NOTES

WHAT WOULD AN ANDROID DO?: PAVING A REGULATORY PATH TO TECHNOLOGICAL PROGRESS

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I. INTRODUCTION

In today's globally-connected world, filled with continually

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evolving intelligent devices,[1] the central role that technology plays in our lives is all but impossible to overlook. Yet technological progress is far from a recent phenomenon. Indeed, innovation has been an indispensable part of the human landscape since the time of primitive hunting tools.[2] With its unrelenting permeation into the fabric of our society,[3] technology has transformed virtually every aspect of the world around us.[4] It has improved our lives tremendously[5] and continues to offer solutions to the vast majority of problems we face as inhabitants of a fragile ecosystem, possessing limited resources and unlimited wants.[6] Thanks to modern scientific advances, we now live lives that are longer, healthier,[7] and fuller[8] than ever before.

A recognition that the continued development of technology is key to improving our lives is also a recognition that technological

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1. One example of evolving technology, beyond today's massive array of widely-used consumer electronics, is artificial intelligence capable of using environmental stimuli to render the types of decisions we normally associate with human intelligence, such as a system recently presented by researchers at Carnegie Mellon, which is capable of screening for suspicious activity based on surveillance feeds. *See* Reuven Cohen, *U.S. Army Sponsored Artificial Intelligence Surveillance System Attempts to Predict the Future*, FORBES (Oct. 29, 2012), http://www.forbes.com/sites/reuvencohen/2012/10/29/u-s-army-sponsored-arti%EF%AC%81cial-intelligence-surveillance-system-attempts-to-predict-the-future.

2. *See generally* HENRY HODGES, TECHNOLOGY IN THE ANCIENT WORLD 21 (1970) (placing use of the hand ax, the earliest known man-made tool, at around two million years ago).

3. *See* TIMOTHY TAYLOR, THE ARTIFICIAL APE: HOW TECHNOLOGY CHANGED THE COURSE OF HUMAN EVOLUTION 6-7 (2010) ("Human life as we know it assumes the presence of artifice—objects we have made ourselves, without which life would either have no meaning or be physically impossible.").

4. *See id.* at 8 ("By organizing our society along the lines of a complex machine, with function-specific parts, some of us have been wholly freed from the daily routines previously essential for personal maintenance.").

5. *See* Miguel Helft, *Thiel vs. Schmidt: The Fireworks Fly*, CNN MONEY (July 17, 2012), http://tech.fortune.cnn.com/2012/07/17/thiel-vs-schmidt-the-fireworks-fly (quoting Google's executive chairman as saying that "technology has had an overwhelmingly positive role, lifting some 2 billion people out of poverty and spreading access to vital information from a relative small number to virtually all the people on earth").

6. This language has been borrowed from that describing scarcity as an economic concept: "[U]nlimited wants competing for limited resources creates the basic economic problem of scarcity." ARLEEN J. HOAG & JOHN H. HOAG, INTRODUCTORY ECONOMICS 6 (4th ed. 2006).

7. *See* Antonia Windsor, *Medicine Will Not Only Make Us Live Longer, But Live Better*, GUARDIAN.CO.UK, http://www.theguardian.com/zurichfuturology/story/0,,1952688,00.html (last visited Feb. 2, 2014) (citing a near doubling of our lifespan since the nineteenth century and various recent medical breakthroughs, which are aimed at improving the quality of our lives into old age).

8. *See supra* note 5.

progress must be nurtured through increasingly arduous scientific research that is only achievable in a technology-friendly legal environment. Indeed, the need for the American legal system to encourage technological progress has been recognized as far back as our nation's founding.[9] Our Founding Fathers not only recognized that need but also considered it important enough to be afforded constitutional protection.[10] In the modern world, the accelerating development of technology,[11] coupled with its growing sophistication,[12] has created the need for more refined legal tools to ensure that the rapid progress of science can be sustained.

Notwithstanding the central role that technology plays in our lives, legal protections for technological progress in the United States are inadequate in some areas[13] and nearly lacking in others.[14] Moreover, some facets of technology-affecting regulation not only fall short of encouraging progress but in fact create barriers to it.[15] Though certain technology-impeding enactments are defensible due to overriding priorities, such as public safety,[16] we must at least be as apprehensive of technology-impeding laws as we are of environmentally-damaging ones. The notion expressed in the preceding sentence may appear questionable, even preposterous at first glance, given the innate affection most of us feel toward the environment.[17] However, elevating technological ideals to a level comparable to that of environmental values becomes easier to accept when we bear in mind that most societal problems, including

9. *See* U.S. CONST. art. I, § 8, cl. 8. The Copyright Clause of the Constitution of the United States is aimed at "promot[ing] the Progress of Science and useful Arts." *Id.*

10. *See id.*

11. *See* discussion *infra* Part II.A.

12. *See supra* note 1.

13. *See, e.g.*, Trevor D. Stiles, *Regulatory Barriers to Clean Energy*, 41 U. TOL. L. REV. 923 (2010) (discussing regulatory hurdles to development of renewable energy facilities).

14. *See, e.g.*, Katie Miller, *Nanotechnology: How Voluntary Regulatory Programs Can Both Ease Public Apprehensions and Increase Innovation in the Midst of Uncertain Federal Regulations*, 8 IND. HEALTH L. REV. 435, 469 (2011) (warning that apprehension of consumers with respect to nanotechnology, due to lack of nano-specific federal regulation, can impede innovation in this important area).

15. *See, e.g.*, *NASA's Space Exploration Plans Take a Galactic Hit*, FOX NEWS (Feb. 13, 2012), http://www.foxnews.com/scitech/2012/02/13/nasa-funding-cuts-coming-space-exploration-to-suffer (discussing NASA's planned 20 percent budget cut that will "affect[] future missions to Mars, lunar science, and the study of the outer planets").

16. *See, e.g.*, 42 U.S.C. § 9701 (2006) (announcing congressional policy of ensuring safe operation of nuclear facilities).

17. Indeed, NEPA, a key environmental statute, makes use of nearly poetic language. Thomas O. McGarity, *The Courts, the Agencies, and Nepa Threshold Issues*, 55 TEX. L. REV. 801, 803 (1977). The section that sets out the purpose of the statute opens: "To declare a national policy which will encourage productive and enjoyable harmony between man and his environment." 42 U.S.C. § 4321 (2006).

environmental ones,[18] can be solved through advances in technology.[19]

Environmental legislation offers more than just a convenient analogy to introduce the main premise of this Note. It offers a working scheme that can be emulated to add more visibility and consideration to regulation that adversely affects the progress of technology. This Note proposes adapting key components of the National Environmental Policy Act (NEPA)[20] to technology-affecting regulation to counteract unsound policies within it.

By taking a closer look at technology and technological trends, Part II of this Note will make a case for adding stronger legal protections to ensure that the pace of technological progress can continue with minimal impediment. Part II will also offer a glimpse at likely consequences of allowing technological progress to stagnate. It will explain why those consequences would be far more disruptive than many would intuitively anticipate.

Part III will outline the framework of NEPA, an immensely important environmental enactment,[21] with a long track record[22] that not only attests to its overall success, but also offers a way to avoid its shortcomings. Both strengths and weaknesses of NEPA, revealed by decades[23] of real-life experience, can be leveraged as a guide for applying its concepts to the realm of technology.

Finally, Part IV will outline a proposal for legislation that borrows key elements from NEPA, specifically NEPA's central feature—the Environmental Impact Statement (EIS).[24] This Note will set out guidelines for enacting such legislation. It will propose a scheme tailored to fit the context of technology, while taking

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18. *See, e.g.*, *Super-Microbes Engineered to Solve World Environmental Problems,* R&D MAGAZINE (Oct. 8, 2012, 1:29 PM), http://www.rdmag.com/news/2012/10/super-microbes-engineered-solve-world-environmental-problems (noting the role of metabolic engineering in creating solutions to environmental problems, such as scarcity of natural resources).

19. *See supra* notes 5, 7.

20. National Environmental Policy Act, 42 U.S.C. §§ 4321-4347 (2006).

21. *See* COUNCIL ON ENVTL. QUALITY, THE NATIONAL ENVIRONMENTAL POLICY ACT: A STUDY OF ITS EFFECTIVENESS AFTER TWENTY-FIVE YEARS 3 (1997), *available at* http://www.blm.gov/or/regulations/files/nepa25fn.pdf ("In 25 years, NEPA has done much to merit Senator . . . Jackson's description of NEPA, at its passage, as 'the *most important* and far-reaching environmental and conservation measure ever enacted by Congress . . . .'") (emphasis added).

22. *See* Jackson County, Mo. v. Jones, 571 F.2d 1004, 1007 (8th Cir. 1978) (listing 1970 as the year of NEPA's enactment).

23. *See id.*

24. *See* Daniel A. Farber, *Adaptation Planning and Climate Impact Assessments: Learning from NEPA's Flaws*, 39 ENVTL. L. REP. NEWS & ANALYSIS 10605, 10608 (2009) (stating that "the most significant provision of NEPA is undoubtedly §102(2)(c)," which is the provision that sets out Environmental Impact Statement requirements).

advantage of lessons learned from decades of NEPA-mandated regulatory experience.

