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# Nanotechnology and the Tragedy of the Anticommons: Towards a Strict Utility Requirement

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# Nanotechnology and the Tragedy of the Anticommons: Towards a Strict Utility Requirement

Graham Reynolds*

NANOTECHNOLOGY HAS BEEN DESCRIBED AS A TRANSFORMATIVE TECHNOLOGY that will bring about the next industrial revolution. Over the last few decades, scientists and their research partners have acquired nanotechnology patents in a manner resembling a gold rush. The nanotechnology gold rush has specifically targeted nanomaterials, nanotechnology's building blocks. Many of the patents that have been granted for nanomaterials are broad, general patents encompassing basic research. A driving force behind the patenting of basic research in nanotechnology was the development-oriented approach to patent rights. This approach emerged in the 1960s and 1970s, and supported the widespread patenting of basic research in the 1980s and 1990s. Development-oriented theorists argued that the most efficient way to achieve the development and commercialization of research is to grant broad patents on research prospects shortly after their discovery. Beginning in 1998 with the publication of Michael A. Heller's "The Tragedy of the Anticommons," the beliefs held by development-oriented theorists have been challenged by proponents of "anticommons theory." In particular, anticommons theorists questioned whether granting broad patents on research prospects necessarily leads to the efficient development of research. Anticommons theorists argued that this assumption fails to take into account the possibility that granting patents on research prospects could stifle development through the phenomenon of the tragedy of the anticommons. This article will examine the contemporary nanotechnology patent landscape in the United States of America to determine whether the broad patenting of nanomaterials has led to the creation of an anticommons. It will also examine whether this anticommons is likely to turn tragic, stifling innovation in nanotechnology. This article proposes the adoption of a strict utility requirement as a solution to the problems posed by the tragedy of the anticommons in nanotechnology in the US.

LA NANOTECHNOLOGIE A ÉTÉ QUALIFIÉE DE TECHNOLOGIE TRANSFORMATIVE apte à provoquer la prochaine révolution industrielle. Au cours des dernières décennies, les scientifiques et leurs partenaires de recherche ont acquis des brevets de nanotechnologie et ce, d'une manière qui s'apparente fort à une ruée vers l'or. La ruée vers l'or de la nanotechnologie a ciblé en particulier des nanomatériaux, qui sont les véritables composantes de la nanotechnologie. Bon nombre des brevets accordés à l'égard de nanomatériaux sont de vaste portée. Rappelons que les brevets de nature générale comprennent de la recherche fondamentale. La force motrice qui sous-tend le brevetage de la recherche fondamentale de la nanotechnologie a été l'approche axée sur le développement envers les droits attachés au brevet. Cette approche a vu le jour dans les années 1960 et 1970, et fut à la base de la vague de brevetage de la recherche fondamentale dans les années 1980 et 1990. Selon les théoriciens axés sur le développement, la manière la plus efficace d'assurer le développement et la commercialisation de la recherche consiste à accorder des brevets d'application générale sur des projets de recherche peu après leur découverte. Au début de 1998, avec la publication de « The Tragedy of the Anticommons » de Michael A. Heller, les croyances théoriciens axés sur le développement ont été remises en question par les adeptes de la « théorie des anticommuns ». Les théoriciens partisans des anticommuns se sont en particulier demandé dans quelle mesure l'octroi de brevets de portée générale à l'égard de perspectives de recherche mène forcément à un développement concret de la recherche. Selon les théoriciens partisans des anticommuns, cette hypothèse ne tient pas compte de la possibilité que l'octroi de brevets sur des perspectives de recherche puisse réprimer le développement en raison du phénomène de la tragédie des anticommuns. Dans cet article, on examine le paysage actuel du brevetage de la nanotechnologie aux États-Unis afin de déterminer dans quelle mesure le brevetage général des nanomatériaux aurait entraîné la création d'un anticommun. On se demande également si cet anticommun pourrait entraîner une innovation étouffante et tragique en matière de nanotechnologie. Selon cet article, l'adoption d'une exigence de stricte utilité permettrait de résoudre les problèmes posés par la tragédie des anticommuns en matière de nanotechnologie aux États-Unis.

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# Nanotechnology and the Tragedy of the Anticommons: Towards a Strict Utility Requirement

Graham Reynolds

## 1. INTRODUCTION

ENCOMPASSING "NEARLY EVERY DISCIPLINE of science and engineering,"[1] nanotechnology has been described as a transformative technology that will bring about "the next industrial revolution."[2] Nanotechnology is broadly characterized as the construction and application of materials and structures at the nanometer scale (1 nanometer = 1 billionth of a meter), where properties of matter differ significantly from those at a larger scale.[3] Nanotechnology is projected to have a global market value of USA$1 trillion by 2010.[4] In addition to being lucrative, some believe that nanotechnology can help solve many of the problems facing the world today. Nanotechnology has been said to have the ability to repair damage caused to the environment, create new and virtually boundless fresh water resources, and cure various diseases, among other astonishing possibilities.[5]

Over the last few decades, scientists and their research partners have

1. Massimiliano di Ventra, Stephane Evoy and James R Heflin Jr., eds, *Introduction to Nanoscale Science and Technology* (Kluwer, 2004) at p. 1.
2. Liming Dal, "From Conventional Technology to Carbon Nanotechnology: The Fourth Industrial Revolution and the Discoveries of C60, Carbon Nanotube and Nanodiamond," in Liming Dal, ed., *Carbon Nanotechnology* (Elsevier, 2006) at p. 3; Joachim Schummer and Davis Baird, eds., *Nanotechnology Challenges: Implications for Philosophy, Ethics and Society* (World Scientific, 2006) at p. 1; J Storrs Hall, *Nanofuture: What's Next for Nanotechnology* (Prometheus Books, 2005) at p. 9.
3. Royal Society and the Royal Academy of Engineering, "Nanoscience and Nanotechnologies: Opportunities and Uncertainties," (July 2004), <http://www.nanotec.org.uk/finalReport.htm> at p. 5.
4. RNCOS, *The World Nanotechnology Market* (October 2005), <http://www.researchandmarkets.com/reportinfo.asp?report_id=307510>.
5. UNCTAD, "Interactive Dialogue on Harnessing Emerging Technologies to Meet the Millennium Development Goals," (14 June 2004), <http://stdev.unctad.org/unsystem/emerging.htm>, cited in Donald C MacLurcan, "Nanotechnology and Developing Countries, Part 1: What Possibilities?" *AZojono Journal of Nanotechnology Online* (2004), <http://www.azonano.com/Details.asp?ArticleID=1428>; Fabio Salamanca-Buentello, Deepa L Persad, Erin B Court, Douglas K Martin, Abdallah S Daar and Peter A Singer, "Nanotechnology and the Developing World," (2005) 2:5 *PLOS Medicine* e97, <http://medicine.plosjournals.org/perlserv/?request=get-document&doi=10.1371/journal.pmed.0020097>.

acquired nanotechnology patents[6] in a manner resembling a "gold rush."[7] The nanotechnology gold rush has specifically targeted nanomaterials.[8] Referred to as nanotechnology's "building blocks," nanomaterials are the foundation of future development in nanotechnology.[9] Many of the patents that have been granted for nanomaterials are broad, general patents that encompass basic research.

Nanotechnology is the first modern technology to have its basic research patented.[10] The basic research of most other twentieth-century technologies, including the computer, software, the internet, and biotechnology, has generally remained in the public domain.[11] A driving force behind the patenting of basic research in nanotechnology was the development-oriented approach to patent rights, which emerged in the 1960s and 1970s. The most prominent account of the development-oriented approach is Edmund Kitch's "prospect theory."[12] Inspired by the principle of the tragedy of the commons[13] and based on the hypothetical Coasean world with zero transaction costs,[14] Kitch argued that the most efficient way to achieve the development and commercialization of research is to grant broad patents on research prospects shortly after their discovery.[15]

Development-oriented arguments supported the widespread patenting of basic research in the 1980s and 1990s.[16] First, development-oriented arguments played a role in the passage of the *Bayh-Dole Act* in 1980, a technology transfer statute that encouraged scientists to patent the results of federally funded research.[17] Scientists responded to the incentives provided by the *Bayh-Dole Act* by increasing their efforts to seek patents.[18] Second, development-oriented arguments played a role in the creation of the Court of Appeals for the Federal Circuit (CAFC) in 1982, a unified court of patent appeals. Decisions of the CAFC weakening various patent requirements led to increased patenting of basic research.[19]

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6. A patent can be defined as a public document that gives the patentee exclusive rights to the use of the invention as defined in the patent claims.
7. Lux Research, Inc., "Nanotechnology Gold Rush Yields Crowded, Entangled Patents" (21 April 2005), <http://www.luxresearchinc.com/press/RELEASE_IPreport.pdf>.
8. Lux Research, "Nanotechnology Gold Rush," *supra* note 7.
9. Lux Research, "Nanotechnology Gold Rush," *supra* note 7; Nicholas A Kotov, ed, *Nanoparticle Assemblies and Superstructures* (Taylor & Francis, 2006) at preface; Ventra, Evoy and Heflin Jr., *Introduction to Nanoscale Science and Technology*, *supra* note 1 at p. 2; John C Miller, Ruben Serrato, Jose Miguel Represas-Cardenas, Griffith Kundahl, *The Handbook of Nanotechnology: Business, Policy and Intellectual Property Law* (Wiley, 2005) at p. 15.
10. Mark A Lemley, "Patenting Nanotechnology," (2005) 58 *Stanford Law Review* 601–630, <http://lawreview.stanford.edu/content/vol58/issue2/lemley.pdf > at pp. 601, 605.
11. Lemley, "Patenting Nanotechnology,"*supra* note 10 at p. 613. Nanotechnology is the first technology to have its basic ideas and building blocks patented since the airplane industry and radio industry experienced "debilitating patent battles" in the early twentieth century. Lemley, "Patenting Nanotechnology,"*supra* note 10 at pp. 605–606.
12. Arti Kaur Rai, "Regulating Scientific Research: Intellectual Property Rights and the Norms of Science," (1999) 94:1 *Northwestern University Law Review* 77–152, <http://eprints.law.duke.edu/451/1/94_Nw._U._L._Rev._77_(1999-2000).pdf> at pp. 77, 120; Edmund W Kitch, "The Nature and Function of the Patent System," (1977) 20 *The Journal of Law & Economics* 265–290, at p. 265.
13. Dan L Burk and Mark A Lemley, "Policy Levers in Patent Law," (2003) 89 *Virginia Law Review* 1575–1696, <http://papers.ssrn.com/sol3/papers.cfm?abstract_id=431360> at pp. 1575–1600.
14. Burk and Lemley, "Policy Levers in Patent Law," *supra* note 13 at p. 1600.
15. Kitch, "The Nature and Function of the Patent System," *supra* note 12 at p. 266.
16. Rai, "Regulating Scientific Research," *supra* note 12.
17. *Bayh-Dole Act*, (1980) 35 *United States Code*, ch 18, ss. 200–212, <http://www4.law.cornell.edu/uscode/35/usc_sup_01_35_10_II_20_18.html>.
18. Rai, "Regulating Scientific Research," *supra* note 12 at p. 109.
19. Rai, "Regulating Scientific Research," *supra* note 12 at p. 120. For instance, the CAFC weakened the utility requirement in *In re Brana* (USA Fed Cir, 1995), <http://bulk.resource.org/courts.gov/c/F3/51/51.F3d.1560.93-1393.html>, 63 *United States Law Week* 2656. In the same year, it weakened the nonobviousness standard in *In re Deuel* (USA Fed Cir, 1995) 51 *Federal Reporter, 3d Ser.* 1552.

In recent years, the beliefs held by development-oriented theorists have been challenged by proponents of "anticommons theory."[20] In particular, anticommons theorists questioned whether granting broad patents on research prospects necessarily leads to the efficient development and commercialization of research.[21] Anticommons theorists argued that this assumption fails to take into account the possibility that granting broad patents on research prospects could stifle development through the phenomenon of the tragedy of the anticommons.

The seminal account of "anticommons theory" is Michael A Heller's "The Tragedy of the Anticommons."[22] Heller and Rebecca Eisenberg are the two most prominent anticommons theorists. They state that anticommons property can be seen as the "mirror image" of commons property.[23] In commons property, multiple individuals have privileges of use in a scarce resource, and no one can exclude another.[24] As a result, the resource is prone to overexploitation.[25] This overexploitation is described as the "tragedy of the commons." The tragedy of the commons is resolved by granting rights of exclusion in the scarce resource. Conversely, anticommons property is created where too many individuals are endowed with rights of exclusion in a scarce resource.[26] In this situation, no one has a privilege of use.[27] The "tragedy" of the anticommons occurs where individuals are unable to bundle the exclusionary rights in the scarce resource, causing the resource to be underused.

Kitch advocated for the broad patenting of research prospects as a response to what he viewed as the tragedy of the commons in scientific research. This article will examine whether, in the context of nanotechnology, the attempt to overcome one tragedy has led to the creation of another. An analysis of the US nanotechnology patent landscape suggests that an anticommons has been created in nanomaterials. Patent rights in nanomaterials are broad, overlapping, and fragmented.[28] Before one can use a nanomaterial, one must first acquire licenses for all of the fragmented and overlapping nanomaterial patents. A "tragedy" of the anticommons will occur if individuals are unable to bundle the patent rights. If the nanotechnology anticommons turns tragic, nanomaterials will be underutilized and nanotechnology innovation will suffer.

