow of a nanotechnology company named Zyvex Inc.).

⁶ See George M. Whitesides & J. Christopher Love, *The Art of Building Small*, in UNDERSTANDING NANOTECHNOLOGY 36, 36 (Sandy Fritz ed., 2002) ("The age of nanofabrication is here, and the age of nanoscience has dawned, but the age of nanotechnology—finding practical uses for nanostructure—has not really started yet.").

⁷ Henry M. Heines, *Patent Trends in Nanotechnology*, CHEM. ENG'G PROGRESS, Sept. 1, 2003, at 22 ("The number of issued patents involving nanotechnology has increased by more than 600% in the last five years, from 370 in 1997 to 2,650 in 2002.").

2003, there were around 7,000 such patents.⁸ None of these patents has been addressed by the Federal Circuit, which means that we can consider the patentability of nanotechnology on a clean slate. Thus, this Note seeks to explore how courts should handle nanotechnology patents—before courts make binding decisions.

¶3 To be patentable, an invention must be patentable subject matter,⁹ useful (utility),¹⁰ novel (novelty),¹¹ nonobvious in light of the prior art,¹² and sufficiently described to enable one skilled in the art to make and use the invention.¹³ This Note focuses on the utility requirement.¹⁴ At its core, this requirement obliges an invention to have some known, useful result.¹⁵ It derives from the U.S. Constitution, which authorizes Congress to promote "the useful arts,"¹⁶ and it has been part of the Patent Act since 1870.¹⁷ Yet the utility standard (or strength of the utility requirement) has fluctuated from being a very low bar to patentability, excluding only affirmatively harmful inventions,¹⁸ to being a very high bar, excluding all inventions lacking a substantial utility in their current form.¹⁹ As described throughout this Note, the current standard lies between these extremes.

¶4 Conceivably, the current utility standard could create problems for nanotechnology. Nonetheless, this Note argues that utility will not—and should not—be applied in a heightened manner that would make the utility requirement an insurmountable obstacle to patenting nanotechnology inventions. Descriptively, this Note argues that the Federal Circuit is unlikely to create a heightened, nanotechnology-specific utility standard. Normatively, it argues that a heightened standard would be bad for the technological and economic development of nanotechnology.

¶5 This Note proceeds in three Parts. Part 1 focuses on four potential utility problems for nanotechnology: (1) interdisciplinary problems created by the breadth of the nanotechnology field; (2) inoperability problems created by the impossible or inoperable nature of some inventions; (3) practical-utility problems created by the uncertain uses of some inventions; and (4) upstream-research problems created by patents at the research stage of development.²⁰ Part 2 (descriptively) predicts that none of these problems will be overwhelming obstacles to patenting nanotechnology. This prediction flows from PTO practice and Federal Circuit precedent. Part 3 moves from prediction to policy. It gives (normative) reasons to support the relatively low utility standard predicted in Part 2. Part 3 argues that both the technology behind nanotechnology and the

⁸ Ronald Bailey, *The Smaller the Better*, REASON, Dec. 1, 2003, at 44. Another researcher, using a more inclusive methodology, concluded that there are substantially more nanotechnology patents. See Zan Huang et al., *Longitudinal Patent Analysis for Nanoscale Science and Engineering: Country, Institution and Technology Field*, 5 J. NANOPARTICLE RES. 333, 334 tbl.1 (2003) (using wildcard-based searches of a full-text patent database, with search terms such as "nano*" to conclude that there are at least 89,153 nanotechnology patents).

⁹ 35 U.S.C. § 101 (2000).

¹⁰ See *id.*

¹¹ See *id.* § 102.

¹² See *id.* § 103(a).

¹³ See *id.* § 112.

¹⁴ The utility requirement is closely related to the disclosure requirement. See Rebecca S. Eisenberg, *Analyze This: A Law and Economics Agenda for the Patent System*, 53 VAND. L. REV. 2081, 2086 (2000) ("The courts treat the utility requirement as a hybrid subject matter limitation and disclosure requirement."). There is considerable debate about what this means. See R. CARL MOY, *MOY'S WALKER ON PATENTS* § 6:6 (4th ed. 2003) ("As this statement of the trend indicates, the effort is closely related to the concepts of adequate disclosure that are applied under the first paragraph of section 112, and there are considerable arguments in favor of classifying the rules there."). However, this Note limits its coverage to utility-related problems, even when those problems concern the adequacy of the disclosure. In other words, anything beyond utility is beyond the scope of this Note.

¹⁵ See *infra* notes 42 and 62–65 and accompanying text.

¹⁶ U.S. CONST. art. I, § 8, cl. 8.

¹⁷ Act of July 8, 1870, ch. 230, § 24, 16 Stat. 198, 201 (current version at 35 U.S.C. § 101) (covering "any new and useful art").

¹⁸ *Lowell v. Lewis*, 15 F. Cas. 1018, 1019 (C.C.D. Mass. 1817) ("All that the law requires is, that the invention should not be frivolous or injurious to the well-being, good policy, or sound morals of society.").

¹⁹ See *infra* notes 82–85 and accompanying text.

²⁰ It is hard to winnow out discrete issues because the field of nanotechnology is so broad. See, e.g., CHARLES P. POOLE, JR. & FRANK J. OWENS, *INTRODUCTION TO NANOTECHNOLOGY* xii (2003) ("Because of the rapid pace of development of the subject, and its interdisciplinary nature, a truly comprehensive coverage [in this book] does not seem feasible."). Thus, this Note cannot hope to deal with all of the unique utility issues that arise within nanotechnology. Still, this Note selects four of the most likely utility problems that could arise in nanotechnology, and this Note's analysis in Parts 2 and 3 should apply to other utility problems not handled explicitly in this Note.

structure of the nanotechnology industry counsel against a heightened utility standard. Ultimately, this Note concludes that despite nanotechnology's potential utility problems, it is better to rely on the current, relatively low utility standard than to create a heightened, nanotechnology-specific standard.

1. POTENTIAL UTILITY PROBLEMS

A. Interdisciplinary Problems

¶6 In theory, patent law applies uniformly to all technologies.²¹ In practice, however, most commentators agree that patent law applies differently in different contexts.²² For example, although theoretically the same utility standard applies to both chemical and mechanical inventions, courts apply the standard with more force in evaluating the patentability of chemical inventions.²³ This split between theory and practice affects emerging technologies because each new technology requires courts to determine the context in which it belongs. Invariably, each emerging technology elicits arguments that rules applied in other contexts are ill-suited.²⁴ Some commentators have made this argument for nanotechnology.²⁵ However, arguments that a new technology requires technology-specific legislation rarely succeed.²⁶ Rather, courts typically place an emerging technology in an existing context by analogizing it to previous technologies. Biotechnology is a recent example of this tendency. Instead of dealing with biotechnology on its own terms, the Federal Circuit handled the technology under its chemistry-based precedent.²⁷ The court used this precedent because it considered "[a] gene [to be] a chemical compound, albeit a complex one."²⁸

¶7 It is always difficult for courts to fit new technologies into old contexts because each new technology presents unique problems. Nanotechnology promises to be even more problematic than usual because of its interdisciplinary nature. It is true that most technologies involve more than one discipline. A recent study concluded that patents in the late 1990s fell within an average of 1.5 technological disciplines.²⁹ What makes nanotechnology different is the breadth of disciplines involved. Nanotechnology can involve chemistry, biology, physics, computer science, pharmaceuticals, materials science, diverse fields of engineering, and other disciplines.³⁰ For some nanotechnology inventions, such as a computer screen that relies on a type of

²¹ See Dan L. Burk & Mark A. Lemley, *Policy Levers in Patent Law*, 89 VA. L. REV. 1575, 1576–77 (2003) ("In theory, then, we have a uniform patent system that provides technology-neutral protection to all kinds of innovation.")

²² *Id.* at 1577 ("A closer examination of patent law demonstrates that it is unified only in concept. In practice the rules actually applied to different industries increasingly diverge."); Teresa M. Summers, Note, *The Scope of Utility in the Twenty-First Century: New Guidance for Gene-Related Patents*, 91 GEO. L.J. 475, 475 (2003) ("To a significant extent, the specific industry sought to be promoted through the patent system influences the boundaries of the law.")

²³ See JANICE M. MUELLER, AN INTRODUCTION TO PATENT LAW 156 (2003) ("Utility is rarely an issue for mechanical or electrical inventions . . ."); Eisenberg, *supra* note 14, at 2085–86 ("Although the utility requirement has played little role in evaluating the patentability of mechanical inventions, it has been more prominent in the chemical and biotechnology fields, in which new compounds are often discovered before their functions are well understood."); DONALD S. CHISUM, CHISUM ON PATENTS §4.01 (1994) ("The [utility] requirement is easily met with most mechanical devices but is a frequent problem with chemical compounds and processes—particularly pharmaceutical compounds (drugs).")

²⁴ See generally J.H. Reichman, *Legal Hybrids Between the Patent and Copyright Paradigms*, 94 COLUM. L. REV. 2432 (1994).

²⁵ See, e.g., Joel Rothstein Wolfson, *Social and Ethical Issues in Nanotechnology: Lessons from Biotechnology and Other High Technologies*, 22 BIOTECH. L. REP. 376, 395 (2003) ("Nanotechnology may seem to fall logically within the existing protections of patent, copyright, and trade secret law. However, it is important to consider the benefits and costs of a sui generis form of protection for this new intellectual property."); V. Weil, *Ethical Issues in Nanotechnology*, in NAT'L SCIENCE FOUND., SOCIETAL IMPLICATIONS OF NANOSCIENCE AND NANOTECHNOLOGY 193, 196 (Mihail C. Roco & William Sims Bainbridge eds., 2001) ("Vigorous and extensive public discussion could even lead to reexamination and revisions of intellectual property policies.")

²⁶ *But see*, e.g., Semiconductor Chip Protection Act, 17 U.S.C. §§ 901–914 (2000) (semiconductors); 35 U.S.C.

§ 287 (2000) (medical procedures); 35 U.S.C. § 273(a)(3) (2002) (business method patents).

²⁷ See Arti K. Rai, *The Information Revolution Reaches Pharmaceuticals: Balancing Innovation Incentives, Cost, and Access in the Post-Genomics Era*, 2001 U. ILL. L. REV. 173, 195 n.100 (2001) (arguing that "the Federal Circuit[] views biotechnology as a subset of chemistry and is thus unlikely to decide biotechnology cases by drawing upon analogies from mechanical cases").

²⁸ *Amgen, Inc. v. Chugai Pharm. Co., Ltd.*, 927 F.2d 1200, 1206 (Fed. Cir. 1991).

²⁹ John R. Allison & Mark A. Lemley, *Who's Patenting What? An Empirical Exploration of Patent Protection*, 53 VAND. L. REV. 2099, 2148 tbl.1 (2002).

³⁰ See, e.g., POOLE & OWENS, *supra* note 20, at 5 ("Work in nanotechnology can be found in university departments of physics, chemistry, and environmental science, as well as electrical, mechanical, and chemical engineering."). Some commentators have noted that nanotechnology's interdisciplinary nature may cause other problems. See, e.g., John Miller, Note, *Beyond Biotechnology: FDA Regulation of*

nanotechnology called carbon nanotubes,³¹ the principle disciplines are computer science and engineering. Other inventions, such as those using nanotechnology to diagnose and treat diseases,³² involve every discipline listed above.

¶8 To complicate matters, nanotechnology spans more than just scientific disciplines; it also spans industries. Because nanotechnology is defined by its size, it includes all industries that develop technology at the nanometer scale.³³ This breadth makes it difficult for courts to make decisions because they must incorporate different industries in their decision-making. For example, in *Fujikawa v. Wattanasin*,³⁴ the Federal Circuit discussed the role of utility in the "pharmaceutical arts."³⁵ It upheld the patent at issue, reasoning that a particular type of testing is "sufficient to establish pharmacological activity in the minds of those skilled in the art."³⁶ The Federal Circuit's ability to cabin its analysis to the "pharmaceutical arts" may not work with nanotechnology. Consider, for example, quantum dots, which are essentially semiconductor nanocrystals.³⁷ Quantum dots have been patented for purposes ranging from use in optoelectronic devices³⁸ to mapping portions of DNA³⁹ to logic gates for computing.⁴⁰ So while quantum dots are within the "pharmaceutical arts," they also fit within several other arts; thus, it is hard to cabin quantum dots in any one context.

¶9 Finally, not only does nanotechnology span disciplines and industries, it also combines different fields into a larger, more diverse field under the roomy umbrella of nanotechnology.⁴¹ This means that when courts and the PTO examine the patentability of nanotechnology inventions, they must address both (1) which context is appropriate across many disciplines and industries, and (2) the contours of this new, converging industry. In sum, patent law is often technology- and industry-specific, and nanotechnology's breadth of technological and industrial contexts makes it hard to determine in which context it fits.