II. PROTECTING THE INANIMATE: WHY TECHNOLOGY IS WORTHY OF OUR UTMOST CONSIDERATION

The importance of technology in today's world can hardly be questioned. In fact, the very survival of the steadily-growing world population depends, to a significant degree, on continued technological advancement.[25] An inhabitant of a typical industrialized city need only look at his or her immediate surroundings to appreciate how dependent we have become on modern technology.[26] Indeed, even a temporary disruption that prevents us from tapping into modern high-tech resources can cause considerable apprehension.[27] This is so notwithstanding the fact that some of that fear is directed at losing access to the type of technology that only a few decades ago[28] was the stuff of science fiction novels.[29]

Yet, despite its prominent position in the modern world, technology, unlike the environment, fails to generate legions of pro-technology activists prepared to line up to protect it.[30] In fact, the

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25. *See* Roy Roberson, *Technology Key to Food Needs*, SOUTHEAST FARM PRESS (Sept. 16 2010), http://southeastfarmpress.com/management/technology-key-food-needs ("Global acceptance and wise use of current and future technologies are critical factors in whether farmers will be able to meet the daunting challenge of feeding an expected 8.5 billion people by the year 2030."); *see also* TAYLOR, *supra* note 3, at 9 (stressing that human beings are unable to survive without technology, which "insulates us, cures us, compensates for our deficiencies of sight, mobility, metabolism, and memory").

26. *See supra* note 3.

27. *See, e.g.*, Gopal Ratnam, *Cyberattacks Could Become as Destructive as 9/11: Panetta*, BLOOMBERG BUSINESSWEEK (Oct. 12, 2012), http://www.businessweek.com/news/2012-10-12/cyberattacks-could-become-as-destructive-as-9-11-panetta (quoting U.S. Defense Secretary Leon Panetta as saying that "[a] cyber attack perpetrated by nation states or violent extremist groups could be as destructive as the terrorist attack of 9/11").

28. *See* Micha Kaufman, *The Internet Revolution Is the New Industrial Revolution*, FORBES (Oct. 5 2012, 3:42 PM), http://www.forbes.com/sites/michakaufman/2012/10/05/the-internet-revolution-is-the-new-industrial-revolution ("In the mid-90s, ARPANet was transformed . . . [into the] Internet that has become such an integral part of our lives, bringing with it change not only technological, but societal and epic in scope.").

29. *See* Tom Colls, *Are We Living in a Sci Fi Future?*, BBC NEWS (May 20, 2011), http://news.bbc.co.uk/today/hi/today/newsid_9489000/9489104.stm (pointing to a 1898 science fiction story, *From the London Times of 1904*, in which Mark Twain described an Internet-like communication network).

30. *Compare* Internet Search Results for Environmental Activist, GOOGLE, http://www.google.com (search "Environmental Activist" in quotes) (generating over 1.2 million results as of January 2014), *with* Internet Search Results for Technological Activist, GOOGLE, http://www.google.com (search "Technological Activist" in quotes) (generating less than five thousand results as of January 2014, most prominently,

growing sophistication of technology conjures up images, particularly in popular media, of a dystopian future, in which the survival of the human race is threatened by the fruit of its own ingenuity.[31] Yet, technology has had a decidedly positive effect on countless aspects of our lives.[32] Its continued progress is essential to our well-being[33]—indeed, our very survival[34]—and, thus, must be maintained and encouraged by our legal system.

A. Background: The Pace of Technological Progress and Its Implications

Technology advances at an exponential rate,[35] a rate of progress that is inherently explosive and thus "profoundly transformative."[36] In forecasting future trends, many observers fail to account for this fact due to a flawed, "'intuitive linear' view of" technological progress instead of "the 'historical exponential' view."[37] The difference between these views is colossal.[38] Instinctively, in the one hundred years between the beginning and end of this century, one would expect to see one hundred years-worth of progress.[39] In reality, however, models of technological trends show that during this

obscure blog posts).

31. *See, e.g.*, THE TERMINATOR (Hemdale Film Corporation 1984) (envisioning a future with intelligent machines threatening the human race); I, ROBOT (20th Century Fox 2004) (same).

32. *See supra* notes 5, 7.

33. *See supra* notes 5, 7.

34. *See supra* note 25.

35. *See* RAY KURZWEIL, THE SINGULARITY IS NEAR: WHEN HUMANS TRANSCEND BIOLOGY 7-8 (2005). In fact, Kurzweil notes that in certain areas, such as price-performance of computing, the rate of progress, or the exponent itself, increases exponentially. *Id.* at 12. A recent study by Santa Fe Institute researchers confirmed this finding by concluding that over the past century, information technology has not merely advanced exponentially, but "superexponentially"; that is, the speed of progress is accelerating at an exponential rate. *Technological Progress Not Slow or Steady, but Superexponential*, SANTA FE INSTITUTE (Feb. 1, 2012, 12:44 PM), http://www.santafe.edu/news/item/technology-progress-superexponential.

36. KURZWEIL, *supra* note 35, at 10 (explaining that exponential growth is multiplicative, rather than additive, which accounts for its explosive nature).

37. *Id.* at 11.

38. A simple example that dramatically illustrates the explosive nature of exponential growth was referenced in a recent film, *The Happening*, in which, to distract a panicked woman, a high school math teacher asks her how much money she would end up with if he were to give her one penny on the first day of the month and then continually double the previous day's amount each day for the remainder of the month. *See* THE HAPPENING (20th Century Fox 2008). The woman's intuitive guesses, ranging from ten to thirty dollars, turned out grossly below the real answer—over ten million dollars. *See id.*

39. *See* KURZWEIL, *supra* note 35, at 11-12 (discussing how even scientific-minded individuals tend to intuitively assume that the current rate of progress will continue at the same rate, while it actually grows exponentially).

century we will in fact witness as much as twenty thousand years-worth of progress, measured by the rate of progress in the first decade of this century.[40] The force that propels this trend forward can be summarized in a single phrase: "[t]echnology feeds on itself."[41] That is, each iteration of the innovation cycle[42] enables new ideas and, consequently, propels and accelerates the next iteration, which becomes the starting point for the next one, and so on.[43] The resultant rate of progress, spawned by this "self-reinforcing cycle" is exponential.[44]

If these trends continue, research in certain areas, particularly in information technology, is likely to produce rather sweeping societal changes in the near future.[45] In fact, some of these changes are already well under way. For example, recent breakthroughs in artificial intelligence have already enabled an IBM supercomputer to not only participate, but win a "Jeopardy!" tournament against human contestants, a feat that only a few years ago may have seemed inconceivable.[46] Though this achievement may appear somewhat inconsequential, it has paved the way for more practical applications of the underlying technology—computerized medical diagnoses.[47]

Of course, recent work in the area of artificial intelligence is not limited to exploiting a particular computer's capabilities.[48] Scientists

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40. *See id.* at 11.

41. *See* ALVIN TOFFLER, FUTURE SHOCK 26 (Bantam Books 1971).

42. Toffler explains that "[t]echnological innovation consists of three stages, linked together into a self-reinforcing cycle. First, there is the creative, feasible idea. Second, its practical application. Third, its diffusion through society." *Id.* at 27.

43. *See id.*

44. As Toffler puts it: "It is not that we are more eager or less lazy than our ancestors, but we have, with the passage of time, invented all sorts of social devices to hasten the process." *Id.* at 27-28.

45. *See id.* at 28-30 (discussing past examples of this trend and predictions of rapid future growth).

46. *See* Seth Borenstein & Jordan Robertson, *IBM 'Watson' Wins: 'Jeopardy' Computer Beats Ken Kennings, Brad Rutter*, HUFFINGTON POST (Feb. 17, 2011, 1:24 AM), http://www.huffingtonpost.com/2011/02/17/ibm-watson-jeopardy-wins_n_824382.html.

47. *See* Steve Lohr, *I.B.M.'s Watson Goes to Medical School,* N.Y. TIMES, BITS BLOG, (Oct. 30, 2012, 7:11 PM), http://bits.blogs.nytimes.com/2012/10/30/i-b-m-s-watson-goes-to-medical-school/ (reporting that Watson, IBM's supercomputer that recently proved itself as a formidable "Jeopardy!" contestant, is to complete medical training in the Cleveland Clinic by interacting with clinicians and students). The long-term goal of the collaboration is a computer that is "able to collect and assess . . . patient data, and then construct 'inference paths' toward a probable diagnosis." *Id.*

48. *See NSF Grant Seeks to Replicate Human Pattern Recognition in Computers*, PENN STATE NEWS (Oct. 24, 2012), http://live.psu.edu/story/62166 (discussing other ways computers are used in research involving medical or security anomalies, robotics, and genetic pattern indexing).

are actively pursuing many other avenues in an effort to achieve new milestones in artificial intelligence.[49] Advanced artificial intelligence that research in this area aims to produce carries enormous potential, which may ultimately be realized in its displacement of the role of human beings as the primary vehicles of innovation.[50] And, with the continually accelerating pace of technological progress, this sweeping result may occur in a matter of decades or even years.[51]

Although models showing exponential trends in information technology are based on relatively recent observations,[52] similar trends emerge when transformative developments from any point in our planet's history are examined.[53] In fact, these trends are not limited to advancements in technology or even to the evolvement of our species. They span further back in time and encompass early biological evolution as well.[54] Interestingly, an examination of major past events in biological and technological development yields the same clear exponential trend irrespective of the source used to identify milestone points in biological or technological history.[55]

Comparing the timescale of biological evolution to that of technological progress dramatically demonstrates this acceleration.[56] Thus, evolution of primitive organisms occurred on a scale of billions of years,[57] whereas major technological developments took only centuries, and more recently, only a few decades or years to

49. *See id.* (describing a three-year collaboration between Penn State and Stanford University researchers aimed at achieving a better understanding of human pattern recognition with the ultimate goal of duplicating it in a digital substrate); *see also supra* note 1.