The nanotechnology anticommons will not necessarily become tragic. The tragedy of the anticommons will be prevented if the fragmented and overlapping patent rights in nanomaterials can be assembled into useful bundles. There are two main ways to bundle the multiple exclusionary rights in nanomaterials. The first occurs through informal market mechanisms, such as cross-licensing agreements or patent pools. The success of informal market mechanisms depends on the

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20. Michael A Heller, "The Tragedy of the Anticommons: Property in the Transition from Marx to Markets," (1998) 111 *Harvard Law Review* 621–688, <http://papers.ssrn.com/sol3/papers.cfm?abstract_id=57627> at p. 621; Michael A Heller and Rebecca S Eisenberg, "Can Patents Deter Innovation? The Anticommons in Biomedical Research" (1 May 1998) 280 *Science* 698–701, <http://www.sciencemag.org/cgi/reprint/280/5364/698.pdf> at p. 698.
21. Heller, "The Tragedy of the Anticommons," *supra* note 20; Heller and Eisenberg, "Can Patents Deter Innovation?" *supra* note 20.
22. Heller, "The Tragedy of the Anticommons," *supra* note 20.
23. Heller and Eisenberg, "Can Patents Deter Innovation?" *supra* note 20 at p. 698.
24. Heller, "The Tragedy of the Anticommons," *supra* note 20 at p. 624.
25. Heller, "The Tragedy of the Anticommons," *supra* note 20 at p. 624.
26. Heller, "The Tragedy of the Anticommons," *supra* note 20 at p. 624.
27. Heller, "The Tragedy of the Anticommons," *supra* note 20 at p. 624.
28. Lux Research, "Nanotechnology Gold Rush," *supra* note 7.

ability of the parties involved to licence their patents effectively. Development-oriented theory is premised on the Coasean assumption of zero transaction costs.[29] In the case of nanotechnology, however, transaction costs and strategic behaviour will likely prove to be substantial impediments to the achievement of informal licensing agreements.

The second way to assemble the fragmented and overlapping patent rights in nanomaterials into useful bundles is through non-market action, namely through legislative or judicial redefinition of rights. This article proposes the adoption of a strict utility requirement as a solution to the problems posed by the tragedy of the anticommons in nanotechnology. The utility requirement is an essential element of patentability. It stipulates that inventions cannot be patented unless they are "useful." In the US, the utility requirement, in the context of scientific research, has fluctuated between a weak and a strict standard.

The adoption of a strict utility requirement is particularly suited as a solution to the tragedy of the anticommons in nanotechnology. Many of the patents making up the nanotechnology anticommons encompass basic research and were granted on the basis of a weak utility requirement. Most of these claims would not satisfy a strict utility requirement. As a result, the adoption of a strict utility requirement would invalidate a substantial number of broad, overlapping patents on nanomaterials.

This solution will not eradicate the anticommons. It is likely that many patents would be able to satisfy the strict utility standard while still having sufficient breadth to be considered part of the nanotechnology anticommons. The removal of multiple exclusionary rights from the nanotechnology anticommons, however, makes it more likely that users will be able to bundle the remaining nanomaterial patents through informal licensing agreements. Thus, the nanotechnology anticommons is less likely to turn tragic.

My analysis is divided into seven parts. Part 2 will introduce nanotechnology and nanomaterials. Part 3 will discuss the patenting of basic scientific research in the US. It will introduce the development-oriented approach and discuss its influence on US patent law. Part 4 will introduce anticommons theory. It will also explain why it is appropriate to critique the development-oriented approach using anticommons theory. Part 5 will suggest the existence of an anticommons in nanomaterials in the US. Part 6 will explore market solutions to the nanotechnology anticommons. It will discuss why informal market mechanisms will likely fail to overcome the nanotechnology anticommons. Part 7 will explore various non-market solutions to the problems posed by the US nanotechnology anticommons. I propose the adoption of a strict utility requirement as a solution to the problems posed by the tragedy of the anticommons in nanotechnology.

This article will address the nanotechnology anticommons in the US. The US leads the world in both government and corporate spending in nanotechnology, in publications on nanoscale science and engineering topics, and in nanotechnology patents.[30] The race to patent nanotechnology inventions is occurring worldwide. As a result, nanotechnology anticommons may have

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29. Burk and Lemley, "Policy Levers in Patent Law," *supra* note 13 at p. 1600.
30. Lux Research Inc., "Top Nations in Nanotech See Their Lead Erode," (8 March 2007), <http://www.luxresearchinc.com/press/RELEASE_NationsRanking2007.pdf>.

developed in countries other than the US. However, given the position of the US as the world's leader in nanotechnology, the elimination of the nanotechnology anticommons in the US will go a long way towards ensuring that, globally, nanotechnology's potential will not be stifled due to excessive transaction and strategic costs.

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## 2. OVERVIEW OF NANOTECHNOLOGY

THIS PART WILL FIRST DEFINE NANOTECHNOLOGY and nanomaterials. Second, it will describe the historical development of nanotechnology. Third, it will comment on nanotechnology's potential. Fourth, it will describe how a significant number of the patents that have been granted for nanomaterials encompass basic scientific research.

### *2.1. Definitions*

#### 2.1.1. Nanotechnology

Nanotechnology is broadly characterized as the construction and application of materials and structures at the nanometer scale, where properties of matter differ significantly from those at a larger scale.[31] The field of nanotechnology is defined primarily by a unit of length, the nanometer.[32] One nanometer, which spans approximately 10 atoms,[33] is equivalent to one billionth of a meter (1 nm = $1x10^{-9}$ m).[34] To put this size in context, a human hair has a thickness of approximately 80,000 nanometers, a DNA molecule is approximately 2.5 nanometers wide, and the diameter of a red blood cell is approximately 5,000 nanometers.[35]

Two aspects of working at the nanometer scale afford the main drive for investment in nanotechnology.[36] First, progressing from the micrometer scale to the nanometer scale allows one to pursue the "miniaturization of current and new instruments, sensors and machines."[37] This miniaturization permits "more functionality in a given space."[38] Furthermore, manufacturing advantages can flow from "increases in a material's surface area and surface-to-volume ratio."[39] These increases are inherent in any progression from the micrometer to nanometer scale.[40]

Second, while materials at the micrometer scale generally exhibit the same physical properties as materials in macro form, materials at the nanometer scale

31. Royal Society and the Royal Academy of Engineering, "Nanoscience and Nanotechnologies," *supra* note 3 at p. 5.
32. Ventra, Evoy, and Heflin Jr., *Introduction to Nanoscale Science and Technology*, *supra* note 1 at p. 1.
33. Miller *et al.*, *The Handbook of Nanotechnology*, *supra* note 9 at p. 13.
34. Ventra, Evoy and Heflin Jr., *Introduction to Nanoscale Science and Technology*, *supra* note 1 at p. 1.
35. ETC Group, "A Tiny Primer on Nano-Scale Technologies and 'The Little Bang Theory,'" (June 2005) 1–20, <http://www.etcgroup.org/upload/publication/55/01/tinyprimer_english.pdf> at p. 1.
36. Roy Shenhar, Tyler B Norsten and Vincent M Rotello, "Self-Assembly and Self-Organization" in Ventra, Evoy and Heflin Jr., *Introduction to Nanoscale Science and Technology*, *supra* note 1at p. 41.
37. Guozhong Cao, *Nanostructures & Nanomaterials: Synthesis, Properties & Applications* (Imperial College Press, 2004) at p. v.
38. Cao, *Nanostructure & Nanomaterials*, *supra* note 37 at p. v.
39. MacLurcan, "Nanotechnology and Developing Countries," *supra* note 5 at p. 2.
40. MacLurcan, "Nanotechnology and Developing Countries," *supra* note 5 at p. 2.

may exhibit physical properties that are dramatically different than those in macro form.[41] This discrepancy is due to the fact that when dealing with matter smaller than approximately 50 nanometers, "the laws of quantum physics supersede those of traditional physics."[42] As a result, shrinking matter to the level of the nanometer scale can cause it to exhibit properties that it does not exhibit at the micro or macro scales, such as "electrical conductivity, elasticity, greater strength, different colour, [tolerance to temperature and pressure,[43]] and greater reactivity."[44] For instance, macro scale carbon is soft and malleable.[45] At the nano-scale, "carbon can be stronger than steel and is six times lighter."[46] Zinc oxide, "usually white and opaque," becomes transparent at the nanoscale.[47] Aluminum can "spontaneously combust at the nano-scale," a property which it does not possess at the macro scale.[48] Nano-particles of silver have some ability to combat microbes, an ability that large particles do not display.[49] The discovery of these new physical properties can lead to technological advancement across all industrial sectors.[50]

### 2.1.2. Nanomaterials

Nanomaterials are arrangements of matter that exhibit unique characteristics and properties as a result of their size (approximately 1 to 100 nanometers in length).[51] They are nanotechnology's "building blocks," the foundation of future development in nanotechnology.[52] John C Miller notes that the analogy of building a house is appropriate to understanding nanomaterials and nanotechnology:

> Houses can be comprised of a variety of materials: wood, nails, sheet rock, bricks, and so on. Just as a builder puts together different shapes and pieces of these materials to construct a home, nanotechnologists experiment with a variety of different nanomaterials to build complex materials, devices and systems.[53]

The key nanomaterials in existence today are fullerenes, carbon nanotubes, nanowires, semiconductor crystals (also referred to as quantum dots), and dendrimers.[54] Nanomaterials can be combined to form various structures, devices, and systems.[55] The present challenge in nanotechnology is to shift from the production of nanomaterials to "organizing them in one-, two-, and three-dimensional structures."[56]

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41. Cao, *Nanostructures & Nanomaterials*, *supra* note 37 at p. 6.
42. MacLurcan, "Nanotechnology and Developing Countries," *supra* note 5 at p. 2.
43. MacLurcan, "Nanotechnology and Developing Countries," *supra* note 5 at p. 2.
44. ETC Group, "A Tiny Primer on Nano Scale Technologies," *supra* note 35 at p. 1.
45. ETC Group, "A Tiny Primer on Nano Scale Technologies," *supra* note 35 at p. 2.
46. ETC Group, "A Tiny Primer on Nano Scale Technologies," *supra* note 35 at p. 2.
47. ETC Group, "A Tiny Primer on Nano Scale Technologies," *supra* note 35 at p. 2.
48. ETC Group, "A Tiny Primer on Nano Scale Technologies," *supra* note 35 at p. 2.
49. Jeffrey H Matsuura, *Nanotechnology Regulation and Policy Worldwide* (Artech House, 2006) at p. 10.
50. Cao, *Nanostructure & Nanomaterials*, *supra* note 37 at p. v; MacLurcan, "Nanotechnology and Developing Countries," *supra* note 5 at p. 2.
51. Miller *et al.*, *The Handbook of Nanotechnology*, *supra* note 9 at p. 13.
52. Kotov, *Nanoparticle Assemblies and Superstructures*, *supra* note 9 at preface; Ventra, Evoy and Heflin Jr., *Introduction to Nanoscale Science and Technology*, *supra* note 1 at p. 2; Miller *et al.*, *The Handbook of Nanotechnology*, *supra* note 9 at p. 15.
53. Miller *et al.*, *The Handbook of Nanotechnology*, *supra* note 9 at p. 15.
54. Lux Research, "Nanotechnology Gold Rush," *supra* note 7; Ventra, Evoy and Heflin Jr., *Introduction to Nanoscale Science and Technology*, *supra* note 1 at p. 2.
55. Ventra, Evoy and Heflin Jr., *Introduction to Nanoscale Science and Technology*, *supra* note 1 at p. 2.
56. Kotov, *Nanoparticle Assemblies and Superstructures*, *supra* note 9 at preface.

### *2.2. Historical Development of Nanotechnology*

Nobel-prize winning physicist Richard Feynman is credited as the first individual to engage with some of the fundamental concepts underlying nanotechnology.[57] On 29 December 1959, in a lecture entitled "There's Plenty of Room at the Bottom" presented at the annual meeting of the American Physical Society at the California Institute of Technology, Feynman discussed the possibilities of "manipulating and controlling matter" on the atomic scale.[58] Anticipating the opportunities that flow from working with matter subject to the laws of quantum mechanics, Feynman stated that:

> When we get to the very, very small world—say circuits of seven atoms—we have a lot of new things that would happen that represent completely new opportunities for design. Atoms on a small scale behave like nothing on a large scale, for they satisfy the laws of quantum mechanics. So, as we go down and fiddle around with the atoms down there, we are working with different laws, and we can expect to do different things. We can manufacture in different ways.[59]

It took fifteen years from the date of Feynman's lecture for the term "nanotechnology" to emerge. Coined by analogy to the epithet "microtechnology," which is "broadly applied to any technology that manipulated matter at the micron scale,"[60] Tokyo Science University Professor Norio Taniguchi in a 1974 paper defined the term "nanotechnology" as "the processing of, separation, consolidation, and deformation of materials by one atom or one molecule."[61]

The term "nanotechnology" was explored in greater depth in the work of K Eric Drexler. In 1987, Drexler published a book entitled *Engines of Creation: the Coming Era of Nanotechnology*.[62] Some mark the publication of *Engines of Creation* as the point where the "field of nanotechnology began its formal existence."[63] In discussing nanotechnology's potential, Drexler describes the ability of "replicating assemblers to copy themselves by the ton, then make other products such as computers, rocket engines, chairs, and so forth."[64] He states that nanotechnology will enable humanity to restore damaged ecosystems, cure the "disease" called aging, return some species from apparent extinction, and travel through space easily and conveniently in a spacesuit that is so light it is barely noticeable.[65] As a result of challenges from the scientific community on the basis of "technological feasibility," Drexler later renamed his vision of nanotechnology

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57. Roger W Whatmore, "Nanotechnology—What Is It? Should We Be Worried?" (2006) 56 *Occupational Medicine* 295–299,<http://occmed.oxfordjournals.org/cgi/reprint/56/5/295> at p. 295.
58. Richard P Feynman, "There's Plenty of Room at the Bottom," (February 1960) *Engineering and Science*, <http://www.zyvex.com/nanotech/feynman.html>.
59. Feynman, "There's Plenty of Room at the Bottom," *supra* note 58 at p. 8.
60. Hall, *Nanofuture*, *supra* note 2 at p. 18.
61. Norio Taniguchi, "On the Basic Concept of 'Nano-Technology,'" (1974) *Proceedings of the International Conference of Production Engineering*, Part II, Society of Precision Engineering, Tokyo, Japan, cited in Whatmore, "Nanotechnology—What Is It?" *supra* note 57 at p. 296.
62. K Eric Drexler, *Engines of Creation* (Oxford University Press, 1986).
63. Francisco Castro, "Legal and Regulatory Concerns Facing Nanotechnology," (2004) 4 *Chicago-Kent Journal of Intellectual Property* 140–146, <http://jip.kentlaw.edu/art/volume%204/4%20Chi-Kent%20J%20Intell%20Prop%20140.pdf> at p. 140.
64. Drexler, *Engines of Creation*, *supra* note 62.
65. Drexler, *Engines of Creation*, *supra* note 62.