B. Inoperability Problems

¶10 A part of the utility requirement called the inoperability standard requires that all inventions work as claimed before they can be patented.⁴² This is a lenient standard,⁴³ and the PTO presumes that an applicant's statements about utility are true.⁴⁴ It is "[o]nly after the PTO provides evidence showing that one of ordinary

Nanomedicine, 4 COLUM. SCI. & TECH. L. REV. 5, ¶ 24 (2003), at <http://www.stlr.org/cite.cgi?volume=4&article=5> (arguing, with respect to FDA regulation of nanotechnology, that "[in] the long run, sophisticated nanomedical products will blur the distinction between 'mechanical', 'chemical', and 'biological' and make it difficult to determine if a product is a drug, device, biologic, or combination product").

³¹ See WILLIAM ILLSEY ATKINSON, NANOCOSM: NANOTECHNOLOGY AND THE BIG CHANGES COMING FROM THE INCONCEIVABLY SMALL 210-11 (2003) (describing how carbon nanotubes can be used to decrease the size and improve the performance of monitors).

³² See generally Katarzyna Bogunia-Kubik & Masanori Sugisaka, *From Molecular Biology to Nanotechnology and Nanomedicine*, 65 BIOSYS. 123 (2002) (outlining different examples of how nanotechnology can improve immunogenetics-related medicine).

³³ See M.C. Roco & W.S. Bainbridge, *Overview: Converging Technologies for Improving Human Performance*, in CONVERGING TECHNOLOGIES FOR IMPROVING HUMAN PERFORMANCE: NANOTECHNOLOGY, BIOTECHNOLOGY, INFORMATION TECHNOLOGY AND COGNITIVE SCIENCE 2 (Mihail C. Roco & William Sims Bainbridge eds., 2003) ("Convergence of diverse technologies is based on *material unity at the nanoscale and on technology integration from that scale*."). Some predict that nanotechnology is the "next industrial revolution," affecting all major industries. Rick Weiss, *Nanotech Poses Big Unknown to Science*, WASH. POST, Feb. 1, 2004, at A1 (quoting unnamed source). Some even make this prediction for specific types of nanotechnology. See Eric Berger, *After Years of Promise, Nanotubes Can Deliver*, HOUS. CHRON., Mar. 4, 2004, at 1. ("Analysts say that's probably optimistic, but the question of a large market for nanotubes is more of a 'when' than an 'if.' Their versatility and almost magical properties make nanotubes a candidate to improve every industry from computing to aerospace.")

³⁴ 93 F.3d 1559 (Fed. Cir. 1996).

³⁵ *Id.* at 1564.

³⁶ *Id.* at 1566.

³⁷ *The Runners-Up*, 302 SCI. 2039, 2043 (2003).

³⁸ *E.g.*, U.S. Patent No. 6,322,901 (issued Nov. 27, 2001).

³⁹ *E.g.*, U.S. Patent No. 6,653,080 (issued Nov. 25, 2003).

⁴⁰ *E.g.*, U.S. Patent No. 6,597,010 (issued July 22, 2003).

⁴¹ SMALL WONDERS, *supra* note 1, at 17 n.1.

⁴² See MUELLER, *supra* note 23, at 162.

⁴³ MOY, *supra* note 14, at § 6:7; see also *Stiftung v. Renishaw PLC*, 945 F.2d 1173, 1180 (Fed. Cir. 1991) ("An invention need not be the best or the only way to accomplish a certain result, and it need only be useful to some extent and in certain applications.")

⁴⁴ U.S. PATENT OFFICE, DEPT. OF COMMERCE, MANUAL OF PATENT EXAMINING PROCEDURE § 2107 (8th ed. 2001).

skill in the art would reasonably doubt the asserted utility [that] the burden shift[s] to the applicant to provide rebuttal evidence sufficient to convince such a person of the invention's asserted utility."⁴⁵

¶11 The inoperability standard bars an applicant from patenting an impossible invention.⁴⁶ The classic example is a perpetual-motion machine that breaks the laws of physics.⁴⁷ A more recent example comes from *EMI Group North America, Inc. v. Cypress Semiconductor Corp.*⁴⁸ *EMI Group* involved an invention for blowing fuses in semiconductor chips involving a "vapor-induced explosion mechanism."⁴⁹ Both the trial and appellate courts accepted the testimony of an expert who concluded "that a fuse simply cannot explode due to vapor pressure."⁵⁰ Because the invention relied on an impossible mechanism that the Federal Circuit called "incorrect science," the invention lacked utility.⁵¹

¶12 Nanotechnology inventions may face similar claims that they are impossible. Nanotechnology's buzz has led to hype,⁵² and this hype has bred criticism that nanotechnology constitutes science fiction, not valid science.⁵³ This hype and criticism could cloud a thoughtful evaluation of the technology,⁵⁴ which could make examiners too quick to rebut the presumption that an invention has utility.⁵⁵ That is, examiners may improperly interpret the popular criticism of nanotechnology as science fiction as reflecting skepticism among those with ordinary skill in the art. This is a real possibility because most examiners are not yet well versed in nanotechnology.⁵⁶

¶13 The claiming style of many nanotechnology patents may complicate this situation. In a new scientific field, one would expect that patent applicants would frequently cite scientific research papers because there are few patents that would qualify as prior art. But studies suggest that most nanotechnology patents only cite other patents as prior art.⁵⁷ This claiming style thus implies that examiners are not being given the information that they need to understand the technology and its place within the field, which may only aggravate an examiner's misunderstanding.

⁴⁵ *In re Brana*, 51 F.3d 1560, 1566 (Fed. Cir. 1995).

⁴⁶ See *CFMT, Inc. v. Yieldup Int'l Corp.*, 349 F.3d 1333, 1339 (Fed. Cir. 2003) ("The inoperability standard for utility applies primarily to claims with impossible limitations."); *Process Control Corp. v. HydReclaim Corp.*, 190 F.3d 1350, 1359 (Fed. Cir. 1999) ("[W]hen an impossible limitation, such as a nonsensical method of operation, is clearly embodied within the claim, the claimed invention must be held invalid.").

⁴⁷ See *Newman v. Quigg*, 877 F.2d 1575, 1581-82 (Fed. Cir. 1989) (holding that a perpetual motion machine was not patentable).

⁴⁸ 268 F.3d 1342 (Fed. Cir. 2001).

⁴⁹ *Id.* at 1349.

⁵⁰ *Id.*

⁵¹ *Id.*; see also *BlackLight Power, Inc. v. Rogan*, 295 F.3d 1269, 1271 (Fed. Cir. 2002) (upholding the PTO's withdrawal of an application even after the issue fee had been paid because "the applicant was claiming the electron going to a lower orbital in a fashion that [the Group Director] knew was contrary to the known laws of physics and chemistry").

⁵² Bruce A. Langer, *Nanotechnology: A New Chapter*, N.Y.L.J., Jan. 13, 2004, at 5.

⁵³ ATKINSON, *supra* note 31, at 134 ("Send nanobots to scour away atherosclerotic plaque when legitimate science is just starting to understand it's not an inert deposit but an inflammatory eruption of staggering complexity? . . . This ain't science. It's sci-fi."); see also A. Barton Hinkle, *The Time Has Come To Seek a Newer World*, RICH. TIMES-DISPATCH, Jan. 9, 2004, at A13 ("Nanotech's critics have leveled two charges against such a concept: (a) It's impossible, and (b) it's too possible—self-replicating machines could run out of control and create a 'gray goo' scenario, spreading like mechanical kudzu and overwhelming an environment.").

⁵⁴ Cf. Gary Stix, *Little Big Science*, in UNDERSTANDING NANOTECHNOLOGY, *supra* note 6, at 11 (Nanotechnology's "bid for respectability is colored by the association of the word with a cabal of futurists who foresee nano as a pathway to techno-utopia: unparalleled prosperity, pollution-free industry, even something resembling eternal life.").

⁵⁵ Cf. *In re Cortright*, 165 F.3d 1353, 1357 (Fed. Cir. 1999) (requiring the PTO to presume an invention's utility "unless it has reason to doubt the objective truth of the statements contained in the written description").

⁵⁶ See Langer, *supra* note 52 ("The U.S. Patent and Trademark Office has not announced any new nano divisions or practice groups to enable examiners to deal specifically with the challenges of nanopatents, so a learning curve may develop that can impact on the effective processing of inventions."); Deb Zuckerman, *Thinking Small—The Patent Office Grapples with Nanotechnology*, MONDAQ BUS. BRIEFING, July 14, 2003, at 2003 WL 57495704 ("However, the U.S. Patent and Trademark Office isn't really treating nanotechnology like biotechnology and business methods. The patent office hasn't established a separate examining group to deal with nanotechnology, as it did for those fields. In the long run this may cause complications for the industry."); Newberger, *supra* note 1, at 654 (noting that "patent examiner inexperience [with nanotechnology] complicates focusing issues early in prosecution").

⁵⁷ See, e.g., M. Meyer, *Socio-Economic Research on Nanoscale Science and Technology: A European Overview and Illustration*, in SOCIETAL IMPLICATIONS OF NANOSCIENCE AND NANOTECHNOLOGY, *supra* note 25, at 217, 231 ("One should assume that a technological field that is generally acknowledged as science-based would encompass patents that frequently cite the corresponding set of scientific research papers. This, however, is not the case. Matching the 5,000 plus nano-patents identified in the Science Citation Index (1991-96) with the nano-patents results in 275 matches.").

¶14 But even when a nanotechnology invention is possible, it still must be operable. For example, *In re Cortrigh*⁵⁸ involved a patent that claimed a method of treating baldness by applying ointment to a balding head.⁵⁹ The Federal Circuit found the method possible.⁶⁰ Yet the court held that the invention was inoperable because it did not substantiate its method; that is, there was no evidence that the ointment was the actual method by which the invention operated.⁶¹ Likewise, one could argue that, because nanotechnology is so new, there are not enough experiments to prove that a particular invention works. In other words, the nanotechnology applicant may lack sufficient rebuttal evidence to convince the examiner that the invention is useful. In the end, all applicants face operability questions. But these questions are harder to answer in the controversial field of nanotechnology.

C. Practical-Utility Problems

¶15 Another part of the utility requirement is substantial or practical utility. Practical utility requires an invention to have a real-world benefit.⁶² The current iteration of this standard comes from the PTO's 2001 Utility Examination Guidelines.⁶³ The Guidelines require all inventions to have "a well-established utility," which happens "(1) if a person of ordinary skill in the art would immediately appreciate why the invention is useful . . . , and (2) the utility is specific, substantial, and credible."⁶⁴ The Guidelines do not define key terms. But they specifically "exclude[] 'throw-away,' 'insubstantial,' or 'nonspecific' utilities."⁶⁵

¶16 Practical utility is a low standard that is rarely litigated, especially for mechanical or electrical inventions.⁶⁶ Nevertheless, it is a real issue for chemistry and biotechnology inventions⁶⁷ because the usefulness of such inventions is often uncertain. *In re Ziegler* illustrates how uncertainty can create practical-utility problems.⁶⁸ *Ziegler* involved the discovery of polypropylene, but the applicant "disclosed only that solid granules of polypropylene could be pressed into a flexible film . . . and that the polypropylene was 'plastic-like.'"⁶⁹ The court rejected the patent on utility grounds because the application "did not assert any practical use for the polypropylene or its film," and the mere contention that polypropylene was "plastic-like" was insufficient.⁷⁰

¶17 A nanotechnology patent application may suffer the same fate as the application in *Ziegler*. Take the assembler, for example. "An assembler is a nanomachine . . . that can both build nanomachines and reproduce itself in the same process."⁷¹ Assemblers thus work en masse to make larger objects, or more

⁵⁸ 165 F.3d 1353 (Fed. Cir. 1999).

⁵⁹ *Id.* at 1355–56 (explaining how the method worked).

⁶⁰ *Id.* at 1359.

⁶¹ *Id.* at 1360 (combining § 112 (written description) and § 101 (utility) to hold that "although the written description states that people observed hair growth after applying Bag Balm® to the scalp, it does not disclose that anyone observed the active ingredient reach the papilla and offset the effects of lower levels of male hormones").

⁶² See *Brenner v. Manson*, 383 U.S. 519, 534–35 (1966) (requiring a "specific benefit to exist in currently available form"); *Juicy Whip, Inc. v. Orange Bang, Inc.*, 185 F.3d 1364, 1366 (Fed. Cir. 1999) ("An invention is 'useful' under section 101 if it is capable of providing some identifiable benefit."); Utility Examination Guidelines, 66 Fed. Reg. 1092, 1094 (Jan. 5, 2001) ("The utility requirement, as explained by the courts, only requires that the inventor disclose a practical or *real world* benefit available from the invention . . ."); Matthew J. Vlissides, Jr., *Are Second-Generation DNA Sequences Useful?: A Defense of Theorized Protein Patents*, 11 FED. CIR. B.J. 901, 917 (2002) ("Thus, in order to prove substantial utility, the new guidelines force applicants to explain the utility of targeted genes, or their expressed proteins, in terms of a real world use, rather than a research use alone.").

⁶³ 66 Fed. Reg. 1092 (Jan. 5, 2001).

⁶⁴ *Id.* at 1098.

