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Notre Dame Journal of Law, Ethics & Public Policy

1998

12 ND J. L. Ethics & Pub Pol'y 9

LENGTH: 34967 words

ARTICLE: THE ECONOMICS OF THE AMERICANS WITH DISABILITIES ACT PART II - PATENTS AND INNOVATIONS IN ASSISTIVE TECHNOLOGY

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LEXISNEXIS SUMMARY:

... The determination includes: the scope and content of the prior art; differences between the prior art and the claims at issue; the level of ordinary skill in the art; and a number of "secondary considerations." ... The district court next turned to the question of obviousness by (i) examining the scope and content of the prior art; (ii) comparing the claims at issue to the prior art; and (iii) determining the level of ordinary skill in the art of wheelchair design and manufacture (Graham factor 3). ... Some argue that technology forecasting based on patent data is inaccurate because patents cannot measure the "null set" of innovations that do not get patented. ...

TEXT:
[*11]

I. Introduction

Shortly after reauthorization of the Technology Related Assistance for Individuals with Disabilities Act (Tech Act) in 1994, [n1] EEOC Commissioner Paul Steven Miller reflected on the exclusion of persons with disabilities from society. [n2] Miller noted that for years, the physical environment, including buildings, worksites, public places, and schools, were constructed without regard to people with disabilities. [n3] Disabled people were sheltered away from participation. [n4] Not ignored, stressed Miller, but invisible. [n5]

The invisible community of persons with disabilities now is estimated to number over fifty million Americans. [n6] The Tech Act and related federal legislation [n7] seek to provide workers and **[*12]** consumers with disabilities access to the goods and services that allow them to participate equally in society [n8] and achieve independence in their lives. [n9] The Americans with Disabilities Act of 1990 (ADA) seeks to make society accessible to people with disabilities as they affirm their civil rights and pursue educational and employment goals. [n10]

The ADA requires equal accessibility for persons with disabilities in transportation, communications, and public settings, [n11] and mandates accommodations for qualified disabled workers in employment contexts. [n12] For many persons with mild and severe disabilities, assistive technology (AT) plays a fundamental role in support of this mandate. [n13] AT includes products or equipment that increase, maintain, or improve the functional capabilities of individuals with disabilities. [n14] AT devices include simple tools **[*13]** with no moving parts to sophisticated mechanical or electronic systems. [n15]

This article examines the ways in which the economic market for AT may be analyzed in the context of effective ADA implementation. It employs patent data from the United States Patent and Trademark Office (PTO) to examine how the ADA may be fostering innovation and economic opportunity for AT researchers and developers, manufacturers, and retailers. The findings suggest that evaluations of the ADA based on its perceived costs to society need to be balanced by the range of societal benefits accruing from the law, including those unanticipated economic benefits illustrated here.

This article is divided into several sections. It begins with a discussion of the role AT plays in furthering the goals of the ADA. It describes empirical objectives and an overview of study. Part II summarizes background information relating to patent law and the patent system. It discusses innovation, economic justifications of the patent system, and patentability standards. Examples of AT, including advances in wheelchair design and other innovations, are used to illustrate the patent law concepts introduced in Part II. Part III describes how patent records, data, and statistics are used by researchers. Part IV discusses the findings from the present study. The results are summarized in graphs and tables that appear in the body of the article and in the appendices. Finally, Part V considers the empirical and policy implications of the findings for ADA stakeholders.

A. ADA Goals Involving Assistive Technology

AT plays a critical role in achieving the ADA goals of inclusion, empowerment, and equal opportunity for persons with disabilities. [n16] Table 1 summarizes the function of AT in each area covered by the law.

The ADA and related enforcement regulations were drafted to ensure flexibility in implementation. The regulations interpreting the law provide examples of accommodations, but do not mandate specific products or devices as accommodations.