"molecular manufacturing."[66] In so doing, Drexler distanced his vision from the definition of nanotechnology as set out above.

### *2.3. Nanotechnology's Potential*

Projected to be a "transformative technology" like the steam engine in the eighteenth century, electricity in the late nineteenth and twentieth centuries, and the internet today,[67] nanotechnology has been heralded as having the potential to bring about a new kind of industrial revolution.[68] The cross-industry applicability of nanotechnology means that its technological impact "can probably not be compared with any other technical development up to the present time, since it will concern all aspects of human life."[69] It has been predicted that nanotechnology will have a positive impact on medical applications, information technologies, energy production and storage, materials science, food, water and environmental research, and security, among other sectors.[70] A 1996 UNESCO-sponsored study states that "nanotechnology will provide the foundation of all technologies in the new century."[71]

Although some point to nanotechnology's potential to widen the divide between the "haves" and "have-nots,"[72] many believe that it can be used for the benefit of developing countries.[73] United Nations representatives have suggested that nanotechnology can help "reduce the cost and increase the likelihood of attaining" the Millennium Development Goals (MDG), eight goals that aim to meet the needs of the world's poorest by the target date of 2015.[74]

#### 2.3.1. Many Patents That Have Been Granted for Nanomaterials Encompass Basic Scientific Research

Many patents that have been granted for nanomaterials encompass basic scientific research. These patents are broad, uncertain, vaguely defined, and remain at a significant distance from any solution to a specific practical problem. Patenting basic research allows patentees to control large sectors of nanotechnology.

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66. MacLurcan, "Nanotechnology and Developing Countries," *supra* note 5 at p. 2.
67. Mohamed H A Hassan, "Small Things and Big Changes in the Developing World," (1 July 2005) 309 *Science* 65–66, <http://www.sciencemag.org/cgi/content/full/309/5731/65> at p. 65.
68. Dal, "From Conventional Technology to Carbon Nanotechnology," *supra* note 2 at p. 3; Schummer and Baird, *Nanotechnology Challenges*, *supra* note 2 at p.1; Hall, *Nanofuture*, *supra* note 2 at p. 9.
69. Gunter Schmid, ed., *Nanoparticles: From Theory to Application* (Wiley-VCH, 2004) at p. 1.
70. European Commission, *Towards a European Strategy for Nanotechnology* (European Commission, 2002), <http://ec.europa.eu/nanotechnology/pdf/nano_com_en_new.pdf> at pp. 4–5.
71. Pat Mooney, "The ETC Century: Erosion, Technological Transformation and Corporate Concentration in the 21st Century," 1999:1–2 *Development Dialogue* 1–128, <http://www.etcgroup.org/en/materials/publications.html?pub_id=281> at p. 51, cited in MacLurcan, "Nanotechnology and Developing Countries," *supra* note 5.
72. Erin Court, Abdallah S Daar, Elizabeth Martin, Tara Acharya, and Peter A Singer, "Will Prince Charles Et Al Diminish the Opportunities of Developing Countries in Nanotechnology," (28 January 2004) *Nanotechweb.org*, <http://nanotechweb.org/cws/article/indepth/18909>, cited in MacLurcan, "Nanotechnology and Developing Countries," *supra* note 5.
73. UNCTAD, "Interactive Dialogue on Harnessing Emerging Technologies to Meet the Millennium Development Goals," *supra* note 5; Salamanca-Buentello *et al*., "Nanotechnology and the Developing World," *supra* note 5.
74. United Nations, *The Millennium Development Goals Report 2005* (United Nations, 2005), <http://unstats.un.org/unsd/mi/pdf/MDG%20Book.pdf> at pp. 4–5. The Millenium Development Goals are: (i) eradicate extreme poverty and hunger; (ii) achieve universal primary education; (iii) promote gender equality and empower women; (iv) reduce child mortality; (v) improve maternal health; (vi) combat HIV/AIDS, malaria and other diseases; (vii) ensure environmental sustainability; and (viii) develop a global partnership for development.

Consequently, patents encompassing basic research are attractive to persons seeking to establish a dominant presence in the nanotechnology industry.

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## 3. THE PATENTING OF BASIC SCIENTIFIC RESEARCH IN THE US

NANOTECHNOLOGY IS THE FIRST MODERN TECHNOLOGY to have its basic research patented.[75] The basic research of most other twentieth-century technologies, including the computer, software, internet, and biotechnology, generally remained in the public domain.[76] Historically, the US academic scientific community had been reluctant to secure property rights in basic research.[77] The reluctance of US academic researchers to patent basic research was supported by traditional scientific norms, government policy, the reward theory of patent law, and judicial decisions that discouraged the patentability of basic scientific research. This attitude of general reluctance towards patenting basic research will be referred to as the "commons model." During the period when the commons model was the prevailing model of patenting, a significant proportion of basic scientific research made its way into the public domain.

For instance, the computer, "largely the result of military research projects during World War II,"[78] remained unpatented due both to military secrecy and to the fact that, at that time, "government-sponsored research was not generally patented."[79] Basic software remained unpatented during the 1960s, 1970s, and early 1980s as a result of the courts' determination that software was not patentable subject matter.[80] The internet's basic protocols remain in the public domain due to the traditional attitude that inventions developed with federal funding and at universities should not receive patent protection.[81] These traditional attitudes also led to biotechnology's basic inventions ending up in the public domain.[82]

Beginning in the 1960s and 1970s, a series of changes led to widespread support for the patenting of basic scientific research.[83] One contributing factor was the emergence of the development-oriented model of patenting.[84] The development-oriented model is centered on the view that patents should be granted early in the process of innovation so as to "induce…firms to commit resources to the development of inventions."[85] Edmund Kitch's "prospect theory," introduced in 1977 in his essay "The Nature and Function of the Patent System,"

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75. Lemley, "Patenting Nanotechnology," *supra* note 10 at pp. 605–606.
76. Lemley, "Patenting Nanotechnology," *supra* note 10 at p. 613.
77. Rai, "Regulating Scientific Research," *supra* note 12 at p. 88.
78. Lemley, "Patenting Nanotechnology," *supra* note 10 at pp. 606–607.
79. Lemley, "Patenting Nanotechnology," *supra* note 10 at pp. 606-607.
80. *Gottschalk v Benson* (USA SC, 1972), <http://supreme.vlex.com/vid/gottschalk-v-benson-19987810>, 409 *United States Reports* 64; *Parker v Flook* (USA SC, 1978), 437 *United States Reports* 584; *Parker v Flook* is cited in Lemley, "Patenting Nanotechnology," *supra* note 10 at p. 608.
81. Lemley, "Patenting Nanotechnology," *supra* note 10 at p. 608.
82. Lemley, "Patenting Nanotechnology," *supra* note 10 at pp. 609–611.
83. Rai, "Regulating Scientific Research," *supra* note 12 at p. 94.
84. When this paper refers to the development-oriented perspective to patent rights, it is referring to development in the context of commercialization of research.
85. Roberto Mazzoleni and Richard R Nelson, "The Benefits and Costs of Strong Patent Protection: A Contribution to the Current Debate," (1998) 27:3 *Research Policy* 273–284 at p. 277.

is the seminal academic example of the development-oriented approach.[86] In this work, Kitch argues that the "reward theory" (at that time the prevailing economic theory in patent law) offers an "incomplete picture of the functions of the patent system."[87] He states that the patent system performs another function, not previously noted.[88] Namely, the patent system helps promote the efficient allocation of resources among prospects, thereby increasing the output of resources used for technological innovation.[89] It does so by permitting the granting of broad patents on prospects, shortly after their discovery.[90] The patentee is then placed in a position to monitor and coordinate the development of the prospect through licensing.[91] Kitch calls this view of the patent system "prospect theory."[92] It has been described as "one of the most significant efforts to integrate intellectual property with property rights theory."[93]

The theoretical foundations of prospect theory are the tragedy of the commons and the hypothetical Coasean world with zero transaction costs.[94] A tragedy of the commons occurs where multiple individuals have privileges of use in a scarce resource, and "no one has the right to exclude another."[95] As a result, the resource is prone to overexploitation.[96] The concept of the "tragedy of the commons" was popularized by Garrett Hardin.[97] Two classic examples of the "tragedy of the commons" are depleted fisheries and overgrazed fields.[98] Heller and Eisenberg note that "[t]oday, Hardin's metaphor is central to debates in economics, law, and science and is a powerful justification for privatizing commons property."[99]

In his essay "The Optimal Timing of Innovation," Yoram Barzel applies Hardin's "tragedy of the commons" principle to scientific research. He takes the position that like common fields and fisheries, basic scientific knowledge is a free public good.[100] Barzel believes that "since the basic knowledge is costless to the innovator, he introduces a discovery when it first becomes profitable instead of waiting until profits are maximized."[101] He states that in this way, basic knowledge is "overexploited comparably to public roads, fisheries, and oil and water pools."[102] In the case of basic knowledge used by innovators, "the excessive use

86. Rai, "Regulating Scientific Research," *supra* note 12 at p. 120; Kitch, "The Nature and Function of the Patent System," *supra* note 12; Jerome Reichman argues that Kitch's "reorientation" of patent law through prospect theory was not merely a contributing factor in the shift towards widespread support for the patenting of basic research. Rather, Reichman argues that Kitch's prospect theory "spearheaded [the] shift" towards widespread support for patenting of basic research. Jerome H Reichman, "Computer Programs as Applied Scientific Know-How: Implications of Copyright Protection for Commercialized University Research," (1989) 42:3 *Vanderbilt Law Review* 639–723 <http://en.scientificcommons.org/23678758> at p. 643.
87. Kitch, "The Nature and Function of the Patent System," *supra* note 12 at p. 266.
88. Kitch, "The Nature and Function of the Patent System," *supra* note 12 at p. 265.
89. Kitch, "The Nature and Function of the Patent System," *supra* note 12 at p. 265.
90. Kitch, "The Nature and Function of the Patent System," *supra* note 12 at p. 265.
91. Kitch, "The Nature and Function of the Patent System," *supra* note 12 at p. 276.
92. Kitch, "The Nature and Function of the Patent System," *supra* note 12 at p. 266.
93. Burk and Lemley, "Policy Levers in Patent Law," *supra* note 13 at p. 1601.
94. Burk and Lemley, "Policy Levers in Patent Law," *supra* note 13 at p. 1600.
95. Heller, "The Tragedy of the Anticommons," *supra* note 20 at p. 624.
96. Heller, "The Tragedy of the Anticommons," *supra* note 20 at p. 624.
97. Garrett Hardin, "The Tragedy of the Commons" (1968) 162:3859 *Science* 1243–1248, <http://www.sciencemag.org/cgi/reprint/162/3859/1243.pdf>.
98. Burk and Lemley, "Policy Levers in Patent Law," *supra* note 13 at p. 1600.
99. Heller and Eisenberg, "Can Patents Deter Innovation?" *supra* note 20 at p. 698.
100. Yoram Barzel, "Optimal Timing of Innovations," (1968) 50:3 *The Review of Economics and Statistics* 348–355 at p. 348.
101. Barzel, "Optimal Timing of Innovations," *supra* note 100 at p. 348.
102. Barzel, "Optimal Timing of Innovations," *supra* note 100 at p. 348.

of resources takes the form of their premature application."[103]

The conventional solution to the tragedy of the commons is the privatization of the commons.[104] It is thought that if property owners suffer the full cost consequence of their actions, they will not overuse the resource.[105] In order to remedy the tragedy of the commons in basic scientific research, Barzel recommends converting basic scientific research into private property.[106] Specifically, Barzel proposes that, "by granting (or auctioning) monopoly rights on potential innovations before resources are committed to the innovating activity," the patent system can prevent such a premature allocation of resources.[107] According to Barzel, private ownership will allow the grantee of the rights to maximize the present value of the object of ownership by undertaking (or contracting for) "the innovation investment at that point of time which is also socially optimal."[108]

Kitch's ideas for prospect theory "crystallized" in response to Barzel's essay.[109] Kitch concurs with Barzel's statement that potential innovations (prospects) are a form of public good, comparable to fisheries, oil, or mineral claims, that will "not be efficiently used absent exclusive ownership."[110] Each public prospect can be pursued by multiple firms, each of which can use any level of resources to develop the prospect.[111] Firms also need not disclose their activities to their competitors.[112] This results in wastefulness as firms expend valuable scarce resources attempting to develop the same prospect.[113]

Rather than adopt Barzel's method of "granting" or "auctioning" monopoly rights in potential innovations, however, Kitch takes the position that the most efficient way to privatize prospects is through the patent system.[114] Kitch advocates awarding patents to prospects shortly after their discovery, "even though the practical significance of the innovation may be but dimly perceived."[115] Kitch notes that since the patent owner has the exclusive right to develop the patented technology, no one is likely to invest in the prospect without first making arrangements with the patent owner.[116] Otherwise, lacking a license to the underlying prospect, they may not be able to reap the benefits of their investment. The patent owner is thus placed in a controlling position with respect to the prospect. She can seek out or entertain licensees, cause prospective searchers to exchange information, and avoid duplicative investments, thereby maximizing the resources available for innovation. Burk and Lemley note that "this is the Coase theorem at work":

103. Barzel, "Optimal Timing of Innovations," *supra* note 100 at p. 348.
104. Burk and Lemley, "Policy Levers in Patent Law," *supra* note 13 at p. 1600.
105. Burk and Lemley, "Policy Levers in Patent Law," *supra* note 13 at p. 1600.
106. Barzel, "Optimal Timing of Innovations," *supra* note 100 at p. 352.
107. Barzel, "Optimal Timing of Innovations," *supra* note 100 at p. 352.
108. Barzel, "Optimal Timing of Innovations," *supra* note 100 at p. 352.
109. Kitch, "The Nature and Function of the Patent System," *supra* note 12 at p. 265.
110. Kitch, "The Nature and Function of the Patent System," *supra* note 12 at p. 276.
111. Kitch, "The Nature and Function of the Patent System," *supra* note 12 at p. 276.
112. Kitch, "The Nature and Function of the Patent System," *supra* note 12 at p. 276.
113. Kitch, "The Nature and Function of the Patent System," *supra* note 12 at p. 276.
114. Kitch, "The Nature and Function of the Patent System," *supra* note 12 at p. 266.
115. Kitch, "The Nature and Function of the Patent System," *supra* note 12 at p. 270.
116. Kitch, "The Nature and Function of the Patent System," *supra* note 12 at p. 270.