50. Indeed, nearly half a century ago, I. J. Good, a statistician, made a famous observation: "[T]he first [machine that can surpass human intelligence] is the last invention that man need ever make." Irving John Good, *Speculations Concerning the First Ultraintelligent Machine, in* 6 ADVANCES IN COMPUTERS 31, 33 (1965) (emphasis removed).

51. *See* KURZWEIL, *supra* note 35, at 293 (estimating that artificial intelligence will reach human capacity by the 2020s).

52. *See* David S. Alberts, *Chapter 3: The Technologies of the Information Revolution, in* THE INFORMATION AGE: AN ANTHOLOGY ON ITS IMPACT AND CONSEQUENCES 36, 36 (1997) (noting that the period commonly labeled as "the Information Age" is one that took root toward the end of the twentieth century).

53. *See* KURZWEIL, *supra* note 35, at 18 (describing a smooth accelerating trend that results when milestone developments in biological and technological history are plotted on a graph).

54. *Id.* at 17.

55. *Id.* at 18.

56. *Id.* at 16-17 (comparing the rate of biological growth and technological growth).

57. *See* Stephen Hawking, *Life in the Universe*, HAWKING.ORG.UK, http://www.hawking.org.uk/life-in-the-universe.html (last visited Feb. 5, 2104) (noting that biological evolution from earliest cells to multi-cell organisms took over two billion years).

achieve.[58] And since the rate is accelerating,[59] we can expect this timescale to continue contracting. This view of technology—as a de facto continuation of biological evolution—once again underscores its monumental importance in our society.

B. Technology-Impeding Laws and Their Likely Consequences

Though many scientific forecasts of future technological trends have been surprisingly accurate and continue to occur at predictable intervals,[60] these trends are quite clearly not self-sustaining laws of nature and, thus, require our continued backing, both scientific and legal. Moreover, allowing scientific research in the United States to stagnate for even a few years can quickly create a competitive gap between it and nations in active pursuit of that research of not just a few years, but a present-day equivalent of centuries. This result logically follows from exponential trends in technological progress.[61]

The Human Genome Project provides a good illustration of the scale of scientific accomplishment that is achievable in a technology-friendly regulatory environment. Launched in 1990 by the U.S. Department of Energy and the National Institutes of Health, the project's goal of sequencing the entire human genome, consisting of three billion DNA base pairs,[62] was a tremendously ambitious undertaking.[63] Despite major breakthroughs by Nobel laureates in the decades leading up to 1990, the portion of the human genome that had been decoded up to that point totaled less than one percent.[64] Yet, what had been viewed as an effort that could take

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58. *See generally Technology Timeline: 1752-1990*, PBS.ORG, http://www.pbs.org/wgbh/amex/telephone/timeline/timeline_text.html (last visited Feb. 5, 2014) (tracing technological developments starting with the lighting rod in 1752 to the Hubble Telescope in 1990).

59. *See supra* note 35.

60. *See, e.g.*, Stephen Shankland, *Moore's Law: The Rule that Really Matters in Tech*, CNET NEWS (Oct. 15, 2012, 12:00 AM), http://news.cnet.com/8301-11386_3-57526581-76/moores-law-the-rule-that-really-matters-in-tech (describing a famous observation by Intel co-founder Gordon Moore, in his 1975 paper, that the number of transistors on a silicon chip has doubled approximately every two years and will likely continue to double at the same rate—a forecast that, despite pessimistic concerns, continues to hold today, thanks to new breakthroughs in chip manufacturing technology). This so-called Moore's Law is another striking example of exponential growth: The number of transistors on a chip has gone from thirty in 1964 to 1.4 billion in 2012. *Id.*

61. *See* discussion *supra* Part II.A.

62. *See About the Human Genome Project*, U.S. DEP'T OF ENERGY OFFICE OF SCI., http://www.ornl.gov/sci/techresources/Human_Genome/project/index.shtml (last modified July 23, 2013).

63. *See* Robert Kanigel, *The Genome Project*, N.Y. TIMES, Dec. 13, 1987, at 44, *available at* http://www.nytimes.com/1987/12/13/magazine/the-genome-project.html.

64. *See id.* at 98.

more than a century to complete[65] took only thirteen years,[66] thanks in no minor part to billions of dollars in funding by the U.S. government.[67] What is more, the Human Genome Project has paved the way for today's medical diagnoses of genetic diseases, with full DNA sequencing performed in a matter of hours instead of years, and costing thousands of dollars instead of billions.[68]

Conversely, had a science-friendly posture not been adopted by the U.S. government, scientists would have likely continued "slogging through the human genome" at a rate that would have effectively foreclosed most of us from witnessing the resulting medical breakthroughs within our lifetimes.[69] Thus, even an ambivalent regulatory posture in the area of technology—one that is short of a hostile stance—can result in profoundly negative consequences.

In order to sustain the advancement of technology, the U.S. statutory and regulatory framework must be better oriented toward that objective. Given the central role of technology in today's world and its potential to solve most of the problems faced by modern societies,[70] treating its continued advancement as anything less than critical is plainly imprudent.

C. Existing Areas Requiring Closer Regulatory Scrutiny

Before laying the foundation for the regulatory scheme proposed by this Note, however, an overview of several existing areas that such a scheme could target is in order. Real examples presented here will strengthen the case for the utility of such a regulatory regime by pointing to its applicability beyond the hypothetical scenario just discussed.

1. Stem Cell Research and Human Therapeutic Cloning

One such example is stem cell research, which often implicates

65. *See id.* ("Scientists are slogging through the human genome like a third-grader reading Kierkegaard. Even a steady rise in the rate of sequencing would leave the job unfinished until the 22d century.").

66. *See About the Human Genome Project*, *supra* note 62.

67. *See Human Genome Project Budget*, U.S. DEP'T OF ENERGY OFFICE OF SCI., http://www.ornl.gov/sci/techresources/Human_Genome/project/budget.shtml#nih (last modified July 23, 2013).

68. *See* James Gallagher, *'50-Hour Genome' Test for Babies with Genetic Diseases*, BBC NEWS (Oct. 4, 2012), http://www.bbc.co.uk/news/health-19812067; *see also* Stephanie Pappas, *Molecular Milestone: Scientists Unravel the Human Genome*, FOX NEWS (Sept. 9, 2012), http://www.foxnews.com/science/2012/09/09/unraveling-human-genome-6-molecular-milestones ("We are now able to read the living human genome at an unprecedented level of detail, and to begin to make sense of the complex instruction set that ultimately influences a wide range of human biology.").

69. *See* Kanigel, *supra* note 63, at 98.

70. *See supra* notes 5, 7, 18 and accompanying text.

human therapeutic cloning.[71] Cloning is a process that involves removing nuclear material from a female's egg and replacing it with that extracted from the cell of a donor.[72] In the case of therapeutic cloning, cells that have not yet developed into a particular cell type—known as stem cells[73]—are removed from the resulting embryo with the goal of utilizing them for research.[74] Such research could ultimately lead to therapies that would address a multitude of medical conditions resulting from diseases and injuries,[75] "includ[ing] Alzheimer's and Parkinson's diseases, cancer, and spinal paralysis."[76]

Despite their "grand therapeutic promise,"[77] human cloning and stem cell research have created a great deal of controversy due to moral objections to the practice of destroying human embryos.[78] Though at this time human therapeutic cloning is not banned by federal law,[79] a House bill had been introduced in 2003 that would have criminalized this practice.[80] A lack of certainty regarding the U.S. government's policy vis-à-vis federal funding for stem cell research has contributed to a cautious attitude among corporate investors, including pharmaceutical and biotech companies.[81] In 1997, President Clinton announced a U.S. policy against the use of federal funds for human cloning,[82] a stance that Congress had reinforced by an appropriations bill provision "that bars federal funding for research in which a human embryo is destroyed."[83] In 2007, President Bush issued an executive order to the same effect.[84]

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71. *See infra* note 73.

72. Steven Goldberg, *Cloning Matters: How* Lawrence v. Texas *Protects Therapeutic Research*, 4 YALE J. HEALTH POL'Y L. & ETHICS 305, 307 (2004).

73. Lucas Mlsna, Note, *Stem Cell Based Treatments and Novel Considerations for Conscience Clause Legislation*, 8 IND. HEALTH L. REV. 471, 483 (2011).

74. Goldberg, *supra* note 72, at 307-08.

75. Mlsna, *supra* note 73, at 488.

76. Daniel J. DeNoon, *The Future of Stem Cells: Disease Research Hindered by Reproductive Cloning Threat, Experts Say*, WEBMD HEALTH NEWS (July 8, 2004), http://www.webmd.com/alzheimers/news/20040708/future-of-stem-cells.

77. *See* Mlsna, *supra* note 73, at 482.

78. *See id.* at 485-87; *see also* Arthur L. Caplan & Glenn McGee, *Cloning Human Embryos: Decisions Must Not Be Made by Private Corporations Behind Closed Doors*, 176 W. J. MED. 78, 78 (2002).

79. Lauren Neal, *Organ Donation, Therapeutic Cloning, and Laws of the States*, 26 SYRACUSE SCI. & TECH. L. REP. 80, 81 (2012).

80. Goldberg, *supra* note 72, at 308-09 n.18.

81. *See* Peter Winter, *The View from the US: Stem Cell Therapy Steps up a Gear with First Approval and Improved Political Climate*, *in* SCI. BUS., REGENERATE THE FUTURE 26 (2012).