⁶⁵ *Id.*

⁶⁶ MUELLER, *supra* note 23, at 162.

⁶⁷ See ROBERT L. H. ARMON, PATENTS AND THE FEDERAL CIRCUIT § 2.3(c) (6th ed. 2003) ("Properly or not, some special considerations have traditionally been thought to apply in the case of chemical compounds, particularly those with claimed therapeutic or pharmacological benefits."); MOY, *supra* note 14, at § 6:18 n.17 ("Yet the concept of practical utility has to date been applied only to attempts to patent chemical processes and chemical products.").

⁶⁸ 992 F.2d 1197 (Fed. Cir. 1993).

⁶⁹ *Id.* at 1203.

⁷⁰ *Id.*

⁷¹ WILSON ET AL., *supra* note 3, at 5.

assemblers.⁷² Some scientists foresee an assembler that "build[s] almost anything that the laws of nature allow to exist."⁷³ Others take a more cautious view.⁷⁴ For instance, Richard Smalley, a Nobel laureate, has argued that "[s]elf-replicating, mechanical nanobots are simply not possible in our world."⁷⁵ This uncertainty about how an assembler will work, and whether it will work, creates practical-utility problems. That is, such uncertainty may make it difficult for the applicant to assert a specific use for an assembler. Or, more precisely, such uncertainty may make it easier for examiners to overcome the prima facie burden that an invention has utility.

¶18 Even if an applicant asserts a specific use, the unique properties of nanotechnology could create additional problems for the inventor. Simply put, nanometer-scale inventions involve different properties than larger inventions.⁷⁶ These properties include complex phenomena such as quantum mechanics,⁷⁷ surface-area-per-unit-volume ratios,⁷⁸ and many others.⁷⁹ While a discussion of these properties is beyond the scope of this Note, suffice it to say that they create uncertainty when one works at the nanometer scale. This uncertainty, in turn, could create at least two practical-utility problems. On the one hand, an examiner may be tempted to take the simplistic view that nanotechnology is merely small technology, and thus merely a nonpatentable derivation of current technology.⁸⁰ This view ignores these properties and could make the patent vulnerable in litigation. On the other hand, an examiner may be too willing to think that these properties mean that all nanotechnology inventions are inherently uncertain. This view gives too much weight to these properties and could make the patent vulnerable in prosecution. In the end, nanotechnology applicants must assert a specific, real-world utility while arguing that their inventions' unique properties do not make them too uncertain.

D. Upstream-Research Problems

¶19 Traditional patent law focuses on the end result, not on the research that led to that result.⁸¹ The seminal case stating this principle is *Brenner v. Manson*.⁸² In *Brenner*, the applicant sought to patent a process for

⁷² See Gupta, *supra* note 5, at 263 ("[T]he consensus is that if trillions of nanomachines are needed to make things on a scale useful for us, the cost will be prohibitive unless the devices can self-replicate.").

⁷³ K. ERIC DREXLER, ENGINES OF CREATION—THE COMING ERA OF NANOTECHNOLOGY 19 (1986).

⁷⁴ See Steven Ashley, *Nanobot Construction Crews*, in UNDERSTANDING NANOTECHNOLOGY, *supra* note 6, at 86, 88-89 (arguing that "any machine outside the biological sphere that could make any number of copies of itself would probably lead to a Nobel Prize, possibly several").

⁷⁵ Richard E. Smalley, *Of Chemistry, Love, and Nanobots*, SCI. AM., Sept. 2001, at 77 (arguing further that problems with assemblers "are fundamental, and [cannot] be avoided"); see also Robert F. Service, *Is Nanotechnology Dangerous?*, 290 SCI. 1526, 1527 (2000) (arguing that analogizing assemblers to biological systems represents "a flawed extrapolation").

⁷⁶ See POOLE & OWENS, *supra* note 20, at 226 ("When the size or dimension of a material is continuously reduced from a large or macroscopic size, such as a meter or a centimeter, to a very small size, the properties remain the same at first, then small changes begin to occur, until finally when the size drops below 100 nm, dramatic changes in properties can occur."); NAT'L SCI. & TECH. COUNCIL, COMM. ON TECH., SUBCOMM. ON NANOSCALE SCI., ENG'G, & TECH., NANOTECHNOLOGY INITIATIVE, RESEARCH AND DEVELOPMENT SUPPORTING THE NEXT INDUSTRIAL REVOLUTION: SUPPLEMENT TO THE PRESIDENT'S 2004 BUDGET 2 (2003) [hereinafter THE NEXT INDUSTRIAL REVOLUTION] ("At this scale, the physical, chemical, and biological properties of materials differ fundamentally and often unexpectedly from those of the corresponding bulk material."). The National Nanotechnology Initiative is "an interagency effort aimed at maximizing the return on the Federal Government's investment in nanoscale R&D through coordination of funding, research, and infrastructure development activities at individual agencies." *Id.* at 5. The Initiative is concerned with five activities: "fundamental research, grand challenges, centers and networks of excellence, research infrastructure, and societal/workforce implications." SOCIETAL IMPLICATIONS OF NANOSCIENCE AND NANOTECHNOLOGY, *supra* note 25, at 2.

⁷⁷ THE NEXT INDUSTRIAL REVOLUTION, *supra* note 76, at 5.

⁷⁸ *Id.* at 16 (Another "reason for the difference in the properties of the nanoscale materials compared to the analogous macroscale, or bulk, material is the large surface area per unit volume. Atoms at surfaces behave differently from those located in the interior of a grain or particle.").

⁷⁹ See POOLE & OWENS, *supra* note 20, at xi ("So, for example, the electronic structure, conductivity, reactivity, melting temperature, and mechanical properties have all been observed to change when particles become smaller than a critical size."); SOCIETAL IMPLICATIONS OF NANOSCIENCE AND NANOTECHNOLOGY, *supra* note 25, at 1 ("The nanoscale is not just another step towards miniaturization, but a qualitatively different scale. The new behavior is dominated by quantum mechanics, material confinement in small structures, large interfacial volume fraction, and other unique properties, phenomena and processes.").

⁸⁰ See Langer, *supra* note 52 ("For one thing, the art is clearly very complicated and unique, and patent applications will need to provide a sophisticated level of nano-communication skills to convince patent examiners that the proposed invention is worthy of patent protection, rather than an extension or derivation of prior art but merely on the nano level.").

⁸¹ See Arti Kaur Rai, *Regulating Scientific Research: Intellectual Property Rights and the Norms of Science*, 94 N.W. U.L. REV. 77, 100 (1999) ("Historically, the case law reinforced traditional scientific norms by discouraging the private appropriation of basic research discoveries.

making steroids that had no known use, but which were homologues of steroids proven to combat tumor activity in mice.⁸³ The Supreme Court rejected arguments that the process was useful because it worked, or because it was the subject of serious study.⁸⁴ Instead, the Court held that until an invention's use "exists in currently available form . . . there is insufficient justification for permitting an applicant to engross what may prove to be a broad field."⁸⁵

¶20 It is unclear how authoritative the *Brenner* holding is now.⁸⁶ But one could argue that it limits patents on upstream research. While a definition of "upstream research" is tricky,⁸⁷ it essentially means "research that is relatively far removed from a commercial end product."⁸⁸ In effect, a limit on upstream-research patents views the utility requirement as "a timing device, helping to identify when an invention is ripe for patent protection."⁸⁹ Commentators make several arguments against such unripe patents.⁹⁰ Some argue that such patents "hinder subsequent research by permitting owners to charge a premium for the use of discoveries."⁹¹ Other commentators worry about an "anticommons" in which numerous or broad patents lead to high transaction costs because subsequent researchers must receive permission from each patent holder.⁹²

¶21 While courts rarely accept these types of arguments,⁹³ they could apply to nanotechnology in at least three ways. First, nanotechnology is a new field without much prior art,⁹⁴ which defines the contours of a patent.⁹⁵ Without much prior art, subsequent researchers will not know how far a particular nanotechnology patent extends, or whether their actions are likely to infringe. To complicate matters, the scant prior art that does exist is not readily accessible because until very recently the PTO did not have a specific class for nanotechnology.⁹⁶ A type of nanotechnology called dendrimers illustrates this problem. Dendrimers "are

Patent law largely steered clear of basic research and focused instead on applied technology.").

⁸² 383 U.S. 519 (1966).

⁸³ *Id.* at 520–22.

⁸⁴ *Id.* at 532.

⁸⁵ *Id.* at 534–35.

⁸⁶ See ROBERT P. MERGES ET AL., *INTELLECTUAL PROPERTY IN THE NEW TECHNOLOGICAL AGE* 141 (3d ed. 2003) ("*Brenner* in many ways represents the 'high-water mark' of the utility doctrine. Most applications of the doctrine have been quite limited in the hurdles they place before inventors. . . . Thus [one] should not assume that *Brenner* can readily be extended by analogy.").

⁸⁷ Natalie M. Derzko, *In Search of a Compromised Solution to the Problem Arising from Patenting Biomedical Research Tools*, 20 SANTA CLARA COMPUTER & HIGH TECH. L.J. 347, 348 (2004) (noting, in the context of biotechnology, that "[t]here [is] a broad range of materials that might be termed 'research tools' because they can be used in the course of biomedical or biotechnological research").

⁸⁸ Arti K. Rai, *Fostering Cumulative Innovation in the Biopharmaceutical Industry: The Role of Patents and Antitrust*, 16 BERKELEY TECH. L.J. 813, 816 (2001). Professor Rai notes, however, that this definition is tricky. She writes that the terms "upstream" and "downstream" "are quite fluid." *Id.* at 816 n.9. Thus, for example, "research identifying a gene linked to a disease might be quite 'upstream' if the commercial goal is a drug therapy. By contrast, if the commercial goal is a diagnostic test, research identifying the gene might be relatively 'downstream.'" *Id.*

⁸⁹ Eisenberg, *supra* note 14, at 2087.

⁹⁰ See Rai, *supra* note 81, at 136 (cataloguing different types of costs).

⁹¹ Arti K. Rai & Rebecca S. Eisenberg, *The Public Domain: Bayh-Dole Reform and the Progress of Biomedicine*, 66 LAW & CONTEMP. PROBS. 289, 295 (2003).

⁹² Michael A. Heller & Rebecca S. Eisenberg, *Can Patents Deter Innovation? The Anticommons in Biomedical Research*, 280 SCI. 698, 698–99 (1998); see also Arti K. Rai, *Engaging Facts and Policy: A Multi-Institutional Approach to Patent System Reform*, 103 COLUM. L. REV. 1035, 1070–71 (2003) ("If the PTO were to have granted patents—particularly broad patents—on large numbers of these relatively trivial upstream inventions, there is reason to fear that downstream research might have been delayed or perhaps even blocked.").

⁹³ See *infra* notes 156–163 and accompanying text.

⁹⁴ See Newberger, *supra* note 1, at 654 ("The absence of prior art affords the opportunity for broad patent protection."); Langer, *supra* note 52 ("Nanoinventors will also seek very broad patent protections due to the value of possibly creating revolutionary art in an open and emerging field.").

⁹⁵ See Eisenberg, *supra* note 14, at 2094 ("In a new field, the prior art sets relatively few constraints on the scope of patent claims, permitting broad patent protection for pioneering inventions.").

⁹⁶ The PTO announced in October 2004 that it had created a new cross-reference digest for nanotechnology. See Press Release, U.S. Patent and Trademark Office, *New Cross-Reference Digest for Nanotechnology* (Oct. 18, 2004), at <http://www.uspto.gov/main/newsandnotices.htm>. On the difficulties of classifying nanotechnology, see Lance D. Reich, *Protecting Tiny Gizmos: The Patent and Trademark Office Is Preparing for Nanotech Applications*, NAT'L L.J., Jan. 26, 2004, at S1 ("A potential problem with the lack of a unique classification for nanotechnology-specific prior art is that the examiner may have a difficult time locating the best available prior art to a nanotech patent application."); see also Stephen B. Maebius, *Key Considerations in Protecting Your Intellectual Property in Nanotechnology*, 4 J. NANOPARTICLE RES. 373, 373 (2002) ("In addition, patents in this area may be broad in scope if there is no known previous work that would give the Patent Office a basis for limiting the scope of the claims.").

man-made, three-dimensional molecules, constructed in layers around a central hollow core."⁹⁷ A dendrimer's hollow core allows it to carry other molecules, making it a versatile tool that is valuable to "medical, electronic and chemical industries."⁹⁸ Because dendrimer-based technology—like all nanotechnology—is still in an early, upstream-research phase, there is not much prior art. This sparse prior art makes it difficult to know the contours of a potentially wide-ranging dendrimer patent. In addition to creating problems at the PTO, this could create litigation problems as courts struggle to determine a patent's scope.⁹⁹

¶22 A second way in which upstream-research arguments apply to nanotechnology is the potential breadth of issued patents. Nanotechnology is a new field, which means that most of its patents will be for basic inventions, not for fully developed final products. This could create problems because patents on basic inventions tend to encompass larger areas than final products. To continue using dendrimers as an example, consider a patent entitled "Angiogenic Inhibitory Compounds."¹⁰⁰ A company described this patent as giving it "broad patent rights related to dendrimer-based products that inhibit angiogenesis (blood vessel growth), a key process in cancer tumour growth and spread."¹⁰¹ In other words, the patent gives the company broad rights over a basic process using dendrimers. And because dendrimers have so much potential in so many industries, a broad patent may affect many subsequent discoveries in cancer research, other medical research, and additional areas. Broad patents can also create anticommons problems by giving patentees the power to block subsequent research.¹⁰² Too many narrow patents also create problems. The greater the number of patents there are (even if they are narrow), the greater the risk of an anticommons because more patents mean more transaction costs in acquiring a license from each patentee. This is especially true for emerging technologies like nanotechnology because its patents are early in the research process.¹⁰³

¶23 A third upstream-research argument involves the costs of inventing. To some commentators, the ease with which one invents should play a role in patentability. They argue that if it is easy to invent, there is less need for patents to serve as incentives.¹⁰⁴ This argument has been most pronounced in DNA sequencing, in which some argue that the automated nature of sequencing single nucleotide polymorphisms (SNPs) militates against broad patent protection.¹⁰⁵ Many commentators couple this argument with the criticism that when inventors receive government funding, they are less deserving of patents.¹⁰⁶ This concern may apply in nanotechnology because the Federal Government is a primary source of funding for nanotechnology research.¹⁰⁷ Indeed, the 21st Century Nanotechnology Research and Development Act¹⁰⁸ has authorized \$3.7

⁹⁷ Beth Quinlivan, *Bio's Star Turn*, BUS. REV. WKLY., Sept. 25, 2003, at 54; see also A. Paul Alivisatos, *Less Is More in Medicine*, in UNDERSTANDING NANOTECHNOLOGY, *supra* note 6, at 65–69 (describing dendrimers).