> under that theorem, giving one party the power to control and orchestrate all subsequent use and research relating to the patented technology should result in efficient licensing, both to end users and to potential improvers—assuming, that is, that information is perfect, all parties are rational, and licensing is costless.[117]

Kitch argues that the "prospect function" is a "significant, if not the predominant, function of the American patent system as it has operated in fact."[118] He bases this statement on three features of the American patent system.[119] First, he states that the scope accorded to patent claims reaches "well beyond what the reward function would require."[120] In support of this point, Kitch provides various examples where the patent claim has been held to include more than what was made or accomplished by the inventor at the time of patenting.[121] Second, Kitch states that "many technologically important patents have been issued long before commercial exploitation became possible."[122] He provides a table of case studies to support his point. Third, Kitch notes that rules of patentability (such as priority and time-bar) "force an early patent application whether or not something of value (and hence a reward) has been found."[123]

Development-oriented arguments were a significant factor in the "dramatic shift" in the legal framework surrounding scientific research.[124] Faced with "mounting […] evidence […] that the US [was] falling behind its international competition in the development of new products and inventions," Congress decided that in order to "[rescue] the results of federally sponsored research […] from oblivion and successfully develop [them] into commercial products," as Eisenberg states, the results of federally sponsored research would have to be "patented and offered up for private appropriation."[125] As a result, the US government, beginning in 1980, "embarked on a concerted effort to apply property-based incentives to scientific research."[126] This concerted effort is demonstrated in the passage of various technology transfer statutes that encourage government agencies, educational institutions, and non-profit institutions to apply for patents on inventions derived from federally funded research.[127] The most influential of these technology transfer statutes is the *Bayh-Dole Act*.[128] Passed in 1980, the *Bayh-Dole Act* gives universities and small businesses the right to "seek patent rights on the results of their federally sponsored research and to retain patent ownership themselves."[129] It also requires universities to share patent royalties with individual inventors. The stated

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117. Burk and Lemley, "Policy Levers in Patent Law," *supra* note 13 at p. 1602.
118. Kitch, "The Nature and Function of the Patent System," *supra* note 12 at p. 267.
119. Kitch, "The Nature and Function of the Patent System," *supra* note 12 at p. 267.
120. Kitch, "The Nature and Function of the Patent System," *supra* note 12 at p. 267.
121. Kitch, "The Nature and Function of the Patent System," *supra* note 12 at p. 267.
122. Kitch, "The Nature and Function of the Patent System," *supra* note 12 at p. 267.
123. Kitch, "The Nature and Function of the Patent System," *supra* note 12 at p. 267.
124. Rai, "Regulating Scientific Research," *supra* note 12 at p. 88.
125. Rebecca S Eisenberg, "Public Research and Private Development: Patents and Technology Transfer in Government-Sponsored Research," (1996) 82:8 *Virginia Law Review* 1663–1727 at p. 1664; see also *House Report* No. 96–1307 at p. 3, reprinted in 1980 *United States Code Congressional and Administrative News* 6460 at p. 6463, cited in Rai, "Regulating Scientific Research," *supra* note 12 at p. 95.
126. Rai, "Regulating Scientific Research," *supra* note 12 at p. 88.
127. Rai, "Regulating Scientific Research," *supra* note 12 at p. 96.
128. Rai, "Regulating Scientific Research," *supra* note 12 at p. 96; *Bayh-Dole Act*, *supra* note 17.
129. Rai, "Regulating Scientific Research," *supra* note 12 at p. 96; *Bayh-Dole Act*, *supra* note 17 at s. 200.

policy objective of the *Bayh-Dole Act* is "to use the patent system to promote the utilization of inventions from federally supported research or development."[130]

The expansion of property rights in research "initially met with loud outcries from the scientific community."[131] However, "universities and individual researchers soon began to respond to the financial incentives of Bayh-Dole by rejecting communalism and increasing efforts to seek patents."[132] The period between 1980 and 2003 saw a near sixteen-fold increase in patents granted to universities (from approximately 250 US patents per year in 1980 to 3933 patents per year in 2003).[133] The development of the public domain was further limited by partnerships between academia and industry that restricted the options of scientists seeking to publish their results in the public domain.[134]

Development-oriented arguments were also used to justify the creation, in 1982, of the CAFC, a unified court responsible for all patent appeals.[135] Rai states that:

> proponents of a single forum for patent appeals argued that the stronger patent rights created by a more uniform interpretation of the patent law were necessary for economic growth and international competitiveness.[136]

The view that the predominant function of patent rights is to promote the efficient development and commercialization of research has been evident in case law emerging from the CAFC.[137] The CAFC weakened both the utility and nonobviousness standards of patentability, and expanded the range of subject matter that could be patented.[138] Taken together, these theoretical and legislative changes helped create an environment that supported the widespread patenting of basic research. Nanotechnology is the first technology to emerge into this environment.

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## 4. ANTICOMMONS THEORY

THIS PART WILL FIRST PROVIDE AN OVERVIEW of anticommons theory. Second, it will argue that it is appropriate to use anticommons theory to critique the development-oriented approach.

### *4.1. Overview of Anticommons Theory*

Heller and Eisenberg describe anticommons property as the mirror image

130. Rai, "Regulating Scientific Research," *supra* note 12 at p. 97; *Bayh-Dole Act*, *supra* note 17 at s. 200.
131. Rai, "Regulating Scientific Research," *supra* note 12 at p. 109.
132. Rai, "Regulating Scientific Research," *supra* note 12 at p. 109.
133. Lemley, "Patenting Nanotechnology," *supra* note 10 at p. 617.
134. Rai, "Regulating Scientific Research," *supra* note 12 at p. 110.
135. Rai, "Regulating Scientific Research," *supra* note 12 at p. 103.
136. Rai, "Regulating Scientific Research," *supra* note 12 at p. 103.
137. Rai, "Regulating Scientific Research," *supra* note 12 at p. 99.
138. Rai, "Regulating Scientific Research," *supra* note 12 at pp. 100–107. See *Brana*, *supra* note 19; *Deuel*, *supra* note 19; *State Street Bank & Trust Co. v Signature Financial Group* (USA Fed Cir, 1998), <*http://cyber.law.harvard.edu/property00/patents/StateStreet.html*>, 149 *Federal Reporter 3d ser.* 1368, at p. 1372, where the Federal Circuit took the position that mathematical algorithms are patentable provided they produce a "useful" result.

of commons property.[139] In commons property, "owners hold rights not to be excluded" from a scarce resource.[140] This situation can lead to overexploitation of the resource, referred to by Hardin and others as a tragedy of the commons.[141] Two canonical examples of the tragedy of the commons are overgrazed fields and depleted lakes. The conventional solution to the tragedy of the commons is the privatization of the resource.[142]

Privatization, however, though solving the tragedy of the commons, can cause another tragedy, that of the anticommons.[143] Heller notes that though the tragedy of the commons metaphor reveals the cost of overuse when many people are given rights to use a scarce resource, it "overlooks the possibility of underuse when governments give too many people rights to exclude others."[144] The latter situation describes an anticommons, a situation where "too many individuals have rights of exclusion in a scarce resource."[145] The scarce resource can be utilized only after all of these rights of exclusion have been bundled together.[146]

An anticommons problem can arise horizontally, vertically, or through a patent thicket.[147] An anticommons problem arises horizontally when a person has to secure licenses to concurrent fragments of rights in order to use a single resource.[148] One example of a horizontal anticommons is described in Heller's "The Tragedy of the Anticommons," namely "empty Moscow storefronts."[149] If one wishes to set up shop, one must secure the consent of all individual rightholders, including those individuals endowed with the right to sell, receive sale revenue, lease, receive lease revenue, occupy, and determine use. [150] If these concurrent rights cannot be assembled, the anticommons will turn tragic and the storefront will go underused. Another example of a horizontal anticommons can be found in basic biomedical research, where individuals must assemble multiple gene fragments held by different patentees in order to create a commercial product.[151] The tragedy of the anticommons arises vertically when there are "too many upstream patent owners [stacking] licenses on top of the future discoveries of downstream use."[152] One situation in which this tragedy occurs is where companies attempt to integrate patents on basic scientific research with those on downstream innovations.[153] Lastly, Siva Vaidhyanathan notes that "one acutely pernicious form of the anti-commons problem is a 'patent thicket.'"[154] The concept of a "patent thicket," developed by economist Carl Shapiro, refers to overlapping spheres of intellectual property rights that a company must "hack

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139. Heller, "The Tragedy of the Anticommons," *supra* note 20 at p. 622.
140. Heller, "The Tragedy of the Anticommons," *supra* note 20 at p. 672.
141. Heller, "The Tragedy of the Anticommons," *supra* note 20 at p. 624.
142. Heller and Eisenberg, "Can Patents Deter Innovation?" *supra* note 20 at p. 698.
143. Heller and Eisenberg, "Can Patents Deter Innovation?" *supra* note 20 at p. 698.
144. Heller and Eisenberg, "Can Patents Deter Innovation?" *supra* note 20 at p. 698.
145. Heller, "The Tragedy of the Anticommons," *supra* note 20 at p. 677.
146. Heller and Eisenberg, "Can Patents Deter Innovation?" *supra* note 20 at p. 698.
147. Burk and Lemley, "Policy Levers in Patent Law," *supra* note 13 at p. 1612; Heller and Eisenberg, "Can Patents Deter Innovation?" *supra* note 20 at p. 699.
148. Heller and Eisenberg, "Can Patents Deter Innovation?" *supra* note 20 at p. 699.
149. Heller, "The Tragedy of the Anticommons," *supra* note 20 at p. 622.
150. Heller, "The Tragedy of the Anticommons," *supra* note 20 at p. 623.
151. Heller and Eisenberg, "Can Patents Deter Innovation?" *supra* note 20 at p. 699.
152. Heller and Eisenberg, "Can Patents Deter Innovation?" *supra* note 20 at p. 699.
153. Burk and Lemley, "Policy Levers in Patent Law," *supra* note 13 at pp. 1612–1613.
154. Siva Vaidhyanathan, "Nanotechnology and the Law of Patents: A Collision Course," in Geoffrey Hunt and Michael Mehta, eds., *Nanotechnology: Risk, Ethics and Law* (Earthscan, 2006) 20 <http://papers.ssrn.com/sol3/papers.cfm?abstract_id=740550>.

its way through" in order to commercialize a new product.[155] Patent thickets are considered to "discourage and stifle innovation."[156]

The anticommons will not necessarily become tragic.[157] If there are no transaction costs or holdouts, "owners may keep property in anticommons form and perfectly coordinate its use so its performance mimics that of private property."[158] Transaction costs and strategic behaviour, however, can sometimes prevent the assembly of the necessary rights.[159] As Heller notes, "once an anticommons emerges, collecting rights into usable private property bundles can be brutal and uneven."[160] With respect to transaction costs, it can be difficult and expensive to determine exactly which rights are needed in order to develop the resource.[161] Furthermore, certain patent holders may decide to act strategically as holdouts, refusing to license their patent unless they are paid a sum in excess of the value of their patent (and in certain cases a "bribe close to the value of the entire project"[162]). Burk and Lemley note that "every property holder needed for the project is subject to this same incentive."[163] The holdout problem is accentuated in the case of an anticommons at the level of basic research, in which case the "value" of a resource itself is sometimes difficult to determine with any accuracy.[164] The "tragedy" of the anticommons occurs where individuals are unable to assemble the fragmented or overlapping rights, causing the resource to be underused.

### *4.2. It is Appropriate to Use Anticommons Theory to Challenge Development-Oriented Theorists' Commitment to Patenting Basic Scientific Research*

The theoretical foundations of the development-oriented approach are the metaphor of the tragedy of the commons and the hypothetical Coasean world with zero transaction costs. Anticommons theory engages with both of these theoretical issues. As a result, it is appropriate to use anticommons theory to challenge development-oriented theorists' belief that patenting basic research will necessarily lead to its efficient development and commercialization.