[*14]

[SEE TABLE IN ORIGINAL] **[*15]** Under ADA Title I, employers are charged with providing accommodations that are "reasonable." [n17] The accommodation requirement is a means by which physical, structural, and attitudinal barriers to the equal employment opportunities facing individuals with disabilities are removed effectively and efficiently. [n18] The regulations interpreting the law identify a range of accommodations, but the obligation to accommodate does not extend to the provision of adjustments or modifications for personal use. [n19]

Under ADA Title II, governmental and municipal entities are required to provide certain types of augmentative devices and services. [n20] An open-ended list of examples is incorporated into the enforcement regulations. [n21] The Department of Justice has emphasized that this list is not exhaustive, and to attempt to provide a complete list would omit devices that will become available through emerging technologies. [n22]

ADA Title III requires covered entities to make reasonable modifications in policies, practices, or procedures when they are necessary to accommodate individuals with disabilities. [n23] Accommodations include providing auxiliary aids [n24] and removing architectural barriers. [n25] Covered entities are charged with implementing available technologies that offer readily achievable [n26] solutions for people with limitations, unless doing so would fundamentally alter the nature

of the goods or services being offered, or would constitute an undue burden. [n27]

ADA Title IV requires local and long distance telephone companies to provide nationwide telephone relay services to individuals with hearing or speech impairments whose communication needs were not adequately addressed by earlier man **[*16]** dates. [n28] Title IV represents the culmination of fifty years of telecommunications legislation aimed at achieving universal service. [n29] Nationwide adoption of text telephone technology is central to the goals of Title IV. [n30]

B. Present Study Objectives and Overview

The ADA has been criticized for supposed economic inefficiencies it imposes on markets. [n31] Critics argue that the economic costs outweigh the economic benefits of ADA compliance. [n32] Some assert that the costs of hiring, accommodating, and retaining workers with disabilities exceed accrued individual or societal benefits. [n33] Although this assertion remains unsupported by data, criticisms of the ADA rooted in cost-benefit rhetoric are frequent. [n34]

Estimating the costs and benefits of ADA implementation is a difficult undertaking. This article approaches the problem of identifying cost-benefit values associated with ADA implementation by focusing on one potential measurable benefit: the stimulation of economic activity in the assistive technology market. [n35]

The research is guided by several propositions:

. The ADA recognizes that to achieve inclusion and equal participation of individuals with disabilities, society must be accessible. [n36]

[*17] . To support their independence and their self-determination, many individuals with severe disabilities require AT devices and services. [n37]

. Monetary benefits associated with inventive activity in the assistive technology market must be factored into current cost-benefit models of the ADA because the law has helped to increase demand for assistive devices and stimulate economic opportunities for assistive device inventors and manufacturers.

The central goal of the present investigation was to examine the extent to which the regulatory shifts ascribed to the ADA may be creating economic opportunities for AT inventors and manufacturers - stakeholders not heretofore mentioned in the literature as beneficiaries of the law. [n38] We consider the question of whether the ADA is influencing inventive activity or patenting behavior among AT developers. To address this issue, we examine patenting trends for AT devices at the United States Patent and Trademark Office (PTO). [n39]

Researchers continue to use patent data and statistics to forecast technology trends and to probe innovation activity. [n40] Patent data has been used to gauge the success of "technology forcing" environmental laws. [n41] More generally, patent application rates provide one measure of the effectiveness of regulation **[*18]** at stimulating technology innovation. [n42] Regulations that stimulate a burst of patent activity may promote innovation. [n43]

The use of patent data and records in the context of disability policy is unique. [n44] This article presents the first examination of patent trends for AT inventions in light of shifts in disability policy and the passage and implementation of the ADA. The results suggest that the ADA is impacting AT inventive activity in economically positive and measurable ways.