82. Shannon H. Smith, Note, *Ignorance Is Not Bliss: Why a Ban on Human Cloning is Unacceptable*, 9 HEALTH MATRIX 311, 317-18 (1999).

83. Sherley v. Sebelius, 644 F.3d 388, 389-90 (D.C. Cir. 2011), *aff'd*, 689 F.3d 776, 778 (D.C. Cir. 2012).

84. *See* Exec. Order No. 13,435, 72 Fed. Reg. 34,591 (June 20, 2007).

In 2009, President Obama signaled a reversal of this policy by an executive order that authorized U.S. funding of "human stem cell research, including human embryonic stem cell research, to the extent permitted by law."[85] In 2012, following protracted litigation, the U.S. Court of Appeals for the District of Columbia endorsed the use of federal funds for human embryonic stem cell research in *Sherley v. Sebelius*.[86]

While these recent legal developments have provided a source of optimism for the scientific community, past regulatory trends and enduring uncertainties have resulted in restraint with respect to research funding among pharmaceutical companies and venture capitalists.[87] Uncertainties in this area are exacerbated by existing state bans and limits on human cloning.[88]

2. Renewable Energy

Another area where more scrutiny could be beneficial is renewable energy. Extensive development of renewable energy sources such as bioenergy, solar energy, hydropower, wind energy, and geothermal energy[89] will result in a multitude of important societal benefits. For instance, many experts believe that transitioning from carbon-emitting energy sources to renewable alternatives is the most promising approach to combating global warming.[90] If left unchecked, the potential impact of current global warming trends could be devastating.[91] Reports published by the Intergovernmental Panel on Climate Change (IPCC) since 1990 have included an array of probable future catastrophic impacts of human-caused climate change, including intense storms, unprecedented

85. *See* Exec. Order No. 13,505, 74 Fed. Reg. 10,667 (Mar. 9, 2009).

86. *See Sebelius*, 689 F.3d at 785.

87. *See* Winter, *supra* note 81 at 7-8.

88. *See, e.g.*, ARK. CODE ANN. § 20-16-1002 (2005); CONN. GEN. STAT. § 19a-32d (2008); IOWA CODE § 707C.4 (2008).

89. *See* OTTMAR EDENHOFER ET AL., RENEWABLE ENERGY SOURCES AND CLIMATE CHANGE MITIGATION: SPECIAL REPORT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE 8-9 (Leonidas O. Giradin & Mattia Romani eds., 2011), *available at* http://www.ipcc.ch/pdf/special-reports/srren/SRREN_FD_SPM_final.pdf (listing various renewable energy sources).

90. *See* Katherine D. Kelly, Note, *Don't Hide Behind Statutory Roadblocks: How the United States Can Resolve Conflicts to Implementing the German Feed-in Tariff Model and Contribute to International Efforts to Control Climate Change*, 50 COLUM. J. TRANSNAT'L L. 726, 729 (2012).

91. *See generally* LENNY BERNSTEIN ET AL., INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE FOURTH ASSESSMENT REPORT: CLIMATE CHANGE 2007: SYNTHESIS REPORT 48 (Abdelkader Allali et al. eds., 2007), *available at* https://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr.pdf (projecting various adverse impacts on, inter alia, ecosystems, food supplies, coastlines, industry, health, and water).

floods, droughts, and many others.[92] These impacts could result in devastating consequences to our physical and economic well-being,[93] including consequences that are impossible to predict due to our limited understanding of the enormously complex interactions within ecosystems affected by climate change.[94] In addition to mitigating climate change, a widespread deployment of renewable energy sources would benefit socioeconomic development, improve access to energy, provide for safer energy supply, and reduce adverse environmental and health effects from harmful fossil fuel emissions.[95]

Though an immediate deployment of many types of renewable energy sources is technologically feasible,[96] their widespread adoption depends, to a large extent, on establishing an accommodating regulatory framework.[97] In order to establish such a framework, regulators must eliminate various obstacles, such as onerous state and federal consumer protection rules, which render large-scale deployment of renewable energy facilities economically unviable.[98]

Further impeding development of renewable energy is the existing entrenched corporate tax structure, which incentivizes continued use of carbon-emitting energy sources, such as oil and gas, by providing for fossil fuel tax subsidies.[99] These subsidies take many forms, including deductions for percentage depletion, intangible drilling costs, geological and geophysical expenditures, and others.[100] Most of these are without counterparts in other commercial spheres and are unique to oil and gas industries.[101]

Additional tax revenue that could be obtained from repealing incentives enjoyed by these industries—which would remain highly

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92. *See id.* at 44-52; Massachusetts v. EPA, 549 U.S. 497, 508 (2007) (referring to the IPCC's contribution to the scientific understanding of climate change); Stephen H. Schneider & Janica Lane, *An Overview of "Dangerous" Climate Change*, *in* AVOIDING DANGEROUS CLIMATE CHANGE 7, 11 (2006) (discussing various IPCC assessments of climate impacts).

93. *See* Massachusetts v. EPA, 549 U.S. at 521-23.

94. *See* Schneider & Lane, *supra* note 92, at 14-15.

95. *See* EDENHOFER, *supra* note 89, at 718-46.

96. *See id.* at 172-74 (describing the rise in renewable energy sources in recent years and the potential going forward).

97. *See* Stiles, *supra* note 13, at 923-24.

98. *Id.* at 940.

99. *See* Temi Kolarova, Comment, *Oil and Taxes: Refocusing the Tax Policy Question in the Aftermath of the BP Oil Spill*, 42 SETON HALL L. REV. 351, 371 (2012).

100. John A. Bogdanski, *Reflections on the Environmental Impacts of Federal Tax Subsidies for Oil, Gas, and Timber Production*, 15 LEWIS & CLARK L. REV. 323, 325-28 (2011).

101. *Id.* at 325.

profitable without those incentives[102]—could be used to provide funding for alternative energy sources.[103] Such funding could be used to offset costs of deploying solar and other developing energy generation technologies that, despite their vast potential, are not yet competitive on the bigger energy market.[104]

3. Other Areas

Additional areas of technological innovation that warrant closer regulatory attention run the gamut, from internet technologies many of us use every day to cutting-edge research in areas of nanotechnology and space exploration.

A significant issue related to internet technologies in recent years has been the proper balance between the rights of users and those of content providers.[105] Such concerns have resulted in recent unsuccessful attempts by Congress to pass legislation to restrict access to potentially infringing sites.[106] These types of legislative initiatives should be subjected to careful scrutiny because, whether one is in support of or in opposition to such legislation, a larger debate about its merits would clearly be conducive to a more sensible result.

Nanotechnology is a fairly novel area of scientific research[107] whose aim is to produce materials and devices on an immensely small scale that possess enhanced qualities achieved through manipulating atoms.[108] Given that research in this area has yet to realize its full potential, the risks and benefits of nanotechnology are presently poorly understood.[109] Due to uncertainties in the area of nanotechnology, the field suffers from under-regulation, which has a chilling effect on corporate investment and, in turn, perpetuates the state of uncertainty, thereby creating a vicious cycle.[110] Given the

102. David Kocieniewski, *As Oil Industry Fights a Tax, It Reaps Subsidies*, N.Y. TIMES, July 4, 2010, at A1 (quoting a policy analyst as saying "[w]e're giving tax breaks to highly profitable companies to do what they would be doing anyway") (internal quotation marks omitted).

103. Bogdanski, *supra* note 100, at 336.

104. *See generally* David Grinlinton & LeRoy Paddock, *The Role of Feed-in Tariffs in Supporting the Expansion of Solar Energy Production*, 41 U. TOL. L. REV. 943, 945-46 (2010) (noting that the Spanish government directly funds alternative energy deployment through the "feed-in tariff" scheme).

105. *See* Veronica Corsaro, Note, *From Betamax to YouTube: How* Sony Corporation of America v. Universal City Studios, Inc. *Could Still Be a Standard for New Technology*, 64 FED. COMM. L.J. 449, 466 (2012).

106. *See id.* at 450-51.

107. *See* Miller, *supra* note 14, at 436.

108. Amit Makker, Note, *The Nanotechnology Patent Thicket and the Path to Commercialization*, 84 S. CAL. L. REV. 1163, 1166 (2011).

109. *See* Miller, *supra* note 14, at 437.

110. *Id.* at 440-41.

enormous potential of nanotechnology and its wide range of applications to fields like electronics, healthcare, and energy, to name just a few,[111] the importance of breaking this cycle is quite clear.

The future of space exploration, which has generated major scientific discoveries over the years, is likewise uncertain due to significant budgetary cuts that NASA plans for the Planetary Science Division in the year 2013.[112] Combined with the recently-dismantled shuttle program, which NASA does not plan to supplant with a comparable venture, the prognosis for sustained space exploration appears bleak.[113] Though future space missions and projects with support by private companies are being considered, the space agency has not yet fully refocused its efforts on a specific goal.[114]

But a more significant motivation for additional regulatory scrutiny than any specific area of focus is the very nature of innovation. Technology develops at an astonishingly fast pace[115] and, through the innovation cycle,[116] continues to create new frontiers that can flourish only with support of a fertile statutory and regulatory framework. Thus, while addressing each area individually based on its unique characteristics is certainly a worthwhile undertaking, a more comprehensive approach is needed to ensure that the expansion of all areas of technology can continue.