⁹⁸ Eli Greenblat, *Starpharma Gets US Nod To Work on HIV Gel*, AGE, Nov. 20, 2003, at 4.

⁹⁹ See Newberger, *supra* note 1, at 656 ("While litigation issues in general are not particular to nanotechnology, the breadth of the field, and the opportunity for broad patent coverage, may create a tension between the monopoly rights of the 'first comers' and ongoing research in the field.").

¹⁰⁰ U.S. Patent No. 6,426,067 (issued July 30, 2002).

¹⁰¹ Press Release, Starpharma, Starpharma Granted Another Nanotechnology Patent in USA (Aug. 5, 2002), at <http://www.nanoinvestornews.com/modules.php?name=News&file=article&sid=611>.

¹⁰² Rai, *supra* note 92, at 1071 n.160.

¹⁰³ Cf. Rai, *supra* note 27, at 192 ("An important impediment to accelerated preclinical and clinical investigation might be created by the hundreds of thousands of patent applications that have been filed by certain firms on early-stage genomics research, such as gene fragments, SNPs, or protein structures of unknown function."). This concern is particularly salient because many commentators agree that the Federal Circuit is moving toward a model in which patents are relatively easy to get, but their scope is relatively narrow. *E.g.*, Burk & Lemley, *supra* note 21, at 1678.

¹⁰⁴ See, e.g., Rai, *supra* note 81, at 141 ("Where transaction and creativity costs are low relative to invention costs, patent protection is probably desirable. Where the reverse is true, patent protection is probably undesirable.").

¹⁰⁵ See, e.g., Linda J. Demaine & Aaron Xavier Fellmeth, *Reinventing the Double Helix: A Novel and Nonobvious Reconceptualization of the Biotechnology Patent*, 55 STAN. L. REV. 303, 307 (2002) ("Sequencing has also become far less laborious. The ability of scientists to rapidly sequence DNA has resulted in an explosion of discoveries of DNA sequences—both meaningful and meaningless scientifically—that, in turn, has caused a deluge of patent applications claiming DNA sequences and the proteins and other biochemicals for which these sequences code."); Rebecca S. Eisenberg, *Re-Examining the Role of Patents in Appropriating the Value of DNA Sequences*, 49 EMORY L.J. 783, 785 (2000) ("As DNA sequence discovery has moved beyond targeted efforts to clone particular genes to large-scale, high-throughput sequencing of entire genomes, new questions have emerged.").

¹⁰⁶ See Rai & Eisenberg, *supra* note 91, at 290–91.

¹⁰⁷ See Newberger, *supra* note 1, at 654 ("Government is the 800-pound gorilla here, because they've got the money and everybody is

billion in federal funding between 2003 and 2007.¹⁰⁹ State governments are also actively funding nanotechnology.¹¹⁰ In sum, courts have been—and commentators are—concerned about patents on upstream research. Given the current, research-intensive stage of the nanotechnology industry, these concerns may create problems for inventors who want to patent their nanotechnology inventions.

2. LIKELY SOLUTIONS

A. Likely Solutions to Interdisciplinary Problems

¶24 As outlined in Part 1.A, patent law applies the same rules in different ways to different contexts. So the first utility problem for nanotechnology is to determine in what context it fits. This is an awkward problem because nanotechnology is an interdisciplinary field. The PTO does not have a solution. It has not said how it will examine nanotechnology, and it is only recently that the PTO created a cross-reference nanotechnology digest.¹¹¹ The main step it has taken is to hold conferences to discuss nanotechnology.¹¹² Nor does the Federal Circuit have a solution, because it has not yet heard a nanotechnology case. This subpart focuses on the Federal Circuit because the PTO's actions will depend on what the Federal Circuit does. The Federal Circuit will likely solve nanotechnology's interdisciplinary problems by applying its chemistry-based¹¹³ utility standard in most nanotechnology cases.¹¹⁴ This subpart advances three reasons for this prediction.

¶25 First, nanotechnology is more akin to chemistry than to any other Federal Circuit utility context. It is true that nanotechnology is not chemistry. It is also true that nanotechnology spans many fields. But at its core, nanotechnology is the manipulation of atoms and molecules.¹¹⁵ And chemistry is about the composition and change of matter.¹¹⁶ So while a chemistry-based utility standard is not a perfect fit, it is the closest fit among the Federal Circuit's main utility contexts. This closeness makes it the court's most likely starting point for evaluating nanotechnology.

¶26 Second, the theory of path dependence suggests that the Federal Circuit will continue to rely on its chemistry-based utility standard. The theory of path dependence advances "specific descriptions and explanations of how history influences the process of legal change in a common law system."¹¹⁷ The current trend in the Federal Circuit is to use a chemistry-based utility standard for new technology, such as biotechnology.¹¹⁸ One view of path dependence suggests that the Federal Circuit will continue this trend by finding that nanotechnology is similar to chemistry. Another view suggests that the Federal Circuit will continue this trend because it is easier than creating a new trend specific to nanotechnology.¹¹⁹ Either view is

going to be playing for it."); LUX CAPITAL GROUP, L.L.C., THE NANOTECH REPORT 2003, at 11 (2003) ("Nanotechnology is on track to be the largest government funded science initiative since the Space Race (larger than the Human Genome Project).").

¹⁰⁸ 15 U.S.C. § 7501 (2004).

¹⁰⁹ Langer, *supra* note 52.

¹¹⁰ See SMALL WONDERS, *supra* note 1, at 23-25 (outlining state-sponsored nanotechnology programs in New Jersey, California, Texas, and New York).

¹¹¹ See *supra* note 96.

¹¹² Reich, *supra* note 96.

¹¹³ This Note uses the term "chemistry-based" to refer to utility standards that derive from the Federal Circuit's chemistry cases. In particular, this includes the court's biotechnology utility standard.

¹¹⁴ While this Note agrees with the somewhat controversial position that patent law is modified slightly depending on the technology, its thesis is not so limited. That is, its thesis—that there neither will nor should be a heightened nanotechnology-specific utility requirement—flows just as well from the noncontroversial position that this Note is merely following the common-law process of reasoning by analogy.

¹¹⁵ See MICHAEL PYCRAFT HUGHES, NANO-ELECTROMECHANICS IN ENGINEERING AND BIOLOGY 4 (2003) ("For example, at a fundamental level, chemistry is the original nanotechnology, where custom molecules are delivered to order.")

¹¹⁶ THE NEW OXFORD AMERICAN DICTIONARY 293 (Elizabeth J. Jewell & Frank Abate eds., 2001) (defining chemistry as "the branch of science that deals with the identification of the substances of which matter is composed; the investigation of their properties and the ways in which they interact, combine, and change; and the use of these properties to form new substances").

¹¹⁷ Oona A. Hathaway, *Path Dependence in the Law: The Course and Pattern of Legal Change in a Common Law System*, 86 IOWA L. REV. 601, 604 (2001).

¹¹⁸ See *supra* note 27 and accompanying text.

¹¹⁹ See Hathaway, *supra* note 117, at 607 ("Path dependence occurs because once a court makes an initial decision, it is less costly to

subject to at least one contingency: the first type of technology that the Federal Circuit faces could influence how it handles all nanotechnology.¹²⁰ For example, if the first case involves a patent on quantum-random-access memory,¹²¹ then the Federal Circuit may not rely on chemistry-based precedent in some subsequent cases. Conversely, if the first case involves a patent on dendrimers that deliver polynucleotides,¹²² then the Federal Circuit may use its chemistry-based precedent. As of now, the most widespread technology—and thus most likely to furnish the test case—is nanomaterials.¹²³ "Nanomaterials are nanoscale materials that exhibit new phenomena or behavior or that can be controlled at the nanometer scale."¹²⁴ These materials are useful because of their molecular properties,¹²⁵ making it likely that when the Federal Circuit confronts them, it will follow its precedent in chemistry cases.

¶27 A third reason that supports this prediction is that both nanotechnology and biotechnology present similar issues. As described in Part 2.C, nanotechnology, like biotechnology,¹²⁶ is a Delphic art. Mechanical and electrical inventions, in contrast, are more predictable. So given nanotechnology's uncertainty, the Federal Circuit seems likely to handle it under the more demanding utility standard applied in chemistry and biotechnology cases than under the liberal standard for mechanical and electrical inventions.

¶28 Although the Federal Circuit will probably decide nanotechnology cases with a chemistry-based utility standard, in some instances the court may apply this standard jointly with another standard. For example, a case involving a mechanical device that uses nanometer-scale gears¹²⁷ to position molecules might involve a mechanical utility standard.¹²⁸ A case involving a nanometer-scale device that generates electric charge might involve an electrical utility standard.¹²⁹ Such inventions—like all nanotechnology—involve the manipulation of atoms and molecules. But they also involve the more staid field of mechanics and electronics. So while the Federal Circuit will likely use its chemistry-based precedent in these cases, it may also rely in part on other standards. This partial reliance will tend to favor patents in marginal cases because the chemistry-based utility standard is more demanding than other utility standards.¹³⁰ Thus, to the extent that applicants can argue that their inventions are more like electrical engineering, for example, than like chemistry, they may face a less-demanding utility standard.

B. Likely Solutions to Inoperability Problems

¶29 Courts and the PTO may face utility problems in determining whether nanotechnology is possible or operable. These problems stem from the cycle of hype and criticism that pervade the field. Still, courts and

continue down that same path than it is to change to a different path.").

¹²⁰ *Id.* at 605 (arguing that "the order in which cases arrive in the courts can significantly affect the specific legal doctrine that ultimately results").

¹²¹ *E.g.*, U.S. Patent No. 6,097,627 (issued Aug. 1, 2000).

¹²² *E.g.*, U.S. Patent No. 6,113,946 (issued Sept. 5, 2000).

¹²³ SMALL WONDERS, *supra* note 1, at 36; *see also* Feder, *supra* note 2, at 9 ("The new generation of nanomaterials is already taking commercial root. Nanoscale clay particles strengthen car bodies. Coatings made with aluminum-titanium nanoparticles add to the durability of boiler components and submarine periscopes for the U.S. Navy."); Gupta, *supra* note 5, at 276 ("Nanotechnology will most likely have its first significant industry impact in the area of materials science.").

¹²⁴ SMALL WONDERS, *supra* note 1, at 36.

¹²⁵ *See* MARK RATNER & DANIEL RATNER, NANOTECHNOLOGY: A GENTLE INTRODUCTION TO THE NEXT BIG IDEA 7 (2003) ("At the nanoscale, the most fundamental properties of materials and machines depend on their size in a way they don't at any other scale.").

¹²⁶ *See* Nathan Machin, Comment, *Prospective Utility: A New Interpretation of the Utility Requirement of Section 101 of the Patent Act*, 87 CAL. L. REV. 421, 434 (1999) (noting that one type of biotechnology called Express Sequence Tags (ESTs) has a "method of isolation [that] provides very little clue as to the processes in which they are involved, much less their precise roles within that process").

¹²⁷ *See* J.K. Gimzewski et al., *Rotation of a Single Molecule Within a Supramolecular Bearing*, 281 SCI. 531, 531 (1998) (describing "the real-space realization of single-molecule rotors surrounded by like molecules that form a supramolecular bearing"). The paper concluded that its "results open the way to fabricate, spatially define, and test recent proposals involving mechanical devices fabricated in molecular structures." *Id.* at 532.