C. Core Findings

Several findings emerge from the study:

1. AT patent numbers have shown annual increases since 1976. [n45]

2. Since 1990, the number of patents citing the ADA has increased substantially, [n46] while reference to other civil rights legislation is atypical of patent records. [n47]

3. The inventors who acknowledge the ADA are a geographically diverse group, many unaffiliated with large corporations. [n48]

4. From 1990-1997, patents were granted for a wide range of assistive devices targeted at a diverse group of consumers with disabilities. [n49]

5. Patentees are staking claims in patentable assistive technologies because of the promise of future economic benefits. [n50]

These core findings suggest that ADA implementation is affecting the AT consumer market in economically positive ways and is creating profit-making opportunities for inventors and **[*19]** manufacturers in the sector. [n51] As the regulatory shifts imposed by the ADA expand the market for goods that improve accessibility, inventors and manufacturers are responding rationally to the practical economic consequences of ADA implementation. [n52]

This article argues that shifts in social policy, embodied in legislative enactments like the ADA, influence decision-making, even among relatively minor societal stakeholders. Inventors and manufacturers have responded to ADA passage by attempting to profit from the regulatory shifts imposed by the law. [n53] The activities of these relatively remote stakeholders is significant on a number of levels. [n54] Foremost, the ADA appears to be contributing to technological and economic activity, much of which was unanticipated when the law was passed. [n55]

In a broader sense, many factors, including those relating to AT inventive and commercial activity, contribute to the costs and benefits associated with implementation of the ADA. Economies of scale, employers' learning curves, and continued technological innovation hold the promise of giving rise to reduced accommodation costs. [n56] These factors need to be reflected in future ADA assessments by courts, employers, and policymakers to gauge the economic impact of the ADA.

II. Patent Law and the Patent System

In 1937, engineers Herbert Everest and Harry Jennings patented an improved wheelchair design based on modifications of technology described in a 1909 patent. [n57] The wheelchair frame, similar to the frame of a director's chair, had a mechanism that allowed it to be folded up. [n58] It was to become the industry stan **[*20]** dard for over fifty years. [n59] Their company, Everest & Jennings (E & J) became the dominant firm in the wheelchair market. [n60]

Once E & J optimized its basic design, time essentially stood still. [n61] Wheelchair design stagnated beyond improving minor components such as bearings and brakes. [n62] E & J's eighty percent market share dwindled away as marketplace and public attitudes toward individuals with disabilities changed. [n63]

Everest and Jennings followed the invention path from concept to production. They built on the work of prior AT researchers and capitalized on the protection afforded to inventors by patent law. Their activity is discussed in this section to emphasize that AT developers respond to market opportunities in the same manner as other profit-seeking

entities.

A. Economics and the Patent System

Article I, Section 8, of the Constitution grants Congress the power to establish a patent system. [n64] A United States patent grants the owner of an invention the right to exclude others from making, using, or selling it for up to 20 years from the application filing date. [n65] Anyone who uses a patented invention without the permission of the patentee is liable for patent infringement. [n66] The exclusionary patent right (considered a **[*21]** temporary monopoly) [n67] is granted by the government in exchange for public disclosure by the patentee of the invention. [n68] Patent infringers may be enjoined from future infringing activity or compelled to pay monetary damages. [n69]

By rewarding exclusive use rights to inventors like E & J for limited periods of time, [n70] the patent system creates incentives for technological advancement. [n71] The fact that the government confers certain property rights to inventors for their labor in exchange for information about how their inventions work acts as an inducement for technological development. [n72]

The negative economic effect created by temporary monopoly is counter-balanced by the long-term benefits society will reap from creating access to information that may lead to innovation. [n73] Disclosure of E & J's invention in the 1937 patent per mitted E & J's competitors to design better wheelchairs, to thebenefitof consumers. Patent protection allows for the development of inventions into marketable innovations by defining the property rights of inventors. [n74] The disclosure requirement encourages knowledge diffusion within and across technologies. [n75]

Although inventors may disclose their inventions for many reasons, profit motives and a desire to protect property rights typically are at stake. [n76] To that end, Invacare, Inc., now a leader in the powered wheelchair market, has patented over forty wheelchair-related inventions since the early 1980's, introduced fifty new products, and spent $ 7 million on research and development in 1993 alone. [n77]