III. NEPA: A WORKING MODEL

NEPA, the principal federal environmental statute[117] which serves to counter environmentally damaging regulation, can be emulated in the realm of technology to serve an analogous purpose—to protect innovation values.[118] NEPA is an expansive statute that sets out a multifaceted disclosure scheme for federal agencies.[119] While a wholesale implementation of NEPA's entire legislative and regulatory scheme within the technological realm would be too

111. *See* Makker, *supra* note 108, at 1167-68.

112. *See NASA's Space Exploration Plans Take a Galactic Hit*, *supra* note 15.

113. *See* Seth Borenstein, *Expert Panel: NASA Seems Lost in Space, Needs Goal*, YAHOO NEWS (Dec. 5, 2012, 6:16 PM), http://news.yahoo.com/expert-panel-nasa-seems-lost-161404282.html.

114. *See id.*

115. *See supra* note 35.

116. *See supra* text accompanying notes 41-43.

117. *See supra* note 21.

118. This language has been adapted from NEPA's stated policy, which is "to protect environmental values." Calvert Cliffs' Coordinating Comm., Inc. v. U.S. Atomic Energy Comm'n, 449 F.2d 1109, 1112 (D.C. Cir. 1971).

119. Natasha Baldauf, Comment, *One-Way Track to Desecration: Implications of the Honolulu Rail's Failure to Comply with Protections Mandated for Native Hawaiian Burials*, 12 ASIAN-PAC. L. & POL'Y J. 141, 161-62 (2010) (describing NEPA's legal framework).

burdensome and, thus, counterproductive, portions of this scheme can be borrowed to help safeguard a sustained path toward technological progress.

Before focusing on specific provisions of NEPA that could be adapted to the realm of technology, an overview of the statute along with the history of its achievements and shortcomings would be instructive.

A. NEPA Background

NEPA prescribes a process for implementing certain environmental actions, though it does not dictate a particular substantive result.[120] The central feature[121] of NEPA is the provision that mandates that "major Federal actions significantly affecting the quality of the human environment" be accompanied by an EIS.[122] The EIS is designed to provide disclosure to decision makers and the public about major environment affecting activities and allow for public participation in gathering information related to those activities.[123] The EIS must include:

> (i) the environmental impact of the proposed action, (ii) any adverse environmental effects which cannot be avoided should the proposal be implemented, (iii) alternatives to the proposed action, (iv) the relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity, and (v) any irreversible and irretrievable commitments of resources which would be involved in the proposed action should it be implemented.[124]

The Council on Environmental Quality ("CEQ") has promulgated regulations that establish procedures that agencies must follow in order to meet NEPA requirements.[125] According to those regulations, in order to determine whether an EIS is required for a proposed agency action, assuming that action is not subject to a pre-determined "categorical exclusion,"[126] an agency must first conduct an environmental assessment.[127] If an agency determines that an

120. Stewart Park & Reserve Coal., Inc. v. Slater, 352 F.3d 545, 557 (2d Cir. 2003).

121. *See supra* note 24.

122. 42 U.S.C. § 4332(2)(C) (2006).

123. *See* Trout Unlimited v. Morton, 509 F.2d 1276, 1282 (9th Cir. 1974); *see also* Jaclyn Lopez, *Too Much Oil for the Rubber-Stamp: The Government's Role in the BP Oil Spill*, 6 FLA. A & M U.L. REV. 201, 205 (2011) ("The goal of NEPA is that the action agency takes a hard look at the activities it proposes and involves the public at an early stage.").

124. 42 U.S.C. § 4332(2)(C)(i)-(v).

125. Heartwood, Inc. v. U.S. Forest Serv., 380 F.3d 428, 431 (8th Cir. 2004).

126. *See* 40 C.F.R. § 1508.4 (2012).

127. *See* 40 C.F.R. § 1508.9 (2012); *see also Heartwood, Inc.*, 380 F.3d at 430 (describing the NEPA procedure, which includes, inter alia, the preparation of an environmental assessment).

EIS is not required because the action "will not have a significant effect on the human environment,"[128] it prepares what is known as a "finding of no significant impact,"[129] or FONSI.

The decision whether to prepare a FONSI or a more comprehensive EIS can only be made after a thorough analysis of environmental effects of the proposal, which is subject to a searching judicial review for reasonableness.[130] The regulations set forth a multitude of factors that an agency must consider as part of its evaluation of the significance of the proposed action.[131] Actions are analyzed in terms of their context and intensity.[132] Context can refer to the interests affected by the action or the locality that the action targets.[133] In evaluating the action's intensity, an agency must look at such factors as effects on public health and safety, uniqueness of the locality, whether the environmental effects of the proposed action would be controversial, the precedential value of the proposal, and other considerations.[134]

If an agency, after evaluating the environmental effects of the proposal, makes a decision to prepare an EIS, it must commence the next step of the process called "scoping."[135] During this stage, an agency solicits input from affected entities, including other cooperating agencies, determines the scope and major issues to be addressed in the EIS, and allocates responsibilities among cooperating agencies.[136]

Following the scoping process, an agency must prepare a draft EIS and publish it for public comment.[137] It must solicit comments from a wide array of affected agencies and other interested entities.[138] Agencies that must provide comments are those with "jurisdiction by law or special expertise with respect to any environmental impact involved or which [are] authorized to develop

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128. *See* 40 C.F.R. § 1508.13 (2012).

129. 40 C.F.R. § 1501.4(e) (2012).

130. *See* Marsh v. Or. Natural Res. Council, 490 U.S. 360, 378 (1989). Although the Court in *Marsh* held that the agency's decision to prepare an EIS was subject to a deferential "arbitrary and capricious" standard, it also stressed that "courts should not automatically defer to the agency's express reliance on an interest in finality without carefully reviewing the record and satisfying themselves that the agency has made a reasoned decision." *Id.*

131. *See* 40 C.F.R. § 1508.27 (2012).

132. *Id.*

133. *See id.* § 1508.27(a).

134. *See id.* § 1508.27(b).

135. *See* 40 C.F.R. § 1501.7 (2012); *see also* Citizens for Envtl. Quality v. United States, 731 F. Supp. 970, 995 (D. Colo. 1989).

136. *See* 40 C.F.R. § 1501.7(a).

137. 40 C.F.R. § 1502.9(a) (2012).

138. 40 C.F.R. § 1503.1(a) (2012).

and enforce environmental standards."[139] If meaningful comment is precluded by an inadequacy in the draft EIS, an agency must revise and reissue the draft EIS.[140] After comments are obtained from interested parties, an agency must prepare the final EIS to respond to those comments and clarify points that were not adequately addressed in the draft EIS.[141] Disputes among agencies over proposed actions are referred to the CEQ, which was established in part to resolve inter-agency disagreements as to federal actions that may affect the environment.[142]

In addition, an agency has an obligation to prepare a supplemental EIS if "[t]here are significant new circumstances or information relevant to environmental concerns and bearing on the proposed action or its impacts"[143] or "[t]he agency makes substantial changes in the proposed action that are relevant to environmental concerns."[144] An agency is expected to undertake the same type of analysis when deciding whether to issue a supplemental EIS as it did to issue the initial EIS.[145]

A particular aspect of NEPA that is worthy of special mention is that the statute imposes environmental obligations not just on agencies whose mission is related to the environment, but on all federal agencies, regardless of their purpose.[146] By applying its policy to a wide range of federal activities, NEPA elevates environmental concerns and imposes on every government agency, as an important mandate, that those concerns be properly addressed.[147] This paradigm comprises the core thesis of this Note. By imposing a mandate on all agencies to properly address technological development concerns, those concerns become subject to considered decisions instead of ignored with potentially unexamined detrimental results.

B. NEPA's Achievements

Designating a proper measure of NEPA's achievements is

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139. *Id.* § 1503.1(a)(1).

140. 40 C.F.R. § 1502.9(a).

141. *Id.* § 1502.9(b).

142. *See* 40 C.F.R. § 1504.1(a) (2012); *see also* Sierra Club v. U.S. Dep't. of Transp., 753 F.2d 120, 124 (D.C. Cir. 1985).

143. 40 C.F.R. § 1502.9(c)(1)(ii).

144. *Id.* § 1502.9(c)(1)(i).

145. Marsh v. Or. Natural Res. Council, 490 U.S. 360, 374 (1989).

146. *See* Wendy B. Davis, *The Fox Is Guarding the Henhouse: Enhancing the Role of the EPA in FONSI Determinations Pursuant to NEPA*, 39 AKRON L. REV. 35, 36 (2006) ("Even if [a] federal agency has no environmental expertise, the agency will have authority to [fulfill NEPA mandates].").

147. Aliza M. Cohen, Note, *NEPA in the Hot Seat: A Proposal for an Office of Environmental Analysis*, 44 U. MICH. J.L. REFORM 169, 175 (2010).

perhaps the most challenging aspect of evaluating the statute's effectiveness. As noted above, NEPA is a procedural statute that centers on guiding the process employed by agencies in taking certain actions, rather than directing a particular result of those actions.[148] Ultimately, NEPA cannot be credited for the successful completion of a project, but rather for the value that it adds by mandating an open discussion about the project's environmental impact that may otherwise not take place.[149] Aside from requiring that agencies carefully deliberate the effects of their actions, NEPA mandates that the debate as to those effects take place at the most logical time—"before the bulldozers . . . begin to roll";[150] that is, before the decision is complicated by a substantial financial investment.[151]

A recent report by the Environmental Law Institute credits NEPA for successfully engaging the public in environmental decisions, and notes that due to public comment "bad decisions have sometimes been avoided and good decisions often have been made better." [152] The same report mentions numerous success stories attributable to NEPA, selected "from the large universe of NEPA successes."[153] These are provided in juxtaposition to the stance taken by many critics that NEPA often results in delays when agencies undertake controversial actions.[154]

But perhaps the biggest endorsement of NEPA is its persistence for over four decades[155] through changing times,[156] shifting societal

148. *See* Robertson v. Methow Valley Citizens Council, 490 U.S. 332, 350 (1989) (stating a "well settled" principle "that NEPA itself does not mandate particular results, but simply prescribes the necessary process").