¹²⁸ *See* HUGHES, *supra* note 115, at 159 (noting that nanotechnology often focuses on "the development of electronic devices for near-single-electron computing on the nanometer scale (nanoelectronics), or in the construction of nanometer-scale mechanical devices for molecular-scale chemistry (nanomechanics)").

¹²⁹ *Id.*

¹³⁰ Burk & Lemley, *supra* note 21, at 1645.

the PTO have the expertise to look past this cycle and objectively evaluate the technology. The upshot is that operability will not be an insurmountable problem for most nanotechnology inventions.

¶30 To begin with, inoperability is a low standard. An invention need not improve the prior art,¹³¹ nor must it satisfy all objections.¹³² It is enough for an invention to have one use.¹³³ To illustrate that most nanotechnology inventions do not present inoperability problems, consider nanofabrication. Nanofabrication means making structures at the nanometer scale.¹³⁴ Some types of nanofabrication currently work, such as using a high-intensity laser to form clusters of atoms,¹³⁵ or electric fields to assemble nucleic acids.¹³⁶ Other types, such as the much-maligned molecular assembler,¹³⁷ have not been proven to work. In these unproven cases, when examiners conclude that a person skilled in the art would reasonably doubt the invention, then examiners can require the applicant to submit additional evidence. Unfortunately, the PTO's inexperience with nanotechnology makes an examiner more likely to require additional evidence, even when such evidence is unnecessary. Still, if the invention works, the only drawbacks to furnishing this additional evidence are delay and cost in prosecuting the application.¹³⁸ This means that even though delay and increased cost are possible, especially in the short-term, inoperability is mainly a reminder to the patent bar to explain an invention's utility clearly.¹³⁹

¶31 In sum, with respect to inventions other than those that are truly inoperable or impossible inventions, inoperability is more of a drafting problem than a patentability problem. For those inventions that present genuine inoperability problems, the PTO can always request additional evidence. Although examiners may make this request too often, such scrutiny is likely a short-term burden that will dissipate as examiners become more familiar with nanotechnology.

C. Likely Solutions to Practical-Utility Problems

¶32 It is hard to predict how courts and the PTO will address nanotechnology's practical-utility problems because the doctrine is in flux.¹⁴⁰ This volatility may fuel arguments, like those described in Part 1.C, that nanotechnology does not have a real-world use. This subpart argues, however, that practical utility is unlikely to be an insurmountable obstacle.

¶33 To begin with, the Federal Circuit is not receptive to arguments for a heightened utility standard. The recent debate over biotechnology illustrates this. In the early 1990s, the PTO rejected applications that did not have proof of clinical efficiency.¹⁴¹ The Federal Circuit responded with *In re Brana*, which some consider "a sharp rebuke."¹⁴² The *Brana* court was not interested in reconsidering the strength of practical utility; it stated that "[t]his is not a new issue; it is one which we would have thought had been settled by case law years ago."¹⁴³ It is true that *Brana* preceded a series of utility guidelines from the PTO.¹⁴⁴ But the debate over

¹³¹ *Custom Accessories, Inc. v. Jeffrey-Allan Indus., Inc.*, 807 F.2d 955, 960 n.12 (Fed. Cir. 1986).

¹³² *See Raytheon Co. v. Roper Corp.*, 724 F.2d 951, 958 (Fed. Cir. 1983) ("When a properly claimed invention meets at least one stated objective, utility under § 101 is clearly shown.").

¹³³ *Id.*; *see also* *Fujikawa v. Wattanasin*, 93 F.3d 1559, 1564 (Fed. Cir. 1996) ("In the pharmaceutical arts, our court has long held that practical utility may be shown by adequate evidence of any pharmacological activity."); HARMON, *supra* note 67, at §2.3(b) ("The fact that [sic] an invention has only limited utility and is only operable in certain applications is not grounds for finding lack of utility.").

¹³⁴ RATNER & RATNER, *supra* note 125, at 173.

¹³⁵ POOLE & OWENS, *supra* note 20, at 74–75.

¹³⁶ U.S. Patent No. 6,652,808 (issued Nov. 25, 2003).

¹³⁷ *See supra* notes 71–75 and accompanying text.

¹³⁸ The courts do not view these as sufficient reasons not to require applicants to prove dubious inventions. *See, e.g., In re Newman*, 782 F.2d 971, 973 (Fed. Cir. 1986).

¹³⁹ For example, one patent practitioner has argued that "filing a patent application relating to an invention in nanotechnology requires careful consideration of the potential end-uses so that they are adequately covered by the patent." Maebius, *supra* note 96, at 373.

¹⁴⁰ MOY, *supra* note 14, at § 6:16 (noting that "the specific content of this requirement is open to considerable doubt at this time").

¹⁴¹ *See Eisenberg, supra* note 14, at 2086.

¹⁴² *Id.*

¹⁴³ *In re Brana*, 51 F.3d 1560, 1564 (Fed. Cir. 1995) (citing *Cross v. Iizuka*, 753 F.2d 1040 (Fed. Cir. 1985); *In re Langer*, 503 F.2d 1380 (C.C.P.A. 1974); *In re Krimmel*, 292 F.2d 948 (C.C.P.A. 1961); *In re Bergel*, 292 F.2d 958 (C.C.P.A. 1961)).

¹⁴⁴ *Demaine & Fellmeth, supra* note 105, at 326–27.

Brana and the content of those guidelines was fought at the PTO and in the academic literature, not in the Federal Circuit.¹⁴⁵ So while the current guidelines are a middle ground between the demanding standard of *Brenner* and the permissive standard of *Brana*, the Federal Circuit seems uninterested in a heightened practical-utility standard.

¶34 Even if the Federal Circuit were interested in changing its utility standard, most nanotechnology inventions have practical utility. To understand why, it helps to distinguish between class and member. While there is uncertainty in the nanotechnology field (class), there is less uncertainty for particular inventions (member). Consider the class of nanotechnology power sources. Power source is a broad term for the various ways in which one can power nanotechnology.¹⁴⁶ Possible ways include batteries, thermoelectric energy, solar energy, steam power, adenosine triphosphate, Brownian motion, and others.¹⁴⁷ As a class, power sources are uncertain because some sources (e.g., Brownian-motion motors¹⁴⁸) have not been proven to work.¹⁴⁹ However, some members have been proven to work, such as using adenosine triphosphate in rudimentary devices.¹⁵⁰ It is true that the more uncertain the class, the more likely it is that examiners can rebut the prima facie burden as to an individual invention. But in the end, examiners judge applications individually. This suggests that the class-member problem—as with inoperability problems—is mainly a drafting problem. In other words, it is mainly a warning to draft applications that distinguish one's invention from the uncertain class from which it came.¹⁵¹

¶35 Finally, it is possible that the PTO may deny patents or grant overly broad patents because examiners misunderstand nanotechnology. As stated in Part 1.C, this can happen in two ways. Examiners may take the simplistic view that nanotechnology inventions are merely smaller versions of technology that already exists. Or they may take the defeatist view that nanotechnology's uncertain molecular properties mean that it has no real-world use. To the extent that these problems arise, they will likely be short-lived and recede as the PTO becomes comfortable with nanotechnology. In the meantime, applicants can work to minimize any problems through clear drafting.

D. Likely Solution to Upstream-Research Problems

¶36 As noted in Part 1.D, several commentators argue that the utility requirement limits patents on upstream research. These arguments are unlikely to succeed against nanotechnology. First, the idea of a limit on upstream-research patents is somewhat overstated. The better view is that the utility requirement treats an upstream-research invention like any other invention. It is true that the PTO's 2001 Utility Guidelines "exclude upstream research results from patent protection unless such research has a 'specific, substantial, and credible' utility."¹⁵² But the word "unless" means that upstream-research inventions must meet the general three-part utility test, like any other invention. A principle reason why courts and the PTO do not treat such inventions differently is that what constitutes "upstream research" is a hard question.¹⁵³ For

¹⁴⁵ Joshua C. Benson, *Resuscitating the Patent Utility Requirement, Again: A Return to Brenner v. Manson*, 36 U.C. DAVIS L. REV. 267, 285–86 (2002) (describing how the Guidelines evolved in response to different critics).

¹⁴⁶ See generally GLENN FISHBINE, *THE INVENTOR'S GUIDE TO NANOTECHNOLOGY & MICROMACHINES* 93 (2002).

¹⁴⁷ *Id.* at 93–106.

¹⁴⁸ See R. Dean Astumian, *Making Molecules into Motors*, in UNDERSTANDING NANOTECHNOLOGY, *supra* note 6, at 72, 75 (explaining that a Brownian-motion motor is theoretically possible "[b]y selectively stopping the motions it doesn't want and letting through the ones it does—using a ratcheting mechanism akin to a ratchet wrench—the motor turns momentum from random environmental influences into organized motion").

¹⁴⁹ See FISHBINE, *supra* note 146, at 104 ("The investment strategy for brownian motors can be summarized in a single word: *Beware*. There is no certainty that brownian motors can be made to work.")

¹⁵⁰ Hiroyuki Noji et al., *Direct Observation of the Rotation of F1-ATPase*, 386 NATURE 299–302 (1997).

¹⁵¹ See Rebecca S. Eisenberg & Robert P. Merges, *Opinion Letter as to the Patentability of Certain Inventions Associated with the Identification of Partial cDNA Sequences*, 23 AIPLA Q.J. 1, 12 (1995) ("Although proof of clinical efficacy may no longer be required to establish patentable utility, it bears emphasis that both the PTO and the Federal Circuit continue to require that, at least in cases where the invention does not have a well-established utility, the utility of a claimed invention be specifically identified in the patent application.")

¹⁵² Rai & Eisenberg, *supra* note 91, at 299 n. 56 (quoting Utility Examination Guidelines, 66 Fed. Reg. 1092, 1098 (Jan. 5, 2001)).

¹⁵³ See generally Christopher D. Hazuka, *Supporting the Work of Lesser Geniuses: An Argument for Removing Obstructions to Human Embryonic Stem Cell Research*, 57 U. MIAMI L. REV. 157, 183–85 (2002).

example, carbon nanotubes can be sold as either a final product to increase the strength of a tennis racquet,¹⁵⁴ or as a tool for further research.¹⁵⁵

¶37 Second, the Federal Circuit is beginning to permit patenting earlier in the research process.¹⁵⁶ *Cross v. Iizyuka*¹⁵⁷ provides a good example. In *Cross*, the Federal Circuit faced a chemical compound that showed utility only in *in vitro* (i.e., outside the living body) testing.¹⁵⁸ The court found sufficient utility in part because such "testing will marshal resources and direct the expenditure of effort to further . . . testing of the most potent compounds, thereby providing an immediate benefit to the public."¹⁵⁹ *In re Brana*¹⁶⁰ provides an even better example. In *Brana*, the Federal Circuit rejected arguments that applicants must describe the specific disease against which their inventions are useful.¹⁶¹ The court then noted the permissive role of research in the utility requirement: "Usefulness in patent law, and in particular in the context of pharmaceutical inventions, necessarily includes the expectation of further research and development."¹⁶² This acceptance is substantially more permissive than the 1966 case of *Brenner v. Manson*, in which the Supreme Court stressed that a patent "is not a reward for the search, but compensation for its successful conclusion."¹⁶³ Thus, the modern trend is to allow patents on upstream research under the same utility standards that apply to other inventions.

¶38 Third, the Federal Circuit does not engage in the type of reasoning that supports arguments against upstream-research patents. These arguments rely on law-and-economics reasoning, such as concerns about an anticommons.¹⁶⁴ The Federal Circuit, however, eschews such reasoning in favor of bright-line rules.¹⁶⁵ There is no reason to think it will deviate from this trend when presented with a nanotechnology case. Indeed, the Federal Circuit may be even more reluctant to use this reasoning in such a new and uncertain field.

¶39 Fourth, neither Congress nor the Federal Circuit considers upstream-research patents harmful to innovation. For its part, Congress enacted the Bayh-Dole Act,¹⁶⁶ which "encourages discover[er]s of rudimentary upstream research tools to patent their product."¹⁶⁷ Similarly, in *Madey v. Duke University*,¹⁶⁸ the Federal Circuit was not troubled about research when it severely limited the experimental-use doctrine, which

¹⁵⁴ Feder, *supra* note 2 ("Carbon nanotubes add stiffness to Babolat tennis rackets.").

¹⁵⁵ Shenzhen Nanotech Port Co., Ltd. is an example of one such company that manufactures carbon nanotubes for subsequent research. Shenzhen Nanotech Port Co., Ltd., *at* <http://seasunnano.com/en.products.htm> (last visited Feb. 18, 2004) (on file with author). It states on its homepage that it uses a "carbon nanotubes synthesis method with [its] own intellectual property" to "supply carbon nanotubes" to meet the "different demands of researching and developing." *Id.*

¹⁵⁶ Eisenberg, *supra* note 14, at 2087; *see also* Rai, *supra* note 81, at 107 ("The PTO's recently expanded view of utility is in keeping with the Federal Circuit's liberalization of the utility requirement. The court has determined that inventions that are quite far away from commercial applicability can nonetheless demonstrate utility."); Utility Examination Guidelines, 66 Fed. Reg. 1092, 1095 (Jan. 5, 2001) ("Current law provides that when the statutory patentability requirements are met, there is no basis to . . . limit a patent's scope in order to allow free access to the use of the invention during the patent term.").