[*22] According to one view, if patent law did not guarantee property rights to the owners of inventions, innovators would be discouraged from developing new, useful products. [n78] An unprotected idea or discovery is considered a public good, susceptible to competitive use. [n79] Profit-maximizing firms will choose not to innovate if they are unable to protect their inventions and recover their costs. [n80] Under a weaker patent protection regime, innovation and knowledge diffusion might occur haltingly because firms would guard their intellectual property assets by maintaining trade secrets, rather than by patenting. [n81]

B. Corporate Research and Development and Patent Economics

The patent system is intended to contribute to economic growth by encouraging technological innovation and production. Technological innovation is the first commercially successful application of a new technical idea - for instance, E & J's folding wheelchair. [n82] It occurs in those institutions, primarily **[*23]** private profit-seeking firms, that compete in the marketplace. Innovation may be embodied in hardware or devices, in the organization of production and work, or in both. [n83]

Early scholars viewed patents as a means to allow inventors to appropriate the economic benefits flowing from their inventive contributions, by preventing imitations and by putting them in a position to force imitators into licensing agreements. [n84] These economic justifications developed at a time when individual inventors were responsible for the majority of innovative activity. [n85]

Several problems arise when the rationale is applied to research and development divisions within modern corporations. First, as Kaufer suggests, invention is a small part of the activity that must be sustained to introduce new technologies to the market. [n86] Firms incur expenditures in developing inventions, acquiring production equipment, and advertising to consumers. [n87]

Second, patents are, at best, imperfect economic appropriation devices. [n88] A paradox of the patent system is that by meeting technical disclosure requirements, inventors often assist imitators. [n89] "Inventing around" patents is less expensive and requires less time than creating the original invention. [n90] One study showed that sixty percent of patented commercial innovations within some industries including chemicals, pharmaceuticals, machinery, and electronics, had been invented around within **[*24]** four years. [n91] The inventing around accusation was leveled against Everest & Jennings: an infringement action brought by a competitor included a theory that E & J had unsuccessfully invented around a patent. [n92]

Studies suggest that the importance of patents varies within industries and firms. [n93] When surveyed about the effectiveness of patents, research and development executives from eighteen different industry and technology groups responded that product patents were easier to protect than process patents. [n94] Patents were viewed as critical in inducing investment within industries where research and development costs are high, as in fields relating to pharmaceuticals, specialty chemicals, and microelectronics. [n95] Other factors, such as sales and service and lead time advantages, were considered as equally or more important than patents in other fields. [n96]

Patents do not always appropriate sufficient economic benefits from research and development. For some firms, secrecy may be a viable alternative to patenting. [n97] Aggressive firms that are first to strike in some markets may be able to hold substantial market shares and sell at prices exceeding production costs without patent protection. [n98]

C. Assistive Technology Innovation

AT consumers benefit to the same extent as any group from the process of innovation. In response to consumer demand, innovators in the wheelchair market produced less expensive, lightweight aluminum sport chairs that outsold conventional E & J chairs. [n99] Chairs constructed from composite materials and alloys provided improvements in strength, flexibility, and mobil **[*25]** ity, [n100] and advances in battery technology led to improved powered wheelchairs and scooters. [n101]

Individuals who are blind or visually impaired also are benefiting from recent innovations. [n102] Several firms have been working to develop reading machines for the blind since the early 1940's. [n103] Raymond Kurzweil, an expert in artificial intelligence and speech synthesis, took up the task in 1975. [n104] Drawing on the knowledge and experiences of blind readers, he developed a software-centered reading machine that absorbs a page of print in about five seconds and changes it into synthetic speech (the "Kurzweil Reader"). [n105]

Assistive hearing technology advances are equally noteworthy. Major changes within the hearing-aid industry are likely to result in continued miniaturization and advanced speech processing technology. [n106] The use of text telephones as personal communication aids is growing rapidly in importance as a result of advances in computer technology, the mass production of keyboards and other components, and the invention of the acoustic coupler. [n107] More recently, advances in cochlear implant technology have led to dramatic improvements in speech understanding. [n108]

To protect these and other AT innovations, firms obtain patents. The law of patents is unique and complicated, requiring an investigation of various underlying principles. The next section discusses patent law and patent system fundamentals.