149. *See* Robert W. Adler, *In Defense of NEPA: The Case of the Legacy Parkway*, 26 J. LAND RESOURCES & ENVTL. L. 297, 300 (2006) ("Because it is an information-based approach to environmental protection, in which decision makers . . . are forced simply to consider the effects of their actions fully and openly, [NEPA] works or does not work depending on the integrity of the process itself.").

150. *Id.* at 299.

151. Cohen, *supra* note 147, at 185 ("NEPA takes an ex ante rather than ex post approach to environmental harms. By requiring agencies to fully disclose foreseeable harms and consider alternative actions before expending great amounts of money, NEPA forces consideration of environmental considerations before a project becomes 'the controlling policy.'").

152. ENVTL. LAW INST., NEPA SUCCESS STORIES: CELEBRATING 40 YEARS OF TRANSPARENCY AND OPEN GOVERNMENT 6 (2010), *available at* https://soe.salsalabs.com/o/1/images/nepasuccessstories.pdf.

153. *Id.* at 8.

154. *Id.* at 7.

155. *See* Jackson Cnty., Mo. v. Jones, 571 F.2d 1004, 1007 (8th Cir. 1978) (listing 1970 as the year of NEPA's enactment).

156. *See* R. B. Smythe, *The Historical Roots of NEPA, in* ENVIRONMENTAL POLICY AND NEPA: PAST, PRESENT, AND FUTURE 3, 12 (1997) ("NEPA articulated a concern for environmental quality that was firmly rooted in the values of America's earlier

values,[157] and countless legal challenges.[158] What is more, the NEPA model has inspired many state-level enactments called SEPAs or "little NEPAs,"[159] as well as comparable international legislation.[160]

C. NEPA's Shortcomings

Like any breakthrough, far-reaching piece of legislation,[161] NEPA has received its share of criticism throughout the decades following its enactment. The statute and its regulations have been criticized for the high cost they add to environmental decisions,[162] for offering too blunt an instrument to properly address the complexities of the environment,[163] for adding inefficiencies and delays to agency action,[164] for introducing inaccuracies by requiring only minimal expert oversight,[165] for tolerating minimally-examined FONSI determinations,[166] for considerable vagueness in many of their

conservation philosophers, but also tempered by more recent utilitarian and scientific perspectives.").

157. *See* BENJAMIN KLINE, FIRST ALONG THE RIVER: A BRIEF HISTORY OF THE U.S. ENVIRONMENTAL MOVEMENT 189 (4th ed. 2011) (summarizing historical trends of the U.S. environmental movement and noting that in the first decade of the twenty-first century "we have seen a backlash against the proliferation of environmental regulations that have intruded into almost every aspect of our lives since the first Earth Day in 1970.").

158. Richard Lazarus, *The National Environmental Policy Act in the U.S. Supreme Court: A Reappraisal and a Peek Behind the Curtains*, 100 GEO. L.J. 1507, 1515 (2012) (noting that many, including NEPA's chief sponsor, were surprised at the unexpected, dramatic rise of NEPA-based litigation in the 1970s). The number of Supreme Court petitions raising NEPA questions had reached 155 in the four decades since NEPA's enactment. *Id.* at 1521.

159. *See* Kenneth S. Weiner, *Little NEPAs: State-Level Environmental Impact Assessment*, ENVTL. LAW INST. (May 30, 2005), http://www.eli.org/sites/default/files/docs/seminars/NEPA/Little%20NEPAs.pdf?q=pdf/seminars/NEPA/Little%20NEPAs.pdf (discussing state-level enactments modeled after NEPA).

160. *See* Lazarus, *supra* note 158, at 1521; *see also* Bradley C. Karkkainen, *Toward a Smarter NEPA: Monitoring and Managing Government's Environmental Performance*, 102 COLUM. L. REV. 903, 905-06 (2002) ("NEPA is without question the most widely emulated of the major U.S. environmental laws. It has inspired dozens of 'little NEPAs' at the state and local levels, numerous progeny around the globe, and countless imitators in other fields.") (footnotes omitted).

161. *See* Karkkainen, *supra* note 160, at 948.

162. *See* Paul R. Portney et al., *The EPA at "Thirtysomething"*, 21 ENVTL. L. 1461, 1462-64 (1991).

163. *See* Daniel R. Mandelker, *The National Environmental Policy Act: A Review of Its Experience and Problems*, 32 WASH. U. J.L. & POL'Y 293, 294 (2010).

164. *See id.* at 296; Ian C. Lindars, *The Future of the National Environmental Policy Act*, 32 REAL EST. L.J. 109, 121-23 (2003) (pointing to delays as the source of major criticism of the NEPA process).

165. *See* Davis, *supra* note 146, at 43.

166. *See id.* at 41.

requirements,[167] and for their weak enforcement structure,[168] to mention only major criticisms.

Several governmental reports have evaluated NEPA by taking a more nuanced view of its shortcomings. In 2003, the CEQ NEPA Task Force produced a comprehensive report, identifying specific issues within areas of regulatory action mandated by NEPA and suggesting various improvements in order to address those issues.[169] Among areas covered by the report were technology, intergovernmental collaboration, categorical exclusions, and environmental assessment.[170] The report's suggestions to CEQ ran the gamut from developing guidance for agencies[171] and the public,[172] to establishing working groups,[173] to creating more precise standards to homogenize agency action.[174]

Another major CEQ publication had been produced several years earlier to evaluate NEPA's effectiveness a quarter century following its enactment.[175] The report focused on such elements as strategic planning, public information and input, and interagency coordination.[176] The introductory portion of this report contains perhaps the most pointed critique of NEPA issued by a governmental study: "[F]requently NEPA takes too long and costs too much, agencies make decisions before hearing from the public, documents are too long and technical for many people to use, and training for agency officials at times is inadequate."[177]

Such pointed criticism from the very body that is responsible for coordinating NEPA's operation begs the question why anyone would seriously consider implementing a similar scheme in a different area.

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167. *See* Jeannette MacMillan, Note, *An International Dispute Reveals Weaknesses in Domestic Environmental Law: NAFTA, NEPA, and the Case of Mexican Trucks (*Department of Transportation v. Public Citizen*)*, 32 ECOLOGY L.Q. 491, 521 (2005) (pointing to the "vagueness of [NEPA's] substantive language"); *see also* Myron L. Scott, *Defining NEPA Out of Existence: Reflections on the Forest Service Experiment with "Case-by-Case" Categorical Exclusion*, 21 ENVTL. L. 807, 813-17 (1991) (criticizing an ad hoc implementation of NEPA's categorical exclusions by the Forest Service).

168. *See* Lawrence Gerschwer, Note, *Informational Standing Under NEPA: Justiciability and the Environmental Decisionmaking Process*, 93 COLUM. L. REV. 996, 1039 (1993).

169. THE NEPA TASK FORCE, REPORT TO THE COUNCIL ON ENVIRONMENTAL QUALITY: MODERNIZING NEPA IMPLEMENTATION 2 (2003), *available at* http://cdn.ca9.uscourts.gov/datastore/library/2013/02/26/Pacific_NEPA%20final.pdf.

170. *Id.*

171. *Id.* at 21.

172. *Id.* at 33.

173. *Id.* at 21.

174. *Id.* at 72-74.

175. COUNCIL ON ENVTL. QUALITY, *supra* note 21, at iii.

176. *Id.* at ix.

177. *Id.*

The answer can be expressed using a famous aphorism: "[d]on't let the perfect be the enemy of the good."[178] Quite clearly, in a vastly complex society such as ours,[179] a statute with a charge as expansive as "achieving 'productive harmony' among our environmental, economic, and social objectives"[180] cannot be implemented flawlessly. Notably, none of the sources of critique offered above advocate an outright repeal of NEPA. Indeed, the same CEQ report that pointedly criticizes NEPA contains the following opening language: "Overall, what we found is that NEPA is a success."[181] Similarly, much of the scholarly writing dealing with NEPA's shortcomings offers recommendations for improvements to the statute, rather than calling for its abandonment.[182]

In the realm of technology, where an existing statutory framework is not yet in place, lawmakers could be offered a unique opportunity to build a superior piece of legislation from the ground up, accounting for the pitfalls identified throughout decades of NEPA experience. Lessons learned from NEPA can be integrated into the foundation of the new framework, cultivating its utility and efficiency from its very inception.

IV. THE PROPOSED SCHEME

As mentioned above, this Note does not advocate a full-scale adoption of NEPA to the realm of technology, but rather a more conservative scheme that borrows major queues from NEPA but stops considerably short of implementing NEPA's expansive span. Specifically, this Note proposes a statutory mandate that "major Federal actions significantly affecting" the advancement of technology be accompanied by a Technological Impact Statement ("TIS").[183] This limited scheme, combined with a proposal for oversight by an expert agency, would address much of the criticism of NEPA by mitigating issues stemming from delays, costs, and unpredictability.