¹⁵⁷ 753 F.2d 1040 (Fed. Cir. 1985).

¹⁵⁸ *Id.* at 1051.

¹⁵⁹ *Id.*

¹⁶⁰ 51 F.3d 1560 (Fed. Cir. 1995).

¹⁶¹ *See id.* at 1567 (reasoning that "it is our firm conviction that one who has taught the public that a compound exhibits some desirable pharmaceutical property in a standard experimental animal has made a significant and useful contribution to the art, even though it may eventually appear that the compound is without value in the treatment in humans").

¹⁶² *Id.* at 1568.

¹⁶³ 383 U.S. 519, 536 (1966). It is important to note, however, that *Brenner* has never been explicitly overruled.

¹⁶⁴ *See supra* notes 92 and 102–103 and accompany text.

¹⁶⁵ *See* Rai, *supra* note 92, at 1103–04 ("In several major areas of patent law decision-making . . . the Federal Circuit's approach to decision-making has been decidedly formalist."); Burk & Lemley, *supra* note 21, at 1579 ("Not only has [the Federal Circuit] proven unwilling to pay much attention to the empirical evidence about innovation, but it has also taken a number of steps toward eliminating the flexible standards of the patent common law in favor of bright-line rules.").

¹⁶⁶ Pub. L. No. 96-517, § 6(a), 94 Stat. 3015, 3019–28 (1980) (codified as amended at 35 U.S.C. §§ 200–212 (2000)). There are several interesting issues dealing with the application of the Bayh-Dole Act to nanotechnology; unfortunately, these are beyond the scope of this Note. For a discussion of some of these issues, see generally FISHBINE, *supra* note 146, at 37–47, and Newberger, *supra* note 1, at 653–57.

¹⁶⁷ Summers, *supra* note 22, at 476.

¹⁶⁸ 307 F.3d 1351 (Fed. Cir. 2002).

protects infringers who use patented inventions for experimental purposes.¹⁶⁹ The *Madey* court held that the doctrine does not apply "so long as the act is in furtherance of the alleged infringer's legitimate business and is not solely for amusement, to satisfy idle curiosity, or for strictly philosophical inquiry."¹⁷⁰ Thus, the Federal Circuit is not deferential to research.¹⁷¹ The Bayh-Dole Act and *Madey* signal that neither Congress nor the Federal Circuit will adopt a heightened utility standard to protect nanotechnology research.

¶40 Fifth, the Federal Circuit is unlikely to accept arguments that extensive public-private involvement militates against patentability. To begin with, the Bayh-Dole Act and the Stevenson-Wydler Act¹⁷² encourage this involvement. These Acts promote "federally-sponsored inventions" even though they do not distinguish "between downstream inventions that lead directly to commercial products and fundamental research discoveries that broadly enable further scientific invention."¹⁷³ Moreover, such involvement has a long history. For example, publicly funded research led to most of the important drug discoveries between 1970 and 1995.¹⁷⁴ Finally, the government is actively encouraging this involvement within nanotechnology.¹⁷⁵ Thus, government funding is a part of the patent milieu, not a reason to deny patentability. Although older cases like *Brenner* and many commentators worry about patents on upstream research, Congress and the Federal Circuit do not share these concerns. The trend of allowing patents on upstream research is likely to continue with nanotechnology.

3. TECHNOLOGY- AND INDUSTRY-SPECIFIC ARGUMENTS IN SUPPORT OF THE LIKELY SOLUTIONS

¶41 Part 2 argued that the utility requirement is unlikely to present an insurmountable obstacle to patenting nanotechnology inventions; rather, courts and the PTO will continue to apply their current, relatively low standard. This Part offers normative arguments to support the desirability of this prediction.¹⁷⁶ Specifically, this Part argues for the current standard by relying on both (1) the specific technology behind nanotechnology, and (2) the structure of the nanotechnology industry.

A. Technology-Specific Arguments

¶42 There are at least four reasons why the technology of nanotechnology supports the utility standard predicted in Part 2. First, nanotechnology's interdisciplinary nature defies a heightened standard. Nanotechnology is an emerging field,¹⁷⁷ yet it has the potential to affect almost all other fields.¹⁷⁸ It is this

¹⁶⁹ Tom Saunders, Case Comment, *Renting Space on the Shoulders of Giants: Madey and the Future of the Experimental Use Doctrine*, 113 YALE L.J. 261, 261 (2003). This Comment argued that *Madey* means that "university researchers accustomed to standing on the shoulders of giants by studying patented technologies freely may now be forced to rent space on those shoulders instead." *Id.* at 261-62.

¹⁷⁰ *Madey*, 307 F.3d at 1362 (Fed. Cir. 2002).

¹⁷¹ *Id.* (viewing university research as projects that are commercial in nature because they "unmistakably further the institution's legitimate business objectives, including educating and enlightening students and faculty participating in these projects").

¹⁷² Pub. L. No. 96-480, 94 Stat. 2311-2320 (codified as amended at 15 U.S.C. §§ 3701-3714).

¹⁷³ Rai & Eisenberg, *supra* note 91, at 290-91.

¹⁷⁴ Iain Cockburn & Rebecca Henderson, *Public-Private Interaction in Pharmaceutical Research*, 93 PROC. NAT'L ACAD. SCI. U.S.A. 12,725, 12,726 (1996).

¹⁷⁵ See SMALL WONDERS, *supra* note 1, at 23 ("Industrial collaboration is strongly encouraged in NSF's Nanoscale Interdisciplinary Research Teams (NIRT) program.").

¹⁷⁶ There is an extensive debate about the philosophical and economic justifications for intellectual property, and how those policies affect innovation. See generally F. Scott Kieff, *The Case for Registering Patents and the Law and Economics of Present Patent-Obtaining Rules*, 45 B.C. L. REV. 55 (2003); Mark A. Lemley, *The Economics of Improvement in Intellectual Property Law*, 75 TEX. L. REV. 989 (1997); John R. Thomas, *The Question Concerning Patent Law and Pioneer Inventions*, 10 HIGH TECH. L.J. 35 (1995); Wendy J. Gordon, *A Property Right in Self-Expression: Equality and Individualism in the Natural Law of Intellectual Property*, 102 YALE L.J. 1533 (1993); Robert P. Merges & Richard R. Nelson, *On the Complex Economics of Patent Scope*, 90 COLUM. L. REV. 839 (1990); Justin Hughes, *The Philosophy of Intellectual Property*, 77 GEO. L.J. 287 (1988). This Note does not seek to add to this generally applicable literature. Rather, it seeks to apply some of these policies within the specific field of nanotechnology.

¹⁷⁷ See Ramón Compañó & Angela Hullmann, *Forecasting the Development of Nanotechnology with the Help of Science and Technology Indicators*, 13 NANOTECHNOLOGY 243, 245 (2002) ("Currently, slightly more than one-quarter of all patents filed are focused on instrumentation. This supports the view that nanotechnology is at the beginning of the development phase of an enabling technology where the first focus is to develop suitable tools for nanostructuring of surfaces, the production of nanomaterials, the analysis of nano-objects etc."); K. Eric Drexler, *Machine-Phase Nanotechnology*, in UNDERSTANDING NANOTECHNOLOGY, *supra* note 6, at 106, 106 ("At the moment, work focuses on the

mix of the new and the all-inclusive that militates against a stringent utility standard. To illustrate, imagine that the first nanotechnology case before the Federal Circuit involved a Brownian-motion motor¹⁷⁹ that powered a self-replicating assembler.¹⁸⁰ Imagine further that the court responded to these (currently) unproven technologies by adopting a heightened utility standard for all nanotechnology. This standard would put undue pressure on nanotechnology with a proven record of success. It might also hamper future technologies¹⁸¹ and industries¹⁸² that do not yet exist. In other words, a heightened standard does not fit the technologies that are now in use, let alone the potential technologies that are yet to develop.¹⁸³ In contrast, as Part 2 illustrated, the current utility standard has sufficient flexibility to reject inventions with no known uses without putting a straightjacket around other, proven nanotechnology.

¶43 Second, practical-utility arguments do not work well against nanotechnology. As outlined in Part 1.C, some commentators argue against patents on gene sequences. They argue that a sequence's most important use—the function(s) of its proteins—is unknown. They further argue that it is immaterial that these sequences have other, relatively less important uses,¹⁸⁴ such as serving as chemical markers.¹⁸⁵ Whatever force these arguments have in biotechnology, they do not apply to nanotechnology. The utility requirement is a spectrum that spans from unpatentable throwaway uses (e.g., complex inventions serving as a paperweight) to an invention's most important use. Gene patents are a rare case that falls in the middle of the spectrum because serving as a marker is neither a throwaway use nor the most important use. Nanotechnology, however, does not present similar problems. It is a run-of-the-mill technology in which for most inventions the described utility will be their most important utility.

¶44 Admittedly, one could argue that nanotechnology still deserves a heightened utility standard because it is too uncertain to have real-world, practical utility. One could make this argument by pointing to uncertainty-causing molecular properties that are unique to nanometer-scale inventions.¹⁸⁶ This argument is misplaced for two reasons. First, it conflates uncertain molecular properties with uncertain nanotechnology inventions. The former creates uncertainty for inventors. The latter signifies the inventor's success over uncertainty by making a process or product that works. Because the PTO only issues patents for inventions that work, a general uncertainty at the molecular level is inapposite. Second, even if there is some uncertainty with nanotechnology, the current utility precedent is nonetheless sufficient. If an invention is so uncertain that it does not have a known use, it cannot be patented.¹⁸⁷ If an invention has some utility, then that is all that is required.¹⁸⁸ Thus, the current, relatively low utility standard can manage any uncertainty that a nanotechnology invention may have.

earliest stages: finding out how to build larger structures with atomic precision, learning to design molecular machine and identifying intermediate goals with high payoffs."); SOCIETAL IMPLICATIONS OF NANOSCIENCE AND NANOTECHNOLOGY, *supra* note 25, at 4 ("Today, nanotechnology is still in its infancy, and only rudimentary nanostructures can be created with some control."). For an example of a research-stage patent that can be used to produce nanostructure materials, see U.S. Patent No. 6,652,808 (issued November 25, 2003).

¹⁷⁸ Jeffrey Gold, *Thinking Small; Nanotechnology Has a Big Future in N.J.*, RECORD, Feb. 3, 2004, at L09.

¹⁷⁹ See *supra* notes 148–149 and accompanying text.

¹⁸⁰ See *supra* notes 71–75 and accompanying text.

¹⁸¹ See generally SOCIETAL IMPLICATIONS OF NANOSCIENCE AND NANOTECHNOLOGY, *supra* note 25, at 2 (discussing future prospects for nanotechnology, ranging from new communication to improved mental health, and from new fashions to better farming techniques).

¹⁸² Michael P. Williams, *Questions Abound About Patents and Nanotechnology*, N.Y.L.J., Sept. 15, 2003, at T7.

¹⁸³ In response to this problem, some have proposed bottom-up rules rather than statutes or judicial precedents. See, e.g., I. Trotter Hardy, *The Proper Legal Regime for "Cyberspace"*, 55 U. PITT. L. REV. 993, 1025 (1994) (recognizing that in a "dynamic situation, we ought to be reluctant to impose behavior control that is inflexible and uniform").

¹⁸⁴ See Eric R. Paley, Note, *Rethinking Utility: The Expediency of Granting Patent Protection to Partial cDNA Sequences*, 44 SYRACUSE L. REV. 1003, 1014 (1993) ("True, the partial gene sequences have utility. It is equally true, however, that the uses listed on the applications are not the uses that scientists and the public are truly interested in. Rather, it could be said that they are constructive uses and not actual or specific uses."). These unimportant uses are often called "throw-away" uses, and this has been a problem in patent law for some time. See generally IVER P. COOPER, BIOTECHNOLOGY AND THE LAW §5:11 (2003). An example of a "throw-away" use is a method for using a complex, expensive device as a paperweight. The usual response to these "throw-away" utilities is that they are neither "specific" nor "substantial." *Id.*

¹⁸⁵ MOY, *supra* note 14, at § 6:18.

¹⁸⁶ See *supra* notes 77–79 and accompanying text.

¹⁸⁷ *E.g.*, *Fregeau v. Mossinghoff*, 776 F.2d 1034, 1039 (Fed. Cir. 1985) (rejecting a patent that claimed that a magnetic device could improve the taste of liquids because the device was not supported by evidence).

¹⁸⁸ See *supra* notes 132–133 and accompanying text.