D. Patent Law Fundamentals

AT inventors follow the same procedures as other inventors seeking patent protection. Inventors or their assignees submit **[*26]** patent applications to the PTO. [n109] Applications (and consequently issued patents) include a range of information. The body of the application is composed of sections that usually describe the invention and how it works, while delineating the boundaries of the patent property that is claimed as described in the specification and claims sections. [n110] The front page of a patent lists demographic information, including:

. Patent title and number

. Patent application date

. Patent issuance date

. Inventors and assignees

. Inventor's home state or country

. Patent class. [n111]

. Field of Search. [n112]

. Prior art references. [n113]

Applications are evaluated by examiners, who are divided into various "art" groups based on their areas of technical expertise - such as chemistry, electronics, materials science, and genetics. [n114] Patent examiners determine whether claims are patentable according to standards promulgated in the 1952 Patent Act and described in the Code of Federal Regulations and the Manual of Patent Examination Procedure. [n115] Examiners focus on the specification and claims sections to make this determination.

[*27]

1. Patentability Requirements

The primary objective of the examination process is to determine whether inventions, as expressed in the language of the claims, are sufficiently distinct from earlier inventions to deserve to be patented. [n116] Under the Patent Act of 1952, certain classes of inventions merit patent protection. [n117] According to Section 101 of the Patent Act, patents may be awarded to the inventors of machines, manufactures, products of manufactures, compositions of matter, processes and methods (utility patents), ornamental designs (design patents), and types of plants and genetically engineered organisms (plant patents). [n118] Mathematical formulas and abstract ideas are not patentable. [n119] Inventions that fall within the limitations of patentable subject matter must additionally be useful and sufficiently distinct from earlier inventions - called the "prior art." [n120]

The utility requirement is derived from the word "useful" in Section 101. [n121] Under the utility requirement, an invention must have an identifiable use. [n122] The invention does not have to be more useful than prior devices or processes: it need only be operable and capable of satisfying a function or benefit to humanity. [n123] Inventions that fail to meet the utility requirement include ones that conflict with scientific principles, require means for accomplishing an impossible result, or are unreasonably dangerous. [n124]

Under Section 102, inventors may obtain patents for inventions that have not been disclosed to the public. [n125] Section 102 of the Patent Act defines what is not new and specifies the condi **[*28]** tions that preclude the issuance of a patent. [n126] Inventions that have been in the public domain for more than one year prior to the filing of a patent application are not new for purposes of the law. [n127] The novelty requirement imposes certain timing restrictions on applicants, that, if violated, "bar" some patent applications. [n128]

Section 103 imposes a "non-obviousness" requirement on inventors. [n129] To meet the non-obviousness

requirement, inventions must be sufficiently distinct from the prior art, based on a standard of one of ordinary skill in the art. [n130] An invention that an examiner determines to be obvious to one of ordinary skill in the art, based on prior art references, is not patentable. [n131] The non-obviousness requirement means that not all "new" inventions qualify for patent protection. [n132]

The Supreme Court delineated a four-part non-obviousness test in Graham v. John Deere Co. [n133] The determination includes: the scope and content of the prior art; differences between the prior art and the claims at issue; the level of ordinary skill in the art; and a number of "secondary considerations." [n134] Commercial success, long-felt but unresolved need, and the failure of other inventors are relevant secondary considerations. [n135]

[*29] The non-obviousness standard varies between disciplines and technologies. Generally, it is easier for inventions within new technologies to meet the non-obviousness standard than inventions in technologically mature fields.