Development-oriented theorists rely on the "tragedy of the commons" principle. They argue that early patenting of scientific prospects will overcome the "tragedy of the commons" in scientific research by eliminating "wasteful" duplicative investment, thus promoting the efficient development and commercialization of research. Anticommons theorists also engage with the "tragedy of the commons" principle. They argue that in certain circumstances,

155. Carl Shapiro, "Navigating the Patent Thicket: Cross Licenses, Patent Pools and Standard Setting," in Adam Jaffe, Joshua Lerner, and Scott Stern, eds., *Innovation Policy and the Economy* (MIT Press, 2001) 119–150, <http://faculty.haas.berkeley.edu/shapiro/thicket.pdf> at pp. 119–120; Raj Bawa, "Will the Nanomedicine 'Patent Land Grab' Thwart Commercialization?" (2005) 1:4 *Nanomedicine: Nanotechnology, Biology, and Medicine* 346–350 at p. 348.
156. Bawa, "Will the Nanomedicine 'Patent Land Grab' Thwart Commercialization?" *supra* note 155 at p. 348; Shapiro, "Navigating the Patent Thicket," *supra* note 155 at p. 119.
157. Heller, "The Tragedy of the Anticommons," *supra* note 20 at p. 673.
158. Heller, "The Tragedy of the Anticommons," *supra* note 20 at p. 673.
159. Heller, "The Tragedy of the Anticommons," *supra* note 20 at pp. 673–674; Burk and Lemley, "Policy Levers in Patent Law," *supra* note 13 at p. 1611.
160. Heller and Eisenberg, "Can Patents Deter Innovation?" *supra* note 20 at p. 698; Heller, "The Tragedy of the Anticommons," *supra* note 20 at p. 678.
161. Heller, "The Tragedy of the Anticommons," *supra* note 20 at p. 673.
162. Burk and Lemley, "Policy Levers in Patent Law," *supra* note 13 at p. 1611.
163. Burk and Lemley, "Policy Levers in Patent Law," *supra* note 13 at pp. 1611–1612.
164. Heller and Eisenberg, "Can Patents Deter Innovation?" *supra* note 20 at p. 699.

the attempt to overcome the tragedy of the commons by granting property rights in a scarce resource can cause another tragedy, that of the anticommons. Thus, rather than facilitating the efficient development and commercialization of research, the attempt to remedy the tragedy of the commons by patenting basic scientific research may, in fact, stifle innovation. Due to the connection between the tragedy of the commons and the tragedy of the anticommons, it is appropriate to use anticommons theory to challenge the assumption held by development-oriented theorists that broad patenting of basic research will necessarily lead to the efficient development and commercialization of research.

Development-oriented theorists argue that granting broad patent rights on basic research will not be problematic, as parties will be able to license patents efficiently. This argument is premised on the existence of the hypothetical Coasean world with zero transaction costs.[165] Anticommons theory, on the other hand, emphasizes the transaction costs and strategic behaviours absent in the hypothetical Coasean world. While development-oriented theorists assume that transaction costs are non-existent, anticommons theorists call attention to the difficulties in assembling fragmented and overlapping property rights. Due to their conflicting views on the importance of transaction and strategic costs, it is appropriate to use anticommons theory to challenge the assumption, held by development-oriented theorists, that parties will be able to license patents efficiently.

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## 5. THE NANOTECHNOLOGY ANTICOMMONS IN THE US

### *5.1. The Nanotechnology Patent "Gold Rush"*

MAJOR PATENT OFFICES WORLDWIDE ARE GRANTING nanotech patents at an extraordinary pace.[166] Lux Research, a company that provides market intelligence and strategic advice on the physical sciences, has described the race for nanotechnology patents as a "gold rush" involving the world's largest transnationals, leading university labs, and nanotech start-ups, where "patents are the precious resource being hoarded."[167] This gold rush has primarily been directed at nanomaterials, nanotechnology's building blocks.[168] Many companies have obtained patents that fence off large areas of basic research in nanomaterials. They have done so in order to secure a controlling position in nanotechnology.

165. Burk and Lemley, "Policy Levers in Patent Law," *supra* note 13 at p. 1600.
166. Lux Research, "Nanotechnology Gold Rush," *supra* note 7 at p. 1; Lemley, "Patenting Nanotechnology," *supra* note 10 at p. 601. David S Almeling notes that between 1997 and 2002, the number of nanotechnology patents increased 600%, from 370 to 2,650. David S Almeling, "Patenting Nanotechnology: Problems with the Utility Requirement," (December 2004) 2004 *Stanford Technology Law Review* N1, <http://stlr.stanford.edu/STLR/Articles/04_STLR_N1/fsarticle.htm> at para. 2, citing Henry M Heines, "Patent Trends in Nanotechnology," (September 2003) 99:9 *Chemical Engineering Progress* 22.
167. Lux Research, "Nanotechnology Gold Rush," *supra* note 7 at p. 1.
168. Lux Research, "Nanotechnology Gold Rush," *supra* note 7 at p. 1.

### *5.2. The Nanotechnology Gold Rush has Resulted in the Creation of an Anticommons in Nanomaterials in the US*[169]

Studies suggest that the nanotechnology gold rush has resulted in the creation of an anticommons in nanomaterials in the US.[170] An anticommons is defined as a situation in which multiple exclusionary rights exist in a scarce resource. Due to the presence of multiple exclusionary rights, no one has an effective privilege of use in the scarce resource. The nanomaterials patent landscape is characterized by the presence of multiple exclusionary rights. The patent landscape in nanomaterials is "complex and fragmented."[171] The nanotechnology "gold rush" has resulted in the issuance of "broad and over-lapping claims" and the creation of a "somewhat chaotic" nanotechnology patent landscape, especially for nanomaterials.[172] One cannot use a nanomaterial without first securing licenses to all of the fragmented and overlapping patent claims on that nanomaterial.[173]

In nanotechnology, anticommons likely exist horizontally, vertically, and through patent thickets. Horizontal anticommons have been created in two main ways. First, persons wishing to use a nanomaterial must assemble all of the fragmented and overlapping rights with respect to that nanomaterial. Second, persons wishing to use a variety of nanomaterials to construct a nanostructure must attempt to secure licenses for all of the nanomaterials involved. Vertical anticommons are likely to exist due to the fact that the nanotechnology anticommons occurs at the building block level. As a result, patent holders will likely attempt to stack licenses on future downstream discoveries. Lastly, patent thickets have developed in nanomaterials. Many of the patents that have been issued for nanomaterials are broad and overlapping. The ETC Group notes that patent thickets at the level of "fundamental nano-scale materials […] are already creating thorny barriers for would-be innovators."[174]

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169. The following analysis is based primarily on the results of a Lux Research report, supplemented by other sources where appropriate (Lux Research, "Nanotechnology Gold Rush," *supra* note 7). The Lux report was based on a comprehensive review of 1,084 US patents (representing 19,485 claims) that relate to five nanomaterials (dendrimers, quantum dots, carbon nanotubes, fullerenes, and nanowires). Ruben Serrato describes the methodology used in this report to compile and categorize patents as "superb," and states that "the authors do an outstanding job of collecting accurate data and identifying general trends in nanotech patents." Serrato, describing the methodology of the report, states that "the authors carefully searched patents with synonyms for the platform name as well as key inventors for each patent by individual and company. Additionally, the team carefully reviewed the claims of each patent to ensure its relevance. The patents were then classified by type: (1) building block; (2) product; (3) process of manufacture; and (4) method of use—and by application category: (1) general; (2) structural materials; (3) energy; (4) optics; (5) electronics; (6) healthcare and cosmetics; and (7) other. After categorizing a patent's individual claims, they assigned the patent itself to the category containing the greatest number of its constituent claims. After classifying the claims, they ran statistics to score patents for each nanomaterial platform in each application category on two axes: "white space," comprising four metrics, and "freedom from entanglement," comprising seven metrics." Serrato notes that "[t]his report can serve as an effective tool for those involved in analyzing the patent landscape and identifying the key patents and patent holders. CEOs, technical staff, lawyers and investors now have a quick and effective way to review patent landscapes." Ruben Serrato, Kirk Hermann and Chris Douglas, "The Nanotech Intellectual Property ("IP") Landscape," (2005) 2:2 *Nanotechnology Law & Business* 2–6, <http://www.foley.com/files/tbl_s31Publications/FileUpload137/2721/viewcontent.pdf> at p. 2.
170. Lux Research, "Nanotechnology Gold Rush," *supra* note 7; Miller *et al.*, *The Handbook of Nanotechnology*, *supra* note 9.
171. Lux Research, "Nanotechnology Gold Rush," *supra* note 7 at p. 1; Lemley notes that "risks of a patent thicket may be exacerbated by the application of pre-nanotechnology patents to nanotech inventions." Lemley, "Patenting Nanotechnology,"*supra* note 10 at pp. 620–621.
172. Miller *et al.*, *The Handbook of Nanotechnology*, *supra* note 9 at p. 65.
173. Lux Research, "Nanotechnology Gold Rush," *supra* note 7 at p. 1.
174. ETC Group, "Nanotech's 'Second Nature' Patents" (ETC Group, June 2005), <http://www.etcgroup.org/upload/publication/pdf_file/54 at p. 5.

### *5.3. Consequences of the Tragedy of the Anticommons in Nanotechnology*

If potential users cannot assemble the fragmented and overlapping nanomaterials patents into usable bundles, the nanotechnology industry could experience significant slowdowns.[175] These could occur in four ways. First, faced with licensing roadblocks, companies could choose to engage in protracted litigation in order to overcome the nanotechnology anticommons.[176] The nanotechnology industry could stagnate as funds are diverted towards court battles instead of research and development. Second, the number of overlapping and fragmented patents on nanotechnology's building blocks could act as a deterrent to new investment. This deterrent could "severely [limit…] the potential commercial impact of nanotechnology."[177] In the context of nanomedicine, one commentator notes that:

> if such a dismal patent climate persists, investors are unlikely to invest in risky nanomedicine commercialization efforts. For them, competing in this high-stakes patent game may prove to be too costly.[178]

Such companies may choose to invest their resources elsewhere, avoiding the nanotechnology anticommons altogether. Third, anticipating industry slowdowns, companies could choose to disengage from the nanotechnology industry, withdrawing their capital and investing in other areas. Fourth, public funding in nanotechnology could decrease as a result of the tragedy of the anticommons in nanotechnology, as the US government may not wish to fund a stagnating industry.

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## 6. USING INFORMAL MARKET MECHANISMS TO OVERCOME THE ANTICOMMONS

THE MERE PRESENCE OF AN ANTICOMMONS will not necessarily prevent the efficient development and commercialization of nanomaterials.[179] If parties license their technology widely, the fragmented, overlapping patent landscape "will not stifle development of products based on nanotechnology."[180] Assuming that there are no transaction costs or holdouts, "owners may keep property in anticommons form and perfectly coordinate its use so its performance mimics

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175. The ETC Group warns that intellectual property roadblocks could "severely retard development of nanotechnology." Miller *et al*, *supra* note 9 at p. 65. In 2002, the US-based industry trade group, Nanotechnology Business Alliance, warned in testimony before the US Congress that "several early nanotech patents are given such broad coverage, the industry is potentially in real danger of experiencing unnecessary legal slowdowns." ETC, "Second Nature," *supra* note 174 at p. 6. Vaidhyanathan also discusses the potential for the nanotechnology anticommons to have a "severe chilling effect on innovation." Vaidhyanathan, "Nanotechnology and the Law of Patents," *supra* note 154 at p. 20.
176. Products are not yet at the stage of commercial application, so the battles are not yet being fought. However, once products do reach the stage of commercial application, according to Matthew Nordan, vice-president of research at Lux Research, "[t]he fights are going to be brutal." ETC, "Second Nature," *supra* note 174 at p. 10.
177. Matsuura, *Nanotechnology Regulation and Policy Worldwide*, *supra* note 49 at p. 71.
178. Bawa, "Will the Nanomedicine 'Patent Land Grab' Thwart Commercialization?" *supra* note 155 at p. 349.
179. Heller, "The Tragedy of the Anticommons," *supra* note 20 at p. 673.
180. Heller, "The Tragedy of the Anticommons," *supra* note 20 at p. 673.

that of private property."[181] There are a variety of informal mechanisms through which individuals can attempt to coordinate the use of anticommons property, including cross-licensing agreements, patent pools, acquisitions and exits, and informal norms.[182] These informal mechanisms have been successful in resolving anticommons situations in other industries (for instance, the semiconductor, automobile, aircraft manufacturing, and synthetic rubber industries).[183]

There are reasons to fear, however, that an anticommons will prove more difficult to overcome in the nanotechnology industry. In nanotechnology, transaction and strategic costs will prove to be a substantial impediment to the achievement of informal agreements between parties. Due to transaction and strategic costs, alternative arrangements such as cross-licensing and patent pools are unlikely to emerge.[184]

Transaction costs, specifically the costs associated with determining with whom one must negotiate in order to acquire the rights to a resource, will be a significant expense for any party seeking to bundle patents in the nanotechnology anticommons. These costs will be particularly high due to the fact that in an anticommons situation, the patent rights to a resource may be overlapping or fragmented between multiple parties. In a situation where patent rights overlap between two parties, persons seeking licenses could choose to negotiate licenses with both parties, knowing that one license will later prove to be unnecessary after patent litigation addresses the overlap. Alternatively, persons seeking licenses could attempt to discern which patent will later be invalidated, negotiating only with the party that they believe will be ultimately successful. The former route is unnecessarily costly. The latter route is risky. If the person wishing to license evaluates the patents incorrectly, they could face a patent infringement lawsuit.

The question of with whom one must negotiate is further complicated in the case of nanotechnology by the fact that many patents on nanomaterials encompass basic research. The scope of these patents may be unclear, making it difficult to determine exactly which party possesses rights to the resource. Furthermore, as nanotechnology is an emerging field, terminology used to describe various aspects of the underlying science may be ambiguous, conflicting, or varied. Difficulties with terminology may make it more problematic to determine exactly with whom one must negotiate, as keyword searches of a patent database may not reveal all of the patents covering a given resource.

In addition to transaction costs, three types of bargaining failures are likely to impede the achievement of informal licensing agreements for nanotechnology patents. First, the nanotechnology industry is not structured in such a way as to facilitate informal licensing agreements. Miller states that informal licensing arrangements are:

> most likely to arise when horizontal competitors who share similar values and are engaged in repeat-play transactions each hold roughly similar portfolios of blocking patents.[185]

181. Heller, "The Tragedy of the Anticommons," *supra* note 20 at p. 673.
182. Shapiro, "Navigating the Patent Thicket," *supra* note 155.
183. Heller and Eisenberg, "Can Patents Deter Innovation?" *supra* note 20 at p. 700.
184. Miller *et al*, *The Handbook of Nanotechnology*, *supra* note 9 at p. 71.
185. Miller *et al.*, *The Handbook of Nanotechnology*, *supra* note 9 at p. 76.