¶45 A third reason that the technology behind nanotechnology supports the current utility standard is that nanotechnology upstream-research patents do not deter innovation. Many commentators make this argument in biotechnology.¹⁸⁹ Their argument relies, in part, on the fact that biotechnology is difficult to design around; that is, there are few substitutes for many biological processes or products.¹⁹⁰ Consider the CCR5 receptor, which is critical to the replication of the HIV virus.¹⁹¹ Commentators argued that a patent on CCR5 gave the patentee a scapious ability to exclude others from researching ways to treat HIV.¹⁹² Whatever force this argument may have in biotechnology, it does not apply well to nanotechnology. While it may be difficult to treat HIV without targeting the CCR5 receptor, nanotechnology is not so limited. For most nanotechnology subfields like materials, optics, sensors, electronics, etc., a nanotechnology patent embodies merely one way to achieve a goal. Indeed, except for nanotechnology that involves biological structures, arguments that its patents are difficult to design around simply do not apply. More importantly, encouraging others to design around patents is a good thing. Attempts to design around patents may lead to better solutions to the same problems,¹⁹³ or to entirely new discoveries.¹⁹⁴

¶46 Fourth, nanotechnology inventions avoid arguments that when innovation is easy or cheap, patents are no longer needed as incentives. As outlined in Part 1.D, some commentators make this argument in reference to SNPs, which are easily found using automated processes. They argue that this automation means that there is no quid pro quo that justifies issuing a patent. The easy answer to this argument is that it runs counter to current law: the patent statute mandates that "[p]atentability shall not be negated by the manner in which the invention was made."¹⁹⁵ The better answer is that this argument does not apply to nanotechnology because nanotechnology is a slow and arduous field. Inventions do not come from automation. They follow a more labor-intensive path in which progress entails "considerable research and development."¹⁹⁶ Thus, because inventions are not easy or cheap, patents retain their function as incentives.

¶47 In response, one could argue that the speed of nanotechnology research may improve. After all, biotechnology inventions were once slow and labor-intensive. It was only over time that the biotechnology-research process became automated. Thus, one could argue that nanotechnology is merely in a temporary stage. Even if true, this argument is too demanding. It needlessly demands that the inventor endure some cost or hardship to qualify for a patent. It also demands that courts engage in the complex process of determining how onerous it was to invent something. The impropriety of such demands was one of the reasons that the 1952 Patent Act¹⁹⁷ rejected the "flash of genius" standard for nonobviousness.¹⁹⁸ This standard required a level of ingenuity semantically greater than ordinary skill in the art.¹⁹⁹ Thus, even if

¹⁸⁹ See, e.g., Hazuka, *supra* note 153, at 205 ("It is also likely that, because there are a finite number of genes, such DNA patents will end up being relevant to many therapeutic discoveries.").

¹⁹⁰ See Heller & Eisenberg, *supra* note 92, at 700 ("Moreover, the lack of substitutes for certain biomedical discoveries (such as patented genes or receptors) may increase the leverage of some patent holders, thereby aggravating holdout problems. Rivals may not be able to invent around patents in research aimed at understanding the genetic bases of diseases as they occur in nature."); Summers, *supra* note 21, at 495 ("One cannot substitute or design around basic biotech research tools. The products of basic biotech research, such as DNA sequences and stem cell lines, represent a finite number of enzymes, receptors, proteins, or tissue, which cannot be synthesized in an infinite number of ways.").

¹⁹¹ Donna M. Gitter, *International Conflicts over Patenting Human DNA Sequences in the United States and the European Union: An Argument for Compulsory Licensing and a Fair-Use Exemption*, 76 N.Y.U. L. REV. 1623, 1625–26 (2001).

¹⁹² See, e.g., Summers, *supra* note 21, at 480–81 (arguing that, given what the patentee knew, issuing a patent on CCR5 to a company that can now "exclude others from using its gene in HIV therapeutic research" was "inequitable and displays free-riding market failure").

¹⁹³ DONALD S. CHISUM, *PRINCIPLES OF PATENT LAW* 67 (1998).

¹⁹⁴ *State Indus., Inc. v. A.O. Smith Corp.*, 751 F.2d 1226, 1236 (Fed. Cir. 1985) ("One of the benefits of a patent system is its so-called 'negative incentive' to 'design around' a competitor's products, even when they are patented, thus bringing a steady flow of innovations to the marketplace.").

¹⁹⁵ 35 U.S.C. § 103(a) (2000).

¹⁹⁶ SMALL WONDERS, *supra* note 1, at 9.

¹⁹⁷ Law of July 19, 1952, ch. 950, § 103, 66 Stat. 792, 798 (current version at 35 U.S.C. § 103 (2004)).

¹⁹⁸ See *Graham v. John Deere Co.*, 383 U.S. 1, 15 (1966) ("It also seems apparent that Congress intended by the last sentence of § 103 to abolish the test it believed this Court announced in the controversial phrase 'flash of creative genius' . . .").

¹⁹⁹ *Cuno Eng'g Corp. v. Automatic Devices Corp.*, 314 U.S. 84, 91 (1941).

nanotechnology became less labor-intensive, it would be unwise to repeat the mistakes of an earlier era by inquiring into the costs of inventing.²⁰⁰

¶48 In sum, the technology of nanotechnology is new and wide-ranging. An overwhelming utility standard may hinder technological development. The better solution is to rely on the current utility standard. It is flexible enough to deny patents for inventions that have no known usefulness while issuing patents on deserving nanotechnology inventions.

B. Industry-Specific Arguments

¶49 The structure of the nanotechnology industry counsels against a heightened utility standard.²⁰¹ First, nanotechnology is an emerging and thus uncertain industry.²⁰² This uncertainty suggests that a decision about how to encourage innovation is premature. The better solution is to proceed case-by-case and retain the flexibility of the current, relatively low utility standard.

¶50 Decisions about how to promote innovation within an industry are multifaceted.²⁰³ The first step is to uncover all of the factors that affect innovation. One must then correctly balance those factors to determine what will produce the most innovative system. The final step is to know the means—what patent rules to change—to implement this new system. At each stage, one is likely to come up short in an analysis of the nanotechnology industry.

¶51 At the first stage, it is almost impossible to know all of the factors that affect innovation because the nanotechnology industry is so new and is changing so rapidly. For more mature industries, some commentators argue that changes in utility—or other patentability requirements—will lead to better policy.²⁰⁴ However, because nanotechnology is not a mature industry, changes to the current utility standard at this time could have significant negative repercussions. Even the Federal Government cautions that "[t]he social and economic consequences of nanoscale science and technology promise to be diverse, difficult to anticipate, and sometimes disruptive."²⁰⁵

¶52 At the second stage, balancing all of the factors that affect innovation in a field as interdisciplinary as nanotechnology is daunting. What makes sense for carbon nanotubes²⁰⁶ may not make sense for dip-pen nanolithography.²⁰⁷ And even if one could balance myriad technologies across myriad industries, such success would be short-lived. A utility standard that balanced all of the factors today would fail tomorrow when new inventions changed the balance. The semiconductor industry presents an apt, cautionary example. Although Congress adopted technology-specific legislation rather than the courts adopting a heightened utility standard, the result was the same: staid rules that decayed into irrelevance as the technology developed.²⁰⁸ This suggests that, at least in the early stages of the rapidly changing nanotechnology industry, it would be futile to fashion a different utility standard to promote innovation.

²⁰⁰ Moreover, this is more of a nonobviousness issue that should be handled under that precedent.

²⁰¹ This Note does not discuss sui generis, legislative protection because such protection is highly unlikely and highly undesirable. See generally Burk & Lemley, *supra* note 21, at 1630–39; Arti K. Rai, *Intellectual Property Rights in Biotechnology: Addressing New Technology*, 34 WAKE FOREST L. REV. 827, 842 (1999). But see Margo A. Bagley, *Patent First, Ask Questions Later: Morality and Biotechnology in Patent Law*, 45 WM. & MARY L. REV. 469, 547 (2003) (arguing for "[a]n intermediate regime, whereby Congress, or its delegate, retains the ability to assess patent eligibility issues on an ad hoc, pre-issuance basis").

²⁰² See Compañó & Hullmann, *supra* note 177, at 244 (using the number of patents and scientific articles to argue that "the peak of scientific activity in nanosciences is still to come, possibly in three to five years from now, and large-scale exploitation of nanotechnology results might arise ten years from now").

²⁰³ See, e.g., Rai, *supra* note 81, at 136 (noting that there are at least four types of costs that one must "balance appropriately" within "the context of basic research").

²⁰⁴ See, e.g., Rai, *supra* note 27, at 180 (arguing that if certain "cost reductions are realized, it should be possible to scale back certain features of the pharmaceutical patent regime that cause patent protection for pharmaceuticals to be significantly stronger than patent protection for other innovation").

²⁰⁵ SMALL WONDERS, *supra* note 1, at 31 (emphasis removed).

²⁰⁶ See generally POOLE & OWENS, *supra* note 20, at 114–32 (describing carbon nanotubes).

²⁰⁷ See generally Richard D. Piner, "Dip-Pen" Nanolithography, 283 SCI. 661 (1999) (describing dip-pen nanolithography).

²⁰⁸ See Burk & Lemley, *supra* note 21, at 1636 ("The history of industry-specific statutes suggests that many fail because they are drafted with current technology in mind and are not sufficiently general to accommodate the inevitable change in technology.").

¶53 At the third stage, even if we knew the right factors and balanced them correctly, making changes to patent law is tricky. Professors Rai and Eisenberg have argued that "it is difficult to calibrate [changes to the patent law] accurately, and the consequences of overdoing it could be grave."²⁰⁹ These consequences include decreased investment.²¹⁰ This is dangerous in the early stages of the nanotechnology industry because its research is cost-intensive.²¹¹ Such consequences may be one reason that courts rarely use complex, economic reasoning to interpret the utility requirement.²¹² Courts have favored stable rules over rules that evolve with technology. Courts may be concerned about the uncertainty—and thus the increased transaction costs—that flow from continually updating their case law to match updates in the technology. They may also be concerned about their ability to keep pace with and understand the state of the industry, and to make subtle changes in response to technological development. In sum, we should not pursue a heightened, nanotechnology-specific utility standard because of the complexities of (1) identifying the relevant factors, (2) balancing them, and (3) implementing the final result. Instead, we should rely on the current utility standard.²¹³

¶54 There are many possible responses to this argument. One could argue that delay is just as much a decision as action, and thus caution masks a desire to avoid a heightened utility standard.²¹⁴ One could also argue that a call for caution is naïve in that as soon as courts and the PTO adopt a position, they are unlikely to change it.²¹⁵ Commentators have made this argument about the Federal Circuit's computer ²¹⁶ and biotechnology precedent: "While the assumption that an art is uncertain may befit a new and undeveloped field, the court has maintained its assumption that biotechnology is an uncertain art long after the industry began to mature."²¹⁷ Finally, one could argue that this subpart has things backwards: it is when technologies are emerging—not when they are mature—that they need a heightened utility standard to foster innovation and avoid the problems of upstream-research patents.

¶55 To reply, there are differences between the right action, inaction, and the wrong action. This subsection argued that nanotechnology presents unique and complex problems for crafting a utility standard that maximizes innovation. With these problems, it is very hard to know what is the right action. Even if we made the right choice, it would not last for long because the industry changes so quickly. So we seem to be left with a choice between inaction and the wrong action. The wrong action is, by definition, wrong. And inaction does not mean doing nothing because the current utility standard is flexible enough to prevent applicants from patenting truly speculative or inoperable nanotechnology inventions. Thus, the safest solution to the four utility problems is to keep the current, relatively low utility standard.

²⁰⁹ Rai & Eisenberg, *supra* note 91, at 299.

²¹⁰ *Cf. id.* ("Patents clearly matter in the biopharmaceutical industry, and undue restrictions on patent protection may deter valuable private investment.")

²¹¹ See SOCIETAL IMPLICATIONS OF NANOSCIENCE AND NANOTECHNOLOGY, *supra* note 25, at 9 ("Because it will take time to achieve economics of scale and to develop the most efficient fabrication methods, costs are likely to be relatively high in the beginning.")

²¹² See Rai, *supra* note 81, at 138 n.313 (stating that law-and-economics reasoning would be a reasonable interpretation of the utility requirement, but "[s]uch as explicitly economic approach would, of course, represent a significant departure from conventional interpretations of the utility requirement").

²¹³ See Burk & Lemley, *supra* note 21, at 1630 (arguing that "policy levers" within the current patent regime "permit patent law to take account of the technology-specific nature of the patent system without inviting the rent-seeking and balkanization that specialized statutes would engender").

²¹⁴ See Rai, *supra* note 92, at 1069–70 ("The Federal Circuit's jurisprudence in this area is particularly problematic because it appears to elevate to the status of invariant legal precedent a determination regarding relevant biotechnological techniques that is clearly time-specific."). *But see* Frederick A. Fiedler & Glenn H. Reynolds, *Legal Problems of Nanotechnology: An Overview*, 3 S. CAL. INTERDISC. L.J. 593, 629 (1994) ("In the case of nanotechnology, passively waiting for regulations to develop may allow unnecessary harm to society, either in the form of technology unregulated, or technology undeveloped. One way to positively control nanotechnology is to contemplate the likely directions new technologies will take and to prepare flexible legislation providing for appropriate regulatory schemes even before the products arrive in the marketplace.")