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178. *See generally* Gretchen Rubin, *Don't Let the Perfect Be the Enemy of the Good*, HUFFINGTON POST (Jan. 18, 2009, 9:26 AM), http://www.huffingtonpost.com/gretchen-rubin/dont-let-the-perfect-be-t_b_158673.html (quoting Voltaire).

179. *See* J.B. Ruhl & Harold J. Ruhl, Jr., *The Arrow of the Law in Modern Administrative States: Using Complexity Theory to Reveal the Diminishing Returns and Increasing Risks the Burgeoning of Law Poses to Society*, 30 U.C. DAVIS L. REV. 405, 407 (1997) (describing society as an "adaptive system" that is "nonlinear, dynamical, and complex in [its] behavior").

180. COUNCIL ON ENVTL. QUALITY, *supra* note 21, at iii.

181. *Id.*

182. *See, e.g.*, Davis, *supra* note 146, at 72 (proposing that lead agencies become more involved in NEPA processes); Portney et al., *supra* note 162, at 1475 (calling for creative solutions to environmental problems within the framework of NEPA).

183. *See supra* note 24, at 10608.

A. Streamlining the Process

As discussed above, the central feature of NEPA is the EIS requirement.[184] In the case of technological regulation, the TIS requirement should not only be the central feature, but should comprise the bulk of the statutory and regulatory disclosure framework. The role of the TIS in government actions affecting the advancement of technology would be analogous to that of the EIS in government actions affecting the environment—to "provide full and fair discussion of significant [impacts on technological progress] and . . . inform decisionmakers and the public of the reasonable alternatives which would avoid or minimize adverse impacts."[185]

The accompanying disclosure process should be free of many of NEPA's auxiliary procedures. Simplifying the process should be a crucial imperative in the realm of technology. A simplified process would address at least two of the biggest criticisms of NEPA—the delays[186] and costs[187] associated with the NEPA scheme. With respect to the first criticism, given the rapid pace of innovation,[188] the interest in avoiding administrative delays is of the utmost importance in the technological realm. To that end, the elaborate procedure set out by NEPA's regulatory structure would need to be streamlined considerably to fit technological goals. The complex, often redundant set of guidelines set out by NEPA has a potential to grind agency action to virtual standstill.[189] One need only read through the summary of the NEPA process discussed above[190] to appreciate the extent to which agency action can be wrapped in a massive bureaucratic web.

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184. *See supra* note 24.

185. This language has been adopted from the section of NEPA regulations that sets forth the purpose of the EIS. *See* 40 C.F.R. § 1502.1 (2012).

186. *See supra* text accompanying notes 164, 177.

187. *See supra* text accompanying notes 162, 177.

188. *See* discussion *supra* Part II.A.

189. One scholar critiques the redundancy of the NEPA disclosure scheme this way:

> [NEPA's] decision-making process [as mandated by regulations] . . . is complicated and redundant
>
> . . . . Redundancy occurs because . . . compliance alternatives overlap. Each requires a significance determination . . . . [A] decision that an action can be categorically excluded must be reversed if its environmental impacts are found to be significant. The environmental assessment, sometimes referred to as a mini-impact statement, also determines whether an action is significant. . . . An environmental impact statement analyzes the environmental significance of the action it considers, and an agency can be reversed in court if the significance evaluation is not adequate.

Mandelker, *supra* note 163, at 298. Notably, the above critique focuses on a mere subset of the overall procedure, which includes even more redundant steps. *See* discussion *supra* Part III.A.

190. *See* discussion *supra* Part III.A.

Furthermore, the benefits of streamlining the process would extend beyond addressing delays and costs, and would indirectly address other related issues, such as undue length and technical detail of NEPA's disclosure documents.[191] A simplified process would condense the amount of resulting paperwork and eliminate excessive minutiae from it.

B. Expert Agency Oversight

Comprehensive oversight by an expert agency would result in a higher level of accuracy in the proposed disclosure scheme by accounting for known pitfalls as early in the process as possible. While some of the consequences of technology-affecting actions may not be known to agencies with only a tangential relationship to technology, those same consequences could be well within the knowledgebase of an expert agency. Furthermore, the knowledgebase of such an agency would continue to expand as a result of its involvement in the proposed TIS process. Thus, any agency, regardless of its primary area of expertise, would be able to take advantage of the synergistic effect of information gathering from other agencies engaged in technology-effecting regulation. As a consequence, such oversight would not only enhance the quality of disclosure by contributing to its accuracy, but would further mitigate the administrative burden of the proposed scheme by reducing the costs and delays of iterative reporting.[192]

A good candidate for an expert agency that could fulfill such a role is the Office of Technology Assessment ("OTA"). The OTA was created in 1972 to "help[] Congress to assess complex issues [related to new technologies] and make wiser legislative choices," but was deprived of funding in 1995.[193] Since then, many individuals and organizations have called for restoring the agency.[194] OTA's potential

191. *See supra* text accompanying note 177.

192. The iterative reporting referred to here is a prominent characteristic of the NEPA regime, which mandates multiple iterations of impact analysis. *See* discussion *supra* Part III.A; *see also* Mandelker, *supra* note 163, at 298 (discussing the inefficiency of the NEPA decision-making process).

193. *Restoring the Office of Technology Assessment*, UNION OF CONCERNED SCIENTISTS (Feb. 24, 2010), http://www.ucsusa.org/scientific_integrity/solutions/big_picture_solutions/restoring-the-ota.html.

194. *See id.* (highlighting several important recommendations made by the OTA during its operation and pointing to the value that an expert body of scientists could add to policy decisions dealing with "issues such as nanotechnology, stem cell research, the effectiveness of airport and port security systems, the best armor and equipment to protect our soldiers, and how best to protect public health and safety"); *see also* Jathan Sadowski, *The Much-Needed and Sane Congressional Office that Gingrich Killed Off and We Need Back*, THE ATLANTIC (Oct. 26, 2012, 3:11 PM), http://www.theatlantic.com/technology/archive/2012/10/the-much-needed-and-sane-congressional-office-that-gingrich-killed-off-and-we-need-back/264160 (pointing to

role in guiding federal agencies in the proposed TIS process can be added to a long list of reasons to restore the office.

C. TIS: Statutory and Regulatory Scheme

Under the proposed TIS scheme, the statutory framework for technological impact disclosure would closely parallel that of environmental impact disclosure. Because NEPA is sufficiently broad to allow for a wide spectrum of implementation patterns,[195] a scheme modeled from NEPA's could retain the bulk of NEPA's statutory provisions.

Thus, the language of the main statutory provision of the proposed TIS scheme could closely parallel its NEPA counterpart:[196] "[A]ll agencies of the Federal Government shall . . . include in every recommendation or report on proposals for legislation and other major Federal actions significantly affecting [the progress of technology], a detailed statement by the responsible official."[197]

The content of the TIS could also closely parallel that of the EIS, with appropriate alterations to tailor it to the requirements of technological impact disclosure. Thus, the TIS could include: "(i) the . . . impact of the proposed action [on technological progress], (ii) any adverse . . . effects [on technological progress] which cannot be avoided should the proposal be implemented, (iii) alternatives to the proposed action," (iv) the correlation of short-term benefits of implementing the proposal and long-term impact on technological progress, taking into account the exponential and superexponential rate of progress in appropriate areas, "and (v) any irreversible and irretrievable commitments of resources which would be involved in the proposed action should it be implemented."[198] The inclusion of language concerning the exponential and superexponential rate of progress would be of particular importance in technological impact disclosure. This language would ensure that lawmakers are properly accounting for the actual rate of progress, instead of adopting an "intuitive linear" view.[199] As noted above, the difference between

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scholarly articles that have praised the legacy of the OTA and calling its dismantling "an unfortunate blow to the efforts of understanding and shaping the effects of complex science and technology").

195. *See* Mandelker, *supra* note 163, at 296-97 (noting the brevity of NEPA's statutory structure and explaining that, in the absence of comprehensive legislative direction, the substantive portion of the scheme is set out by the regulatory framework).

196. *See supra* note 24.

197. This language parallels the language in NEPA that mandates the creation of the EIS. *See* 42 U.S.C. § 4332(2)(C) (2006).

198. This language parallels the language in NEPA that sets out the content requirement of the EIS. *See* 42 U.S.C. § 4332(2)(C).

199. *See supra* notes 35-37 and accompanying text.

these two measures of progress is immense.[200]

The regulatory framework, as noted above, should be substantially streamlined in order to better suit the context of technology and to avoid some of the major pitfalls in NEPA regulation.[201] The precise formulation of TIS-enabling regulations would be subject to careful deliberation by an expert agency, such as the OTA.[202] In addition to promulgating TIS regulations, the OTA would produce a list of comprehensive guidelines with detailed criteria for actions that must be accompanied by a TIS.[203]

The procedure would be conducted as follows: First, an agency would consult OTA guidelines to determine whether a TIS is required.[204] If so, an agency would solicit input from interested entities, such as members of the scientific community and institutions conducting research in the affected field.[205] Most importantly, an agency would be required to solicit input from the OTA, which would be responsible for providing pertinent sources of information and noting specific items to be addressed in the TIS.[206] An agency would then prepare a TIS based on the information gathered during the solicitation process and publish it for public

200. *See supra* note 38.

201. *See* discussion *supra* Part IV.A.

202. *See* discussion *supra* Part IV.B.