This describes the semiconductor industry, where informal agreements have been successful. It does not, however, describe the nanotechnology industry, which is characterized by parties with different sizes and agendas, operating across a variety of industries.[186] Parties possessing nanotechnology patents may not be competitors, could be engaged in one-off transactions, and hold different intellectual property portfolios. It is likely that complications arising from the structure of the nanotechnology industry will "doom private efforts to establish pooling arrangements" in nanotechnology.[187]

Second, the fact that many nanotechnology patents encompass basic scientific research increases the likelihood of bargaining failure. First, companies may wish to preserve the strategic position of their pioneering patent. Second, difficulties in patenting around nanomaterials patents may cause patentees to hold out for greater licensing fees. Third, valuation difficulties with respect to basic research patents may make it more difficult for companies to achieve informal licensing agreements. All three difficulties are accentuated by nanotechnology's cross-industry structure.

Third, the shift in scientific norms, from "communalism" to "commercialism," that occurred following the passage of the *Bayh-Dole Act* suggests that patent holders will be more likely to grant exclusive licenses rather than broad, non-exclusive licenses. Lemley notes that "the royalty rates for exclusive licenses are significantly higher than the rates for non-exclusive licenses."[188] Exclusive licenses are generally incompatible with informal licensing arrangements such as cross-licensing agreements between multiple parties or patent pools. The ETC group notes that between 2003 and 2005, twenty nanotechnology licenses were publicly announced by universities.[189] Of these licenses, "at least nineteen and perhaps all twenty were exclusive."[190]

Development-oriented theorists argued that patenting basic scientific research will lead to its efficient development and commercialization. An analysis of the nanotechnology patent landscape has suggested that patenting basic scientific research in nanotechnology has led to a nanotechnology anticommons. Though the mere presence of this anticommons does not preclude the efficient development and commercialization of nanotechnology research, an analysis of the transaction and strategic costs associated with participation in the nanotechnology industry indicates that it is likely that rightsholders and prospective patentees will be unable to bundle the multiple exclusionary rights through informal agreements. As a result, unless the nanotechnology anticommons can be overcome through non-market routes, it is likely that the nanotechnology anticommons will turn tragic, causing slowdowns in innovation.

A significant disparity thus exists between the assumptions of the development-oriented approach and the reality of the nanotechnology patent landscape. The disparity between theory and reality, in the case of nanotechnology, is caused by the failure of the development-oriented approach to account for the

186. Miller *et al.*, *The Handbook of Nanotechnology*, *supra* note 9 at p. 76.
187. Miller *et al.*, *The Handbook of Nanotechnology*, *supra* note 9 at p. 81.
188. Lemley, "Patenting Nanotechnology," *supra* note 10 at pp. 626–627.
189. ETC, "Second Nature," *supra* note 174 at p. 14, cited in Lemley, "Patenting Nanotechnology," *supra* note 10 at p. 627.
190. Lemley, "Patenting Nanotechnology," *supra* note 10 at p. 627, citing ETC, "Second Nature," *supra* note 174 at p. 14.

transaction and strategic costs involved in licensing nanomaterials patents. Kitch himself, in a more recent work, states that the "failure to consider the importance of licensing, transfer, and other transactions by which intellectual property rights are shared" is an "elementary and persistent" error in the economic analysis of intellectual property.[191] He states that:

> the ability of the owners of intellectual property rights to transfer these rights in whole or in part to others is an important feature of the systems. The rights can easily arise in the hands of persons or firms who are not in the best position to exploit them. In order to involve others in the full exploitation of the economic potential of the right, the owners must be able to enter into a wide range of arrangements with other firms.[192]

In nanotechnology, the full exploitation of the economic potential of nanomaterials is limited by the inability (and, in certain situations, unwillingness) of owners to enter into arrangements with other firms. In this article, I am not taking the position that the development-oriented approach should be abandoned. Where licensing costs are not an issue, early patenting may lead to the efficient development and commercialization of research. In the case of nanotechnology, however, unless non-market routes are successful at bundling the anticommons, broad patenting of basic research in nanotechnology is likely to hinder the development and commercialization of nanomaterials.

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## 7. USING NON-MARKET SOLUTIONS TO OVERCOME THE ANTICOMMONS

THE SECOND MAIN WAY TO OVERCOME THE ANTICOMMONS is through legislative or judicial intervention to redefine, remove, or reallocate property rights.[193] These forms of intervention will be grouped under the heading "non-market solutions." There are a variety of non-market solutions that can be adopted to overcome the tragedy of the anticommons in nanotechnology in the US. These solutions include Barzel's grant/auction approach, compulsory licensing, compelling licensing under the *Bayh-Dole Act*, the formation of a government-sponsored patent pool, the creation of a broad experimental use exception, and a modification of the utility requirement. In this Part, I will focus on one non-market solution to the problems posed by the tragedy of the anticommons in nanotechnology in the US, namely the adoption of a strict utility requirement.

### *7.1. Adoption of a Strict Utility Requirement*

This section will proceed in three parts. First, it will describe the utility requirement as it has been interpreted in US law. In the context of scientific research, the utility requirement has fluctuated between a weak and a strict utility requirement.

191. Edmund W Kitch, "Elementary and Persistent Errors in the Economic Analysis of Intellectual Property," (2000) 53:6 *Vanderbilt Law Review* 1727–1741 at p. 1739.
192. Kitch, "Elementary and Persistent Errors," *supra* note 191 at p. 1740.
193. Heller, "The Tragedy of the Anticommons," *supra* note 20 at p. 641.

Second, this section will argue that the adoption of a strict utility requirement is particularly suited as a solution to the problems posed by the tragedy of the anticommons in nanotechnology. I will also demonstrate the effect that a strict utility requirement would have on the nanotechnology anticommons in the US. Third, this section will argue that US courts are likely to adopt a strict utility requirement for nanotechnology inventions over a weak utility requirement.

#### 7.1.1. The Utility Requirement in US Law

The utility requirement is one of the essential requirements of patentability. It stipulates that an individual may patent only "useful" inventions. In the US, the utility requirement is grounded in the constitutional limitation of patent protection to the "useful arts."[194] The utility requirement has had a central place in US patent legislation since the first patent law in 1790.[195] It is currently dealt with in Chapter 10, Title 35 of the US Code, section 101, where it is stated that:

> whoever invents or discovers any new and *useful* process, machine, manufacture, or composition of matter, or any new and useful improvement thereof, may obtain a patent therefor, subject to the conditions and requirements of this title.[196]

In the US, utility is generally not an issue when dealing with the patentability of mechanical inventions.[197] However, utility has reemerged as a controversial issue in US patent law in fields involving scientific research.[198] In the context of scientific research, the utility requirement in the US has fluctuated between two standards, a weak utility requirement and a strict utility requirement. Each standard is supported by a line of precedents and by a theory of intellectual property law. The first standard represents a weak utility requirement.

##### *7.1.1.1. Weak Utility Requirement*

Echoing the arguments of prospect theory and the development-oriented approach, individuals advocating for a weak utility requirement argue that patents should be granted early in the research process in order to provide an "incentive for private firms to undertake the further investment necessary to translate the inventions into marketable products."[199] Thus, although the invention may not demonstrate any practical utility, patents should be granted in order to ensure that persons will continue to develop the research prospect. To advocates of a weak utility requirement, granting patents in basic research is the most efficient way to develop and commercialize research. Consistent with prospect theory, licensing concerns do not appear to be an issue to advocates of the weak utility requirement.

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194. *Brenner v Manson*, (USA SC, 1966), <http://supreme.vlex.com/vid/brenner-v-manson-19992706>, 383 *United States Reports* 519 [*Brenner* cited to *United States Reports*].
195. *Brenner*, *supra* note 194 at p. 529.
196. *Patent Act* (USA), "Inventions Patentable," (1996) 35 *United States Code* sec. 101 (emphasis added), <http://www.uspto.gov/web/offices/pac/mpep/documents/appxl_35_U_S_C_101.htm#usc35s101>.
197. Georgios I Zekos, "Utility and Biotechnology Patenting," (2006) 5 *Web Journal of Current Legal Issues*, <http://webjcli.ncl.ac.uk/2006/issue5/zekos5.html>.
198. Zekos, "Utility and Biotechnology Patenting," *supra* note 197.
199. Rai, "Regulating Scientific Research," *supra* note 12 at p. 96.

The historical origin of the weak utility requirement is found in Justice Story's judgment in *Lowell v Lewis*, an 1817 decision of the District Circuit Court of Massachusetts.[200] In this decision, Justice Story adopts a de minimis view of the utility requirement, stating that a useful invention is one "which may be applied to a beneficial use in society, in contradistinction to an invention injurious to the morals, health, or good order of society, or frivolous and insignificant."[201] In the broadest sense of this definition, "little or nothing is wholly beyond the pale of 'utility.'"[202] In *Lowell*, Justice Story was not contemplating the utility requirement as it applies to scientific research. Rather, *Lowell* dealt with a purported improvement of a pump invention. Even though Justice Story was not contemplating scientific research when he set out his view of the utility requirement, however, advocates of early patentability of scientific research have continued to cite Justice Story's de minimis view of the utility requirement as support for their position.[203] They have done so on the basis that it provides an established judicial precedent for development-oriented theory's contention that patents should be granted at an early phase in the research process.

*7.1.1.2. Strict Utility Requirement*

The second standard represents a strict utility requirement. Advocates of a strict utility requirement take a less optimistic view of the ability of patents to support innovation. While recognizing the need to provide incentives for research, they state that in certain circumstances, granting patents for basic research will stifle rather than support innovation. Patents can stifle innovation in two main ways. First, a broad patent encompassing basic research may allow a company to block off an entire area of scientific development. Second, granting patents for basic research may result in the creation of an anticommons. If individuals are unable to bundle the multiple exclusionary rights in the anticommons, innovation may be stifled. As a result, in order to guard against those situations where patent protection stifles rather than supports innovation, advocates of a strict utility requirement argue for more limited patent protection.

*Brenner v Manson* is the representative case for the strict utility model.[204] It "represents the high-water mark" of the strict utility requirement.[205] It is also the leading United States Supreme Court decision on utility. *Brenner* addresses the applicants' patent application for an "allegedly novel process for making certain known steroids."[206] Three years after the applicants' patent application, the respondent Manson filed an application to patent the same process, asserting that he had discovered the process and claiming an earlier filing date than that of the applicants.[207] A Patent Office examiner denied Manson's application on the grounds that it failed to disclose any utility for

200. *Lowell v Lewis* (USA Cir Ct Mass, 1817), 15 *Federal Cases* 1018.
201. *Lowell*, *supra* note 200, cited in *Brenner supra* note 194 at p. 533.
202. *Brenner*, *supra* note 194 at p. 530.
203. *Lowell* is cited in decisions addressing the utility of scientific research up to and including the most recent decision by CAFC on the utility requirement: *In re Fisher* (USA Fed Cir, 2005), <http://www.cafc.uscourts.gov/opinions/04-1465.pdf>, 421 *Federal Reporter 3d ser.* 1365.
204. *Brenner*, *supra* note 194 at p. 520.
205. Robert P Merges, Peter S Menell and Mark A Lemley, *Intellectual Property in the New Technological Age*, 3d ed. (Aspen, 2003) at p. 141; Almeling, "Patenting Nanotechnology," *supra* note 166 at para. 20.
206. *Brenner*, *supra* note 194 at p. 519.
207. *Brenner*, *supra* note 194 at pp. 520–521.

the chemical compound produced by the process.[208] This denial was affirmed by the Board of Appeals within the Patent Office, but was later reversed by the Court of Customs and Patent Appeals (CCPA) on the basis that the utility requirement applied by the examiner was too strict. Instead, the CCPA applied Justice Story's de minimis view of the utility requirement.

The CCPA's decision was reversed by the US Supreme Court, which rejected Justice Story's view of the utility requirement.[209] According to Justice Fortas (who delivered the opinion of the Court), Justice Story's view "sheds little light on our subject."[210] A narrow reading of Justice Story's view forces the adjudicator into determining whether the invention is "frivolous and insignificant."[211] Justice Fortas states that this term gives no more guidance than the term "useful" itself.[212] Justice Fortas also notes that a broad reading of Justice Story's view would allow the patenting "of any invention not positively harmful to society."[213] This interpretation of "useful" would strip the standard of any meaning, as virtually all inventions would satisfy this utility requirement. Justice Fortas states, correctly, that such an interpretation cannot be accepted in the "absence of evidence that Congress so intended."[214]

Justice Fortas further states that one of the purposes of the patent system is to "encourage dissemination of information concerning discoveries and inventions," and recognizes that a strict utility requirement would "to some extent [discourage] disclosure and [lead] to greater secrecy than would otherwise be the case."[215] Demonstrating a certain cynicism towards patentees, however, Justice Fortas takes the position that the benefits flowing from early patenting with respect to the increased dissemination of information are more exaggerated than real.[216] He notes that patentees frequently attempt to disclose as little useful information as possible while broadening the scope of their claim as widely as possible.[217] In a similar manner, the Court takes a skeptical view of the importance of patents in reducing secrecy, stating that if a process inventor cannot discern a product, he has "every incentive to make his invention known to those able to do so."[218]

Having minimized the potential positive effects of early patenting, Justice Fortas takes the position that a "more compelling consideration" is the negative impact of early patenting on scientific development.[219] According to the Court, granting patents before a process or product has been developed to a degree of specific and substantial utility "creates a monopoly of knowledge" which "may engross a vast, unknown, and perhaps unknowable area."[220] The Court states that "[s]uch a patent may confer power to block off whole areas of scientific development, without compensating benefit to the public," and should

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208. *Brenner*, *supra* note 194 at p. 521.
209. *Brenner*, *supra* note 194.
210. *Brenner*, *supra* note 194 at p. 533.
211. *Brenner*, *supra* note 194 at p. 533.
212. *Brenner*, *supra* note 194 at p. 533.
213. *Brenner*, *supra* note 194 at p. 533.
214. *Brenner*, *supra* note 194 at p. 533.
215. *Brenner*, *supra* note 194 at p. 533.
216. *Brenner*, *supra* note 194 at p. 534.
217. *Brenner*, *supra* note 194 at p. 534.
218. *Brenner*, *supra* note 194 at p. 534.
219. *Brenner*, *supra* note 194 at p. 534.
220. *Brenner*, *supra* note 194 at p. 534.

be granted "only if clearly commanded by the statute."[221]

While affirming the value of contributions short of something "useful" to "the fund of scientific information," Justice Fortas rejects the idea that a patent should be used to reward such a contribution.[222] In an oft-quoted passage, Justice Fortas states that:

> a patent is not a hunting license. It is not a reward for the search, but compensation for its successful conclusion. [A] patent system must be related to the world of commerce rather than the realm of philosophy.[223]

The phrase "world of commerce" seems to imply that patents should not be granted until the invention reaches the point of commercial applicability. Both the reference to a patent as compensation for a "successful conclusion" and the rejection of the concept of a patent as a "reward for the search" imply that patents should not be granted until the end of the research process.