2. Filing Process Exceptions

The patent system attempts to control knowledge diffusion in technological areas relating to national security, such as for inventions relating to the use of atomic energy. [n136] All patents are screened initially for nationally sensitive subject matter. [n137] Section 181 of the Patent Act permits the PTO to refer applications to other governmental agencies for review. [n138] The Patent Commissioner is authorized to issue an Order of Secrecy, based on the evaluations of NASA, DOE, or the Armed Services Advisory Board. [n139] This special Order bars the grant of a patent for the time required to preserve national interests. [n140]

At the same time, the patent system encourages diffusion in other technological areas. [n141] Patent applications that are deemed of peculiar importance to some branch of the public service may be examined in an accelerated process, [n142] whereby upon payment of a fee, patentees may file a "Petition to Make Special." [n143] The Petition permits an application to be examined out of turn, [n144] but the statutory requirements and standards for patentability remain the same. Petitions may be granted because an infringing product or device is on the market, the applicant's health is failing, or the applicant is elderly. [n145]

[*30] Special status may be accorded to patent applications for inventions that contribute to technology advancements in subject areas such as those relating to environmental quality, energy use and resources, and recombinant DNA technology. [n146] Patent applications that advance important public policy objectives in these areas do not require an application fee. [n147] As an example, Petitions to Make Special may be granted to applications relating to pollution control inventions. [n148] Inventors in this area do not have to pay a filing fee, [n149] and their applications may receive prioritized review. [n150]

In practice, the Petition to Make Special has not streamlined the examination process for environmental technology applications, at least according to some authors. [n151] It has not resulted in a shift toward the rapid issuance of patents for environmental technology. This may indicate the patent system's failure to induce innovation in the pollution control sector. [n152]

Scholars argue that some patents, particularly environmental patents, should be made easier to obtain. [n153] Gollin suggests that the PTO could facilitate patent prosecution and avoid regulatory reform by creating a new patent class for environmental inventions. [n154] However, this proposal would be difficult to implement, because of the existing patent classification scheme. [n155] Other analysts propose legislative gap filling to rectify the problem and favor the creation of a distinct environmental patent subtype. [n156]

[*31] In a related situation, one scholar has advocated a Modified Petition to Make Special as a component of an "Orphan Patent Act" for AT inventions. [n157] As indicated earlier, AT inventors must currently follow the same substantive and procedural requirements as other inventors seeking patent protection; moreover, there is no discrete

patent class of AT inventions at the PTO.

Verzani identifies processing delays at the PTO as a major factor hampering the rapid introduction of new assistive devices to consumers with disabilities. [n158] Under the proposed Modified Petition, an AT applicant would be required to show that the claimed invention was intended for use by individuals with disabilities, as statutorily defined by the ADA in Title 42. Examiners would be charged with applying both the Patent Act and the definitional components of the ADA to patent applications. Applications found to meet the requirement would not incur a fee, and would be subject to a streamlined examination procedure. [n159]

3. Patent Infringement

Patents are costly investments. Firms incur costs for research and development, for the work of preparing and filing patent applications, and for the costs of litigation in protecting them. [n160] Costs can be considerable, particularly for patent infringement actions.

[*32] Under section 271(a) of the Patent Act, infringement occurs when, without authority, anyone makes, uses, or sells any patented invention during the patent term. As indicated, the patented invention is defined by the language of the claims, supported by the patent specification. [n161] Infringement is determined by comparing the claims of the patented device with the claims of the accused infringing device. [n162]

Literal infringement occurs when the patented device claims literally "read" on the claims of the accused device. [n163] Infringement under the doctrine of equivalents occurs when an inventor who has not literally copied every detail of the claims nonetheless misappropriates the true invention from the patent owner. [n164] The next section discusses litigation involving patent infringement by examining cases involving Everest & Jennings.

4. Illustrating Patent Law Fundamentals: Two Cases Involving Assistive Technology

By the 1960's, most of E & J's competitors had been eliminated, leaving E & J with an eighty percent share of the wheelchair market. [n165] The company aggressively protected its intellectual property. [n166] In 1952, patent number 2,592,449 ('449 patent) was issued to E & J for an improved wheelchair design with detachable footrests. [n167] Some years later, the Colson Corporation began marketing a product with a similar feature. Because E & J was within the term of patent protection, the company brought an infringement suit against Colson. [n168] Colson **[*33]** defended on the grounds that E & J's '449 patent claims were invalid. [n169] The appellate court upheld the district court's finding that the '449 patent was invalid.