203. Incidentally, recommendations for expert guidance comprise a major theme in the 2003 report by the CEQ NEPA Task Force. *See generally* THE NEPA TASK FORCE, *supra* note 169 (recommending that the CEQ provide additional guidance in most areas considered in the report).

204. This should not be confused with the "categorical exclusion" practice under NEPA. *See* 40 C.F.R. § 1508.4 (2012). In fact, OTA guidelines would address the criticism that categorical exclusions lack standards and, therefore, result in inconsistent determinations. *See* Scott, *supra* note 167, at 816. Instead, OTA guidelines should utilize specific criteria to enable agencies to determine whether a TIS is required. These criteria could include, for instance, regulatory areas triggering the TIS requirement and norms for comparative evaluation between relevant developments in the United States and those in other nations. Thus, for example, banning research that is actively pursued in other developed nations should trigger a TIS. Additionally, where appropriate, the OTA could establish monetary thresholds to ensure that budgetary allocations above a certain dollar amount must be accompanied by a TIS.

205. This would be akin to the "scoping" process under the NEPA regime. *See* 40 C.F.R. § 1501.7 (2012).

206. To some extent, this would be similar to the provision in NEPA regulations that requires agencies to "[o]btain the comments of any Federal agency which has jurisdiction by law or special expertise with respect to any environmental impact involved or which is authorized to develop and enforce environmental standards." 40 C.F.R. § 1503.1(a)(1) (2012). The important difference is that an agency would not be required to prepare a draft statement as a prerequisite to obtaining expert comments. By obtaining such comments ahead of preparing a TIS, an agency would be immediately steered in the appropriate direction, avoiding some of the delays criticized in the NEPA process. *See supra* note 164 and accompanying text.

comment.[207] This scheme would be free from many of the regulatory burdens of the NEPA process, such as environmental assessment,[208] FONSI determination,[209] draft EIS,[210] and supplemental EIS preparation.[211]

D. Applying the Scheme

A concrete example will help illustrate the operation of the proposed scheme. A good candidate agency for its application is NASA, whose recent budget proposal has included cuts to several of its important programs.[212] Under the proposed scheme, before the space agency could divert funds away from its Planetary Science division, it would be required to consult OTA guidelines.[213] A twenty percent budget cut[214] by NASA could well exceed the TIS threshold.[215] Assuming that it would, NASA would then be required to consult its own experts as well as those of other scientific bodies.[216] That list would include major institutions that have utilized the vast body of knowledge obtained from space research and exploration, such as meteorological establishments that have taken advantage of Earth-imaging satellites[217] and National Institutes of Health that have utilized microalgae research.[218] NASA would also consult the OTA for additional guidance.[219] The agency would then prepare a TIS, noting the impact of its budgetary allocation on the progress of technology and figuring in the exponential rate of progress, as required by the statutory provision.[220] Finally, NASA would publish

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207. To further streamline this procedure, for actions involving administrative rulemaking, the TIS public comment process could be incorporated into the general "notice and comment" process, which is already mandated by the Administrative Procedure Act. *See* 73 C.J.S. PUBLIC ADMINISTRATIVE LAW AND PROCEDURE § 186 (2004).

208. *See* 40 C.F.R. § 1508.9 (2012).

209. *See* 40 C.F.R. § 1508.13 (2012).

210. *See* 40 C.F.R. § 1502.9(a) (2012).

211. *See id.* § 1502.9(c).

212. *See supra* note 15.

213. *See supra* note 204 and accompanying text.

214. *See supra* note 15 and accompanying text.

215. *See supra* note 204 and accompanying text.

216. *See supra* note 205 and accompanying text.

217. *See Commercial Earth-Imaging Satellites*, SPACE FOUND., http://www.spacefoundation.org/programs/space-technology-hall-fame/inducted-technologies/commercial-earth-imaging-satellites (last visited Jan. 25, 2014).

218. *See Micro Algae Nutritional Supplements: Martek/Formulaid Nutritional Products from Space Research*, SPACE FOUND., http://www.spacefoundation.org/programs/space-technology-hall-fame/inducted-technologies/micro-algae-nutritional-supplements-%E2%80%93 (last visited Jan. 25, 2014).

219. *See supra* note 206 and accompanying text.

220. *See supra* text accompanying note 198.

the TIS for public comment.[221] Alternatively, in the course of this process, NASA could discover that the action is indefensible from a technological impact standpoint and, consequently, change its course.

Concededly, the proposed scheme would be more effective at counteracting affirmative bans or efforts to divest research in certain areas than at compelling agencies to fund promising research. However, the latter category can be addressed using budget allocations as TIS triggers.[222] Thus, disproportionally low federal funding within a particular area as compared to funding allocated by other developed nations within that same area could, by itself, trigger the TIS requirement. Additionally, the OTA could conduct studies to identify important areas of technological development that are underfunded, and trigger the TIS process on its own. Doing so would not only bring important issues to light, but would engage relevant agencies by compelling them to account for their inaction.

V. CONCLUSION: ENTER THE ANDROID

The android reference in the title of this Note may seem too removed from our time to be relevant in today's policy choices.[223] Yet, this reference is not as futuristic as it may appear. We are always working hard to overcome our innate limitations by not only utilizing technology in each facet of our lives,[224] but also increasingly relying on it for our survival.[225] No, we are not literally androids,[226] but we certainly are a society that cannot take our technological values lightly. We are always on the verge of new world-transforming innovations that constantly change the landscape of everything around us and will continue to uncover new frontiers for the foreseeable future.[227]

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221. *See supra* note 207 and accompanying text.

222. *See supra* note 204 and accompanying text.

223. The Merriam-Webster dictionary defines the term android as "a mobile robot usually with a human form." *Android: Definition*, MERRIAM-WEBSTER, http://www.merriam-webster.com/dictionary/android (last visited Jan. 25, 2014). This definition conjures up decidedly futuristic images.

224. *See supr*a text accompanying notes 3-4.

225. *See supra* text accompanying note 25.

226. Interestingly, some observers consider this status quo temporary and believe that at some future point, we will literally have to merge with advanced technology in order to remain relevant. *See* Michio Kaku, *Space Elevators and Smart Machines: Life in the Year 2100*, CNN OPINION (Dec. 16, 2011, 7:20 AM), http://www.cnn.com/2011/12/16/opinion/michio-kaku-life-2100 ("[R]obots surpass[ing] us in intelligence . . . may leave open one . . . option: merge with our creations. This may not sound as preposterous as it first appears. And there are perks involved with merging with our robotic creations, such as immortality and perfect, superhuman bodies."); *see also* KURZWEIL, *supra* note 35, at 9 (noting that in the future world "[t]here will be no distinction . . . between human and machine or between physical and virtual reality").

227. *See* discussion *supra* Part II.A.

To name just a few examples from the massive array of world-changing breakthroughs just on the horizon, the manufacturing world is currently on the verge of being transformed by the vast potential of 3-D printing,[228] scientists are anticipating major breakthroughs in federally-funded AI research,[229] and traffic congestion may soon be a thing of the past with self-driving cars soon to be mass-produced.[230] The world is constantly changing and, if we are to remain at the helm of these transformations, we must not only anticipate those changes, but work actively at bringing them about.

To aid us in this effort, this Note proposes a disclosure scheme—a seemingly modest improvement to the status quo. But the power of information should not be underestimated. Indeed, a rapid diffusion of ideas, fueled by social networking and other disseminating means, has brought revolutionary changes to many parts of the world, sometimes literally.[231] The value of transparency can scarcely be diminished, and adding it to one of the most important aspects of our modern lives—the advancement of technology—should not just be an option, but an imperative.

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228. Doug Gross, *Obama's Speech Highlights Rise of 3-D Printing*, CNN TECH (Feb. 13, 2013, 3:22 PM), http://www.cnn.com/2013/02/13/tech/innovation/obama-3d-printing/index.html?hpt=hp_c4 (quoting President Obama as saying "[a] once-shuttered warehouse is now a state-of-the art lab where new workers are mastering the 3-D printing that has the potential to revolutionize the way we make almost everything").

229. *See* John Markoff, *Seeking to Boost Study of Human Brain*, N.Y. TIMES, Feb. 18, 2013, at A1 (reporting on an upcoming long-term federally-funded project to gain insights into the human brain, which, among other benefits, "holds the potential of paving the way for advances in artificial intelligence").

230. *See* Christian Wüst, *Auto Revolution: A Promising Future for Self-Driving Cars*, ABC NEWS (Feb. 1, 2013), http://abcnews.go.com/International/auto-revolution-promising-future-driving-cars/story?id=18378323 ("The technology needed for driverless cars is here and could be ready for the market in less than a decade.").

231. *See, e.g.*, Ryan Holmes, *Why Social Media Is (Really) Revolutionary: Looking Back at Egypt*, LINKEDIN (Nov. 26, 2012), http://www.linkedin.com/today/post/article/20121126213602-2967511-why-social-media-is-really-revolutionary-looking-back-at-egypt ("When hundreds of thousands of Egyptians flooded Tahrir Square in early 2011, . . . an entirely new kind of uprising was about to boil over and ripple throughout the Middle East. During this period, . . . technology—primarily social media—would play a role in shaping the [2011 Egyptian Revolution]."); Lina Ben Mhenni, *How the Web Fed Our 'Dignity Revolution'*, CNN OPINION (Jan. 23, 2012, 2:36 PM), http://www.cnn.com/2012/01/23/opinion/lina-ben-mhenni-opinion (noting the role of the Internet in ending Tunisia's dictatorship).