Both *In re Joly* and *In re Kirk*, decided the year after *Brenner*, affirmed *Brenner* in adopting a strict utility requirement.[224] Dissenting judges in both cases, however, continued to advocate for a weak utility requirement based on concerns that denying patent protection will harm future research and innovation. After *Kirk* and *Joly*, the CCPA permitted the weak utility requirement to reemerge as the dominant view of the utility requirement in US patent law.[225] It did so in part as a response to the concerns of researchers that patent protection is necessary in order to progress efficiently from research to products ready for commercialization.[226]

The high-water mark of the weak utility requirement in the modern era occurred in 1995, with the decision of the CAFC in *In re Brana* and the passage of the 1995 *USPTO Utility Examination Guidelines*.[227] In *Brana*, the CAFC noted that "usefulness in patent law, and in particular in the context of pharmaceutical inventions, necessarily includes the expectation of further research and development."[228] In 1995, a set of *USPTO Utility Examination Guidelines* was released.[229] These guidelines are to be used by USPTO personnel in their review of patent applications for compliance with the "utility requirement."[230] These guidelines echoed *Brana* in adopting a weak standard of utility. According to the guidelines:

> if the applicant has asserted that the claimed invention is useful for any particular purpose (i.e., a "specific utility") and that assertion would be

221. *Brenner*, *supra* note 194 at p. 534.
222. *Brenner*, *supra* note 194 at p. 535.
223. *Brenner*, *supra* note 194 at p. 536.
224. *In re Joly* (USA CCPA, 1967) 376 *Federal Reporter 2d ser.* 906, 153 *United States Patents Quarterly* 45; *In re Kirk* (USA CCPA, 1967) 376 *Federal Reporter 2d ser.* 936, 153 *United States Patents Quarterly* 48.
225. Salim A Hasan, "A Call for Reconsideration of the Strict Utility requirement in Chemical Patent Practice," (1994) 9:2 *High Technology Law Journal* 245–290, <http://www.law.berkeley.edu/journals/btlj/articles/vol9/Hasan.pdf>.
226. Hasan, "A Call for Reconsideration," *supra* note 225.
227. *Brana*, *supra* note 19; Patent and Trademark Office (USA), *Utility Examination Guidelines* (Patent and Trademark Office, 1995), <http://www.uspto.gov/go/og/1995/week34/patutil.htm> [*USPTO Utility Examination Guidelines 1995*].
228. *Brana*, *supra* note 19 at para. 1567.
229. *USPTO Utility Examination Guidelines 1995*, *supra* note 227.
230. *USPTO Utility Examination Guidelines 1995*, *supra* note 227.

> considered credible by a person of ordinary skill in the art, [an officer should not…] impose a rejection based on lack of utility.[231]

Following the decision in *Brana* and the issuance of the 1995 PTO guidelines, concerns began to grow regarding the negative effects of early patenting. One expression of these concerns is found in Heller and Eisenberg's work on anticommons theory, published in 1998.[232] The USPTO responded to concerns regarding the negative effects of patenting basic research on 5 January 2001, with the release of a new set of Utility Examination Guidelines.[233] These guidelines call for a more stringent utility requirement to be applied in patent decisions.[234] Incorporated into the Manual of Patent Examining Procedure, the 2001 guidelines state that in order for the utility requirement to be satisfied, there must be a "specific, substantial, [and] credible utility."[235] Specific utility is "particular to the subject matter claimed and would not be applicable to a broad class of invention."[236] The Utility Guidelines "explain that a substantial utility defines a 'real world' use."[237] The guidelines quote various statements from *Brenner*, including the statement that "a patent is not a hunting license. It is not a reward for the search, but compensation for its successful conclusion."[238]

*In re Fisher*, a 2005 CAFC decision, is the most recent decision of the CAFC to address the utility requirement.[239] *Fisher* reaffirms the strict utility requirement as established in *Brenner*, adopts the 2001 utility examination guidelines, and articulates definitions for "specific" and "substantial" utility. The claimed invention in *Fisher* relates to "five purified nucleic acid sequences that encode proteins and protein fragments in maize plants."[240] These claimed sequences are commonly referred to as "expressed sequence tags" or "ESTs."[241] ESTs have been described as representing:

> one discrete portion of a larger gene, and are most often marketed by biotechnology companies as tools for investigating parts of the genome that are active in producing proteins. Patents are often sought for ESTs before any function is known beyond their significance for further research.[242]

The examiner, finding that the claims were not supported by a specific and substantial utility, rejected them for lack of utility.[243] The Board affirmed the examiner's rejection of the application for lack of utility.[244] Asserting that

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231. *USPTO Utility Examination Guidelines 1995*, *supra* note 227 at s. IIB 2a.
232. Heller, "The Tragedy of the Anticommons," *supra* note 20; Heller and Eisenberg, "Can Patents Deter Innovation?" *supra* note 20; Miller *et al.*, *The Handbook of Nanotechnology*, *supra* note 9.
233. Patent and Trademark Office, *Utility Examination Guidelines* (Patent and Trademark Office, 2001), <http://www.uspto.gov/go/og/2001/week05/patutil.htm> [*USPTO Utility Examination Guidelines 2001*].
234. *USPTO Utility Examination Guidelines 2001*, *supra* note 233.
235. *USPTO Utility Examination Guidelines 2001*, *supra* note 233 at sec. I(1).
236. *Fisher*, *supra* note 203 at p. 1372; *USPTO Utility Examination Guidelines 2001*, *supra* note 233.
237. *Fisher*, *supra* note 203 at p. 1372; *USPTO Utility Examination Guidelines 2001*, *supra* note 233 at s. I(4).
238. *Brenner*, *supra* note 194 at p. 536; *USPTO Utility Examination Guidelines 2001*, *supra* note 233 at s. I(23).
239. *Fisher*, *supra* note 203.
240. *Fisher*, *supra* note 203 at p. 1367.
241. *Fisher*, *supra* note 203 at p. 1367.
242. Julian David Forman, "A Timing Perspective on the Utility Requirement in Biotechnology Patent Applications," (2002) 12 *Albany Law Journal of Science & Technology* 647–682 at p. 655.
243. *Fisher*, *supra* note 203 at p. 1368.
244. *Fisher*, *supra* note 203 at pp. 1368–1369.

the Board applied a heightened standard for utility in the case of ESTs, Fisher appealed to the CAFC, contending that section 101 demands a standard no higher than Justice Story's view of utility.[245]

In *Fisher*, the government was supported by various academic institutions and biotechnology and pharmaceutical companies, writing as amici curiae.[246] These groups "assert that Fisher's claimed uses are nothing more than a 'laundry list' of research plans."[247] They are general, speculative, and do not provide a "specific and substantial benefit in currently available form."[248]

As did the US Supreme Court in *Brenner*, the CAFC in *Fisher* rejects Justice Story's de minimis view of utility, adopting a strict utility requirement.[249] Chief Judge Michel, writing for the court, notes that "following *Brenner*, our predecessor court [the CCPA], and this court have required a claimed invention to have a specific and substantial utility to satisfy section 101."[250] This utility is also referred to as practical utility, which is synonymous with attributing "'real-world' value to claimed subject manner."[251] In other words, the discovery must provide some "immediate benefit to the public."[252]

Chief Justice Michel notes that a specific utility is specific to the subject matter claimed and can "provide a well-defined and particular benefit to the public."[253] This contrasts with a general utility that is applicable to a broad class of invention. Chief Judge Michel also notes that for an invention to have specific utility, its use must not be "so vague as to be meaningless."[254]

Chief Judge Michel then proceeds to define "substantial utility." According to Chief Judge Michel, substantial utility "defines a 'real world' use."[255] Utilities that "require or constitute carrying out further research to identify or reasonably confirm a 'real world' context of use are not substantial utilities."[256] As noted in *Fisher*:

> [A]n application must show that an invention is useful to the public as disclosed in its current form, not that it may prove useful at some future date after further research. Simply put, to satisfy the "substantial" utility requirement, an asserted use must show that the claimed invention has a significant and presently available benefit to the public.[257]

Chief Judge Michel specifically notes the concerns by government and its amici that "allowing EST patents without proof of utility would discourage research, delay scientific discovery, and thwart progress in the 'useful Arts' and 'Science.'"[258] Furthermore, it could give rise to multiple patents relating to the

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245. *Fisher*, *supra* note 203 at pp. 1369–1370.
246. *Fisher*, *supra* note 203 at p. 1370.
247. *Fisher*, *supra* note 203 at p. 1370.
248. *Fisher*, *supra* note 203 at p. 1370.
249. *Fisher*, *supra* note 203 at pp. 1370–1371.
250. *Fisher*, *supra* note 203 at p. 1371.
251. *Fisher*, *supra* note 203 at p. 1371.
252. *Fisher*, *supra* note 203 at p. 1371.
253. *Fisher*, *supra* note 203 at p. 1371.
254. *Fisher*, *supra* note 203 at p. 1371.
255. *USPTO Utility Examination Guidelines 2001*, *supra* note 233 at s. I(4).
256. *Fisher*, *supra* note 203 at p. 1372.
257. *Fisher*, *supra* note 203 at p. 1371.
258. *Fisher*, *supra* note 203 at p. 1378.

same gene and create an unnecessarily convoluted licensing environment.[259] Rather than explicitly making his decision on these policy grounds, however, Chief Judge Michel notes that these considerations are more appropriately directed to Congress.[260] Instead, Chief Judge Michel bases his decision on past precedent. By citing passages from *Brenner* which focus on the dangers of locking up vast unknowable areas of research, however, Chief Judge Michel implicitly addresses the policy concerns of anticommons theorists.

### 7.1.2. The Adoption of a Strict Utility Requirement is Particularly Suited as a Solution to the Tragedy of the Anticommons

The nanotechnology anticommons emerged as a consequence of the broad patenting of nanomaterials. A solution to the tragedy of the anticommons in nanotechnology, therefore, can be achieved by removing property rights from nanomaterials. The utility requirement is particularly suited to effect this change. Many of the patents making up the nanotechnology anticommons encompass basic research. These patents were granted on the basis of a weak utility requirement. They would not have been granted under a strict utility requirement. The adoption of a strict utility requirement for nanotechnology inventions will shift patents away from basic scientific research in nanomaterials towards the practical application of nanomaterials.[261] As a result, many of the broad, overlapping patents in the nanotechnology anticommons will be invalidated.

The adoption of a strict utility requirement is not a complete solution to the problems posed by the tragedy of the anticommons in nanotechnology. Many patents on nanomaterials would, in all probability, satisfy the elevated utility requirement while still having sufficient breadth to be considered part of the nanotechnology anticommons. Nevertheless, the elimination of multiple exclusionary rights from the nanotechnology anticommons makes it more likely that users will be able to bundle the remaining nanomaterial patent fragments through informal licensing agreements. Consequently, the adoption of a strict utility requirement makes it less likely that the nanotechnology anticommons will turn tragic. This part will proceed by evaluating the effects of the weak and strict utility requirements on the nanotechnology anticommons.

#### *7.1.2.1. Effects of the Various Utility Requirements on the Nanotechnology Anticommons*

##### 7.1.2.1.1. Weak Utility Requirement

The adoption of a weak utility requirement would perpetuate the existing nanotechnology anticommons by permitting further patenting of basic scientific research in nanotechnology.

259. *Fisher*, *supra* note 203 at p. 1378.
260. *Fisher*, *supra* note 203 at p. 1378.
261. Lemley, "Patenting Nanotechnology," *supra* note 10 at p. 628.

#### 7.1.2.1.2. Strict Utility Requirement

The adoption of a strict utility requirement would play a positive role in ensuring that the nanotechnology anticommons does not turn tragic. As noted above, as held in *Brenner* and affirmed in both the *2001 USPTO Utility Examination Guidelines* and *Fisher*, inventions will be considered to be useful in the US under a strict utility requirement if they provide a "specific, substantial and credible utility."[262] The adoption of a strict utility requirement for nanotechnology inventions would invalidate those patents that do not disclose a specific, substantial, and credible utility. This would have the effect of removing various rights of exclusion from the anticommons. In addition to weakening the anticommons, the adoption of a strict utility requirement would also have the effect of reducing transaction and strategic costs, making it more likely that users would be able to bundle the remaining rights in the anticommons.

The adoption of a strict utility standard would invalidate a substantial number of nanomaterial patents. For example, US patent 5,424,054 is one patent that would, in all likelihood, be invalidated under a strict utility requirement. It claims "a hollow carbon fiber wall consisting essentially of a single layer of carbon atoms" (a carbon nanotube). In terms of utility, the patent application states that:

> These single atomic layer fibers could be used to assemble structures with low density and high surface to volume ratios, wires with extremely small diameters and solids with highly anisotropic properties. They also could be semiconducting or metallic depending on their helicity. These single atomic layer fibers could be used directly in assemblies or structures, or could serve as uniform "seed" substrates for growth of larger ordered structures.[263]

The application above demonstrates neither specific nor substantial utility, and would likely fail to meet the "strict" utility standard.