The district court determined that E & J's '449 patent comprised a combination of parts and components that E & J had used in earlier wheelchair design. In addition, the chair embodied in the prior art was manufactured and sold by E & J for more than a year before the firm applied for the '449 patent. The relevant claims of the '449 patent therefore were invalid because the invention was not "new" for the purposes of section 102. [n170]

The district court next turned to the question of obviousness by (i) examining the scope and content of the prior art; (ii) comparing the claims at issue to the prior art; and (iii) determining the level of ordinary skill in the art of wheelchair design and manufacture (Graham factor 3). [n171] The court concluded that the E & J chair required no more than the solution of simple engineering problems well within the learning and scope of those skilled in the art. [n172] As a result, the invention did not meet the non-obviousness requirement of section 103.

The second case transpired after complacency had caughtupwith E & J. The company was selling a line of overpriced,cumbersome wheelchairs. [n173] Disabled consumers werecaptive to the unresponsive wheelchair industry. [n174] E&Jwas no longer innovating to meet customer needsandwasdemandinghigh prices for its products. [n175] **[*34]** Thecompanywas accused of antitrust violations in

1979. [n176]

Because of E & J's oversight, competitors were able to capitalize on new market opportunities and changing consumer demographics. [n177] Wheelchair consumers now included veterans of the Vietnam War, who were accustomed to a non-disabled life. [n178] These consumers wanted less stigmatizing, less expensive chairs. [n179] International and domestic competitors like Invacare started to design improved chairs and to undercut E & J prices. [n180] Manufacturers responded to consumers who wanted other alternatives to conventional wheelchair designs. [n181] Sewell, Inc. captured the three-wheel scooter market - popular among older individuals. [n182] Athletic consumers wanted lightweight sport chairs, rather than the cumbersome chairs that defined the E & J product line. [n183] Motion Designs responded accordingly and captured the sport chair business. [n184]

E & J's market share quickly dropped to eighteen percent before it began trying to stake positions in these new wheelchair markets. Scooters were becoming a popular alternative to conventional wheelchairs by the early 1990's. [n185] In 1991, a group of wheelchair manufacturers were accused of infringing a scooter patent issued the previous year to Burke, Inc., a small Kansas company. [n186] The Burke '739 patent was based on a novel combination of prior art components that produced new and different **[*35]** functions in the scooter. [n187] These functions included flexible use, both indoors and outdoors, and convenient separation into components for easy transportation. [n188] Burke contended that E & J had also infringed. [n189]

During the protracted trial, E & J announced that it was planning to close its Missouri production plant and lay off one hundred twenty-one of its remaining one hundred sixty-nine workers. [n190] In the three years since the production plant had opened in Missouri, company officials rarely replaced equipment or bought supplies. [n191] In late 1996, E & J began purchase negotiations with Graham Field Health Products. [n192]

E & J failed to innovate at a time when the assistive technology market was diversifying and expanding. [n193] By 1995, wheelchair revenues had exceeded one billion dollars worldwide. [n194]

In 1990, the year the ADA was passed, more than 13.1 million people, or about 5.3 percent of the American population were AT users. [n195] Of these, an estimated 1.2 million used wheelchairs - a number that is increasing at a three percent annual rate. [n196] Increases in the number of people using AT outpaced population growth between 1980 and 1990. [n197] Although the aging of the population accounts for a significant part of this increase, the data indicate that AT use among other age groups also increased at a rate more rapid than population growth. [n198]

III. Patent Data Use in Research

In an early essay on the use of patent records, a scholar commented that the patent system is inseparable from "a folklore on **[*36]** inventors, progress, discovery, [and] property...." [n199] The idea that technology and invention should be understood in terms of historical and cultural contexts is widely recognized, [n200] and scholars frequently employ patent records as data to study developments in technology, invention, business, and economic development. [n201]