²¹⁵ See John R. Thomas, *Formalism at the Federal Circuit*, 52 AM. U. L. REV. 771, 775 (2003) (arguing that "the prevailing trend in Federal Circuit patent jurisprudence [is] towards formalism").

²¹⁶ See Dan L. Burk & Mark A. Lemley, *Is Patent Law Technology-Specific?*, 17 BERKELEY TECH. L.J. 1155, 1200 (2002) (arguing that instead of updating their case law in computer cases to keep up with the level of skill in the art, the Federal Circuit has "tended to rely on prior cases holding that code need not be disclosed").

²¹⁷ *Id.* at 1193.

¶56 Second, the industry requires patents for commercial success.²¹⁸ Most obviously, companies argue that without patents, they would be less willing to engage in fundamental research.²¹⁹ And because nanotechnology is an emerging industry, most projects are at the fundamental-research stage.²²⁰ Patents encourage this research by giving companies the confidence that they will have some return on their investment through the competitive advantage of patent protection.²²¹ Without this confidence, companies would hesitate to invest in costly research. Applied Nanotechnology is one company that relies in part on its patents.²²² In 2003, it had 68 patents (with 86 more pending) that it licensed to create cash flow to fuel further research.²²³ Another small company that relies in part on its patents is C Sixty, a company that uses nanotechnology in drug design.²²⁴ C Sixty recently signed an exclusive license with Merck, a large company that will develop drugs based on C Sixty's patented technology.²²⁵ One commentator has suggested that C Sixty is a "platform company" that uses its patents to "derive most of its future revenues from licensing and partnering."²²⁶

¶57 Another reason that the nanotechnology industry needs strong patent protection is that much of the innovation surrounds small companies,²²⁷ and patents are critical to these companies. Without patents, small companies have few defenses against larger companies that are better equipped to take inventions to market.²²⁸ This would be unfortunate because small companies are critical in creating new markets,²²⁹ and small companies often have greater flexibility in emerging markets than large companies.²³⁰ The Federal Government has recognized the importance of small nanotechnology companies by directing funding to these companies.²³¹ Thus, because patents are a vital incentive for the entire industry to fund research, and because patents are particularly vital to small companies, adopting a heightened utility standard would harm innovation.

¶58 Third, a heightened utility standard is riskier—and thus less economically efficient—than a low one. Regardless of whether the PTO has a high or low utility standard, there will be errors: the PTO will grant

²¹⁸ See John R. Allison & Mark A. Lemley, *The Growing Complexity of the United States Patent System*, 82 B.U. L. REV. 77, 81 (2002) (reporting statistics that suggest that, in general, "patents are increasingly valuable to businesses, and that companies that expect to use patents in licensing or litigation are willing to spend more time and effort in the PTO to get a better patent").

²¹⁹ See Langer, *supra* note 52 ("Unless proprietary products are offered from which there can be recoupment of costs and ultimate profits, licensing deals will dry up and competitive products will be created overseas to the detriment of young startups.").

²²⁰ See Mike Angell, *Nanotechnology Stocks Saw Big Gains in '03, Some Without Earnings*, INVESTOR'S BUS. DAILY, Jan. 6, 2004, at 2004 WL 61405523 (stating that "nanotech projects are still mostly research"); Compañó & Hullmann, *supra* note 177, at 246 ("Nanotechnology—as a whole—is still an emerging area with the need to make progress in both scientific and technological terms before massive commercialization of products may occur.").

²²¹ SMALL WONDERS, *supra* note 1, at 25–26; see also FISHBINE, *supra* note 146, at 10 ("In an emerging industry such as nanotechnology, the key to creating assets that can lead to investment that can lead to an IPO is the acquisition of proprietary intellectual property.").

²²² RATNER & RATNER, *supra* note 125, at 149.

²²³ *Id.*

²²⁴ See ATKINSON, *supra* note 31, at 201 ("As interesting as these individual products are, they merely illustrate C Sixty's real intellectual property (IP): a lockup of many of the key patents governing buckyball use in drugs.").

²²⁵ *Collaborations, Research License, Supply Agreement to Commercialize Fullerene Technology*, MED. DEVICE & SURGICAL TECH. WK., Nov. 16, 2003, at 53.

²²⁶ ATKINSON, *supra* note 31, at 201.

²²⁷ See Carolina Braunschweig, *VCs Reap Big Rewards from \$3.7B Nano Bill*, PRIVATE EQUITY WK., Dec. 8, 2003, at 2003 WL 9280984 ("Startups and small companies—which number about 500 worldwide—are the biggest players thus far in nanotechnology."); RATNER & RATNER, *supra* note 125, at 143 (describing the nanotechnology industry as divided between open research labs like universities, large corporations, and small start-ups).

²²⁸ See Phanesh Koneru, *To Promote the Progress of Useful Article's?: An Analysis of the Current Utility Standards of Pharmaceutical Products and Biotechnological Research Tools*, 38 IDEA 625, 662–63 (1998) ("Faced with the need for additional capital to apply for a patent and the reality that additional funds may not be forthcoming from investors unless one has a patent on hand, it is unlikely that many small companies will persist to the next stage.").

²²⁹ See ATKINSON, *supra* note 31, at 205 ("[I]nnovation creates entirely new classes of objects—seemingly out of thin air. Buckytube nanotechnology is on the brink of doing this for structural materials and, through them, for almost every substance in our lives."); Gupta, *supra* note 5, at 271 ("Although nanotechnology could drastically improve certain existing processes, its real impact will most likely be as a *disruptive technology*. It will introduce a package of attributes different from those that customers have traditionally valued and that often perform worse along one or more dimensions of particular importance to those customers at a certain time.").

²³⁰ RATNER & RATNER, *supra* note 125, at 142.

²³¹ THE NEXT INDUSTRIAL REVOLUTION, *supra* note 76, at 5.

some patents when inventions are not useful, and deny other patents when they are. So the better rule is not perfect, it merely has more benefits than costs. This cost-benefit analysis is inherent in a patent law that issues patents on marginally useful inventions, such as inventions that serve as mere amusements.²³² The rationale for granting patents on such inventions is market-driven: "the marketplace decides which inventions are the most useful, through the price the inventor can command for her patented product."²³³ A heightened utility standard, on the other hand, would not let useless inventions languish in the marketplace. Rather, it would make errors on the other side of the equation, denying patents on useful inventions. These denials could have an immense effect on the market by diminishing the incentives of patents. Thus, because all rules are under- or over-inclusive, the best rule is the latter because the market is better at sorting out marginally useful inventions than legal rules.²³⁴

C. Combining Technology and Industry Arguments: A Call for Caution

¶59 Parts 3.A and 3.B described the complexity of nanotechnology. Its technology is complex. No one knows what technology will fit under its interdisciplinary umbrella, or how best to promote innovation. Its industry is complex. No one knows how the industry will develop, or how best to promote its development. These subparts also acknowledged the complexity of patent-law scholarship. Some commentators advocate sui generis protections; others, heightened patentability requirements; others still, lowered patentability requirements.

¶60 When one multiplies the complexities of nanotechnology with the complexities of the academic literature on promoting innovation, the product seems clear: caution. Indeed, at present it seems impossible to deduce what will best promote the development of nanotechnology. Thus, in order to avoid making a premature decision that could hurt its development, the best solution is to accept the default rules of current utility standard. But this does not mean that we are throwing up our hands and conceding defeat to a flawed utility standard. On the contrary, Part 2 argued that the current, relatively low standard works well for nanotechnology. That is, it is sufficient to issue patents for the vast majority of nanotechnology inventions, while denying patents for inventions with no known use. The Federal Circuit can change this standard when, and if, these default rules no longer work. However, such a change requires a better understanding of nanotechnology than we have now.²³⁵

¶61 In 1995, Professor Lawrence Lessig made a similar argument when he discussed possible regulation of the nascent Internet.²³⁶ At that time, it was impossible to predict how the Internet would develop, or how to craft a law that would balance the medium's competing interests. Professor Lessig did not address "what the balance should be"; rather, his point was "about timing—when the balance should be drawn."²³⁷ He argued that it was only "[w]hen the technology, when the experience, when the life in cyberspace presses us, [that we] should expect law to understand enough to resolve these questions rightly."²³⁸ Such is the case with nanotechnology. As of now, with such widely differing views about how its technology and industry will develop, and with such widely differing views in the academic literature about how to promote innovation,

²³² *E.g.*, U.S. Patent No. 5,457,821 (issued Oct. 17, 1995) ("Hat Simulating a Fried Egg"), *cited in* MUELLER, *supra* note 23, at 157.

²³³ MUELLER, *supra* note 23, at 158.

²³⁴ One would likely respond that marginally useful patents are hardly cost-free because of their effects on subsequent research. However, as argued in Part 3.A, such effects are minimal. *See supra* notes 189–194 and accompanying text.

²³⁵ If one accepts this call for caution, then the big question is when will we sufficiently understand nanotechnology to justify making changes. This is a difficult question to answer. *See* Monroe E. Price, *The Newness of New Technology*, 22 CARDOZO L. REV. 1885, 1913 (2001) ("In the flood of novelty captured by the new technology . . . [n]ewness is a quality that fits uneasily with law."). This Note argues that—as of now—the current utility standard is sufficient. It would require too much prescience to know when, or if, this standard is no longer sufficient. So whether this standard will ever, many years from now, be insufficient is categorically beyond the scope of this Note.

²³⁶ *See generally* Lawrence Lessig, *The Path of Cyberlaw*, 104 YALE L.J. 1743 (1995); *see also* Edward Lee, *Rules and Standards for Cyberspace*, 77 NOTRE DAME L. REV. 1275, 1372 (2002) (advancing a framework "designed to help courts handle the difficulties of applying law to the rapidly changing technology of the Internet").

²³⁷ Lessig, *supra* note 236, at 1752.

²³⁸ *Id.*

we should embrace the flexible, default rules of the current utility standard.²³⁹ It is only after we better understand nanotechnology that the courts should consider adjusting these rules.

¶62 Even if this call for caution is unpersuasive, the alternative is not necessarily a heightened utility requirement. Adjustments to other patent requirements might be better. In other words, even if one thinks that there are too many nanotechnology patents, one must consider whether utility is the best patent doctrine to deter subsequent patenting. There are several such deterrents—or "policy levers"²⁴⁰—that one can use to control the scope of patents. A discussion of these levers is beyond the scope of this Note.²⁴¹ It mentions them merely to suggest that if one disagrees with this Part's normative arguments and concludes that patents on nanotechnology should be harder to get, one should first canvass all of the potential policy levers to determine which works best before deciding to raise the current utility standard.

CONCLUSION

¶63 Nanotechnology is a relatively new field. But its inventors are not waiting to patent their inventions. Thus, while there are only a few thousand patents and no decided cases, it is not too early to address the patentability of nanotechnology. This Note analyzed one patentability requirement—utility. Specifically, it detailed four problems that a nanotechnology patent applicant may have with the utility requirement. This Note then argued that these problems are not—and should not be—insurmountable obstacles to patenting nanotechnology. Simply, there is no special reason to worry about nanotechnology patents. Instead, the current, relatively low utility standard has sufficient flexibility to address nanotechnology's utility problems. To require anything more is to mar the technological and economic development of nanotechnology.

²³⁹ Justice Souter made a similar argument about the complexity of technological change in a case about what constitutes indecent programming. *See Denver Area Educ. Telecomm. Consortium, Inc. v. FCC*, 518 U.S. 727, 777 (1996) (Souter J., concurring) ("Because we cannot be confident that for purposes of judging speech restrictions it will continue to make sense to distinguish cable from other technologies, and because we know that changes in these regulated technologies will enormously alter the structure of regulation itself, we should be shy about saying the final word today about what will be accepted as reasonable tomorrow.").

²⁴⁰ *See generally* Burk & Lemley, *supra* note 21.

²⁴¹ Given the complexity of this debate, and the purpose of this Note to outline likely utility problems and solutions, a detailed discussion of other ways in which one can adjust patent scope is beyond the scope of this Note. For a discussion of how best to adjust patent scope, see Julian David Forman, Comment, *A Timing Perspective on the Utility Requirement in Biotechnology Patent Applications*, 12 ALB. L.J. SCI. & TECH. 647, 657 (2002) ("Some may argue that the subject matter and non-obviousness requirements are better suited to the task of appropriately limiting patentability by addressing timing concerns. However, this part will demonstrate the limited applicability of these requirements in the biotechnology context and will argue that utility can be a very useful doctrinal lever."); Burk & Lemley, *supra* note 216, 1156 ("Much of the variance in patent standards is attributable to the use of a legal construct, the 'person having ordinary skill in the art' (PHOSITA), to determine obviousness and enablement."); Eisenberg, *supra* note 14, at 2094 ("Patent scope turns on legal rulings made at two separate stages in the life of a patent: prosecution and infringement litigation.").