As noted in *Fisher*, in order to satisfy the "specific" utility requirement, "an application must disclose a use which is not so vague as to be meaningless."[264] The asserted use must demonstrate that the "claimed invention can be used to provide a well-defined and particular benefit to the public."[265] According to the *2001 USPTO Utility Examination Guidelines*, a specific utility is particular to the subject matter claimed and would not be applicable to a broad class of invention.[266]

A court could interpret the application above as being "so vague as to be meaningless." The application refers to "structures with low density and high surface to volume ratios" without describing these structures in detail. In the same way, it refers to "wires with extremely small diameters," "solids with highly anisotropic properties," assemblies and structures. These vague references to larger order structures provide little to no specificity. Furthermore, the application is not "particular to the subject matter claimed." Rather, it is applicable to a

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262. *USPTO Utility Examination Guidelines 2001*, *supra* note 233 at s. I(1); Brenner, *supra* note 194; Fisher, supra note 203.
263. Miller *et al.*, *The Handbook of Nanotechnology supra* note 9 at pp. 69–70.
264. *Fisher*, *supra* note 203 at p. 1371.
265. *Fisher*, *supra* note 203 at p. 1371.
266. *USPTO Utility Examination Guidelines 2001*, *supra* note 233.

broad class of invention. It could be said that the description could apply to any carbon fiber, not simply one with a single layer of carbon atoms. This invention thus provides neither a well-defined nor particular benefit.

In a similar manner, the application could fail to satisfy the "substantial" utility requirement. As noted in *Fisher*, the substantial utility requirement demands "practical utility" and "real world" utility.[267] The invention must provide some "immediate benefit" or a "presently available benefit" to the public.[268] As noted by the USPTO and in *Fisher*, the application must show that an "invention is useful to the public as disclosed in its current form, not that it may prove useful at some future date after further research."[269]

If the words "immediate benefit" and "presently available" are interpreted strictly, the fact that the application only discloses potential utilities would mean that it will likely fail the substantial utility requirement. In the case of the patent noted above, further research is required to confirm real world contexts of use. The application also seems to fall under one of the USPTO's enumerated situations in which no substantial utility is found, namely, a claim to an intermediate product for use in making a final product that has no specific, substantial and credible utility.[270] The structures and wires discussed in the application are not identified. As a result, they are not "specific." Therefore, under the USPTO's 2001 guidelines, the patent would likely fail the utility requirement.

The adoption of a strict utility requirement is not a complete solution, however, to the problems posed by the tragedy of the anticommons in nanotechnology. Many patents on nanomaterials would, in all probability, satisfy the elevated utility requirement while still having sufficient breadth to be considered part of the nanotechnology anticommons. However, the adoption of a strict utility requirement would substantially weaken the nanotechnology anticommons. In addition to weakening the anticommons, a strict utility requirement will also reduce transaction and strategic costs with respect to patents on nanomaterials, making it more likely that patentees and licensees will be able to reach informal agreements to bundle the remaining exclusionary rights through informal market mechanisms.

The application of a strict utility requirement for nanotechnology inventions will reduce transaction costs in three main ways. First, costly negotiations will not have to be conducted with those patent holders whose patents have become invalidated as a result of the strengthened utility requirement. Second, the elevated utility requirement may also make it easier for a potential licensee to determine exactly which patents she needs to pursue in seeking to license a nanomaterial. It is likely that many patents that do not satisfy the strict utility requirement will have been granted earlier in nanotechnology's development. As terminology was less settled in the early phases of nanotechnology research, these patents may have been described, in patent applications, in ways that would cause them to go undetected in routine patent searches. Third, it may be easier to negotiate informal licensing agreements once a significant number of nanomaterial patents are purged through the adoption of a strict utility standard.

267. *Fisher*, *supra* note 203 at p. 1371.
268. *Fisher*, *supra* note 203 at p. 1371.
269. *Fisher*, *supra* note 203 at p. 1371; *USPTO Utility Examination Guidelines 2001*, *supra* note 233.
270. *USPTO Utility Examination Guidelines 2001*, *supra* note 233.

Strategic costs can be reduced in two main ways. First, the application of a strict utility requirement should reduce valuation difficulties in nanotechnology patents. Those patents that fail the strict utility test are likely to be vague and broad. It is more difficult to quantify the value of these patents than those that demonstrate a specific and substantial utility. Patents that demonstrate a substantial and specific utility are closer to commercial application than patents for basic research. As a result, it is likely easier to make a determination as to their value. Second, the application of a strict utility requirement will eliminate many patents held by individuals as "tollbooths" on the road to development. To serve effectively as a tollbooth, patents must be broad, vague, and general so as to cast as wide a net as possible. These patents will likely be invalidated through the application of a strict utility requirement. Having reduced the incentive to hold pioneering patents, patentees may be more inclined to enter into informal licensing agreements.

#### 7.1.3. US Courts are Likely to Adopt a Strict Utility Requirement when Faced with a Nanotechnology Patent Application

The issue of the strength of the utility requirement in nanotechnology inventions has not yet been examined by a US court. This issue is likely to arise in the near future, as products made using nanomaterials become profitable enough to trigger expensive patent litigation. When faced with a utility issue in a nanotechnology patent application, courts will in all likelihood adopt a strict utility requirement over a weak utility requirement. First, as compared to 1995, when *Brana* was decided and the 1995 *USPTO Utility Examination Guidelines* were released, precedent now points in the direction of a strict utility requirement. The controlling US Supreme Court case, the most recent CAFC case, and the most recent USPTO Utility Examination Guidelines all adopt a strict utility requirement.[271] As well, *Fisher* demonstrates that the CAFC, a court which has traditionally expanded rather than contracted patent rights, is ready to follow the US Supreme Court and apply a heightened utility requirement. *Fisher* reverses the trend of permitting patenting at an earlier phase in the research process.

Second, since the late 1990s, skepticism has been growing regarding the ability of basic research patents to lead to the efficient development and commercialization of research. This skepticism is demonstrated in anticommons theory, in the passage of the 2001 *USPTO Utility Examination Guidelines*, and the CAFC's decision in *Fisher.* Though the CAFC explicitly disavowed contemporary policy concerns in *Fisher*, it implicitly recognized them and reacted to them through references from *Brenner.* In *Brenner*, Justice Fortas was concerned that giving a patentee broad control over an unknowable area will lead to slowdowns in innovation. This concern is similar to the anticommons theorists' concern that excessive transaction costs will render individuals unable to assemble fragmented and overlapping patents into a single usable bundle, thus causing a broad, unknowable area of scientific research to remain inaccessible to future innovators.

It is unlikely that the CAFC, after adopting a strict utility requirement for ESTs, will adopt a weak utility requirement for nanotechnology inventions. A

271. Brenner, supra note 194; Fisher, *supra* note 203; *USPTO Utility Examination Guidelines 2001*, *supra* note 233.

weak utility requirement presents an overly optimistic view of the ability of broad patents on basic scientific research to lead to the efficient development and commercialization of research. A strict utility requirement achieves a workable balance between providing support and incentives for companies to invest resources in the development of basic research while ensuring that the building blocks of scientific research remain accessible to future innovators. The adoption of a strict utility requirement will play a positive role in overcoming the tragedy of the anticommons in nanotechnology.

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## 8. CONCLUSION

NANOTECHNOLOGY HAS BEEN HERALDED as the next transformative technology, a USA$1 trillion industry that has the potential to prolong life and end world hunger, among other spectacular possibilities.[272] Over the last few decades, scientists and their research partners have acquired nanotechnology patents in a manner resembling a "gold rush."[273] The nanotechnology gold rush has specifically targeted nanomaterials, nanotechnology's building blocks.[274] Many of the patents that have been granted for nanomaterials are broad, general patents encompassing basic research.

Nanotechnology is the first modern technology to have its basic research patented.[275] Basic research in most other technologies in the twentieth century remained in the public domain.[276] A driving force behind the patenting of basic research in nanotechnology was the development-oriented approach to patent rights. This approach emerged in the 1960s and 1970s. Development-oriented theorists argued that the most efficient way to achieve the development and commercialization of research is to grant broad patents on research prospects shortly after their discovery. Development-oriented arguments supported the widespread patenting of basic research in the 1980s and 1990s.[277]

Beginning in 1998 with the publication of Heller's "The Tragedy of the Anticommons," proponents of "anticommons theory" challenged the claims of development-oriented theorists that the broad patenting of basic research necessarily leads to the efficient development and commercialization of research.[278] Anticommons theorists argued that this assumption fails to take into account the possibility that granting broad patents on research prospects could stifle development through the phenomenon of the tragedy of the anticommons.

This article has examined the US nanotechnology patent landscape in

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272. Dal, "From Conventional Technology to Carbon Nanotechnology," *supra* note 2 at p. 3; Schummer and Baird, *Nanotechnology Challenges*, *supra* note 2 at p. 1; Hall, *Nanofuture*, *supra* note 2; MacLurcan, "Nanotechnology and Developing Countries," *supra* note 5 at p. 2; UNCTAD, "Interactive Dialogue on Harnessing Emerging Technologies," *supra* note 5; Salamanca-Buentello *et al.*, "Nanotechnology and the Developing World," *supra* note 5; RNCOS, *The World Nanotechnology Market*, *supra* note 4.
273. Lux Research, "Nanotechnology Gold Rush," *supra* note 7.
274. Lux Research, "Nanotechnology Gold Rush," *supra* note 7; Kotov, *Nanoparticle Assemblies and Superstructures*, *supra* note 9 at preface; Ventra, Evoy and Heflin Jr., *Introduction to Nanoscale Science and Technology*, *supra* note 1 at p. 2; Miller *et al.*, *The Handbook of Nanotechnology*, *supra* note 9 at p. 15.
275. Lemley, "Patenting Nanotechnology," *supra* note 10 at p. 605.
276. Lemley, "Patenting Nanotechnology," *supra* note 10 at pp. 605–606.
277. Rai, "Regulating Scientific Research," *supra* note 12.
278. Heller, "The Tragedy of the Anticommons," *supra* note 20.

order to determine whether the broad patenting of basic research in nanomaterials has stifled development in nanotechnology through the phenomenon of the tragedy of the anticommons. An analysis of the nanotechnology patent landscape suggests that the nanotechnology "gold rush" has created an anticommons in nanomaterials. Patents in nanomaterials are broad, overlapping, and fragmented.[279] Before a person can use a nanomaterial, they must first secure licenses to all of the exclusionary rights. If they cannot, the resource will go underused and innovation will suffer. In short, the anticommons will turn tragic.

There are two main ways to prevent the nanotechnology anticommons from becoming tragic. The first is through informal market mechanisms. As demonstrated above, transaction costs and strategic behaviour will likely prove to be substantial impediments to the achievement of informal licensing agreements in nanotechnology. The second way to prevent the anticommons from becoming tragic is through non-market solutions. This article has canvassed various non-market solutions. I have proposed the adoption of a strict utility requirement as a solution to the problems posed by the tragedy of the anticommons in nanotechnology in the US.

The adoption of a strict utility requirement for nanotechnology inventions will shift patents away from basic research in nanomaterials towards the practical application of nanomaterials. As a result, a substantial number of broad, general patents encompassing basic research in nanotechnology will be invalidated, weakening the anticommons and reducing transaction and strategic costs. It is likely that US courts, when confronted with the question of the proper strength of the utility requirement in nanotechnology inventions, will adopt a strict utility requirement in line with *Brenner*, the 2001 *USPTO Utility Examination Guidelines*, and *Fisher*.[280]

The adoption of a strict utility requirement, however, is not a complete solution to the problems posed by the tragedy of the anticommons in nanotechnology. In all probability, many patents on nanomaterials will satisfy the elevated utility requirement while still having sufficient breadth to be considered part of the nanotechnology anticommons. Transaction and strategic costs associated with licensing these patents may prevent users from bundling the remaining exclusionary rights in the nanotechnology anticommons. Thus, although the adoption of a strict utility requirement will weaken the anticommons, innovation may still be stifled.

If licensing difficulties cause significant damage to the nascent US nanotechnology industry after adoption of the strict utility requirement, Congress must take its cue from the CAFC in *Fisher* and take further action to address the problem of the tragedy of the anticommons in nanotechnology. In seeking to provide a complete solution to the problems posed by the tragedy of the anticommons in nanotechnology, Congress should create government-sponsored patent pools for nanomaterials. The creation of government-sponsored patent pools for nanomaterials will ensure that nanomaterials can be used in downstream implementations. It will also reward those researchers who originally discovered and developed basic research in nanomaterials. Difficulties

279. Lux Research, "Nanotechnology Gold Rush," *supra* note 7.
280. Brenner, *supra* note 194; Fisher, *supra* note 203; *USPTO Utility Examination Guidelines 2001*, *supra* note 233.

with respect to patent valuation, patent validity, and the scope of patent pools must be addressed before government-created patent pools can act as a solution to the problems posed by the nanotechnology anticommons. Furthermore, given the disruptive effects that the creation of a government-sponsored patent pool will have on investment and capital, Congress should create patent pools for nanomaterials only after it is satisfied that licensing difficulties are causing harm to the nanotechnology industry.

Nanotechnology has been said to have the potential to help attain the Millennium Development Goals, to bring everlasting life, to reverse the trends of global warming, to eliminate disease and poverty, and to build a utopian world one atom at a time. Whether nanotechnology will accomplish any of these goals, or whether it is all merely science fiction, is a matter for debate. Unless action is taken to eliminate the nanotechnology anticommons, however, transaction and strategic costs may stifle nanotechnology's incredible potential. This would be truly tragic.