The relationship between patents and the nature of the innovations they disclose is inherently limited, because patents are primarily legal devices. [n202] Yet patents themselves can be seen as artifacts of how societies define the concept of invention and of how the PTO makes validity determinations in particular classes and instances. [n203] A patent application itself - the rhetoric embodied in each of its sections and the appearance of the drawings and schemes - transcends legal significance by contributing to social and cultural understanding of inventors and inventions. [n204] How inventors describe their devices is significant. Whether an inventor refers to a wheelchair as a "personal mobility device" [n205] or an "invalid carriage" [n206] reflects how society views and values people with disabilities.

A. Using Patent Data in Social Science Research

In the aggregate, patents and patent statistics have been employed as technology and economic indicators. [n207] The

quest for technology indicators that predict accurately technological innovation trends and economic growth has led to the develop **[*37]** ment of a number of patent research methods based in statistics and bibliometrics. [n208]

The theory behind bibliometric analysis of scientific papers and patents is that highly cited publications are more influential than ones that are less cited. [n209] A highly cited, influential patent contains significant technological information that enables further patentable advancements. [n210] The number of citations a patent receives, known as the citation count, is an indicator of technological significance or quality. [n211] Because most patents or scientific papers are not highly cited, [n212] the small number that are highly cited are considered technologically or scientifically significant. [n213]

Using patents for economic and statistical analysis is complicated by a number of factors. One problem is incompleteness in the patent data set. Many inventions are not patented because of variations in patent law and patenting philosophy. Other complicating factors are that patenting behavior and the propensity to patent varies across industries, and that patents vary in their technological significance and quality. These and other considerations are discussed in the following sections, in the context of the study of the ADA patents.

[*38]

1. Variations in Claim Scope and Patent Philosophy

Patenting philosophy and the motivation to patent varies between firms and industries. [n214] Patents play a significant role in protecting intellectual property portfolios in fields with high research and development expenditures, such as the pharmaceutical, medical device, microelectronic, and computer technology industries. [n215] AT fields that fall in this "high-tech" category include the development of communication aids, such as the Kurzweil reader, cochlear implants, and text telephones. [n216] In industries where research and development costs are relatively low and aggressive market behavior is important, patents play a less significant role. [n217] Assistive technology types that fall in this "low-tech" category include simple or customized devices with non-moving parts.

Scholars argue that variations in patenting philosophy and the motivation to patent are not reflected adequately in current patent bibliometric methods. Some argue that technology forecasting based on patent data is inaccurate because patents cannot measure the "null set" of innovations that do not get patented. [n218]

2. Variations in Patent Significance

It is difficult to predict the relative economic value of specific patents for firms. [n219] Patents are awarded for relatively minor modifications to established designs [n220] - recall the Burke scooter patent and the infringing E & J patent. Others are more innovative, [n221] like text telephones. Still others might be markedly new, such as the Kurzweil reader. [n222]

[*39] Patents vary in the type and scope of the inventions they claim. The subject matter claimed by an inventor may be for a process or a minor improvement over a pre-existing design. On the other hand, the invention claimed in a patent might represent a radical innovation over prior art patents.

Conducting patent bibliometric research without considering claim scope and type may give rise to misleading results. [n223] This concern - a fear of grouping significant patents with insignificant patents - is rectified through citation counting and weighting methods. [n224] The idea behind citation analysis is that if a previously issued patent is cited in many subsequent patents, then the earlier highly cited prior art patent contains significant advances necessary to further innovation and economic development. [n225]

Narin and his colleagues correlated expert evaluation of patent significance in the field of photographic science to citation counts to test the validity of the technique. [n226] Narin randomly assigned photographic chemistry patents to a group of photographic technology specialists for evaluation, including senior research scientists, laboratory managers, and patent lawyers. [n227] The participants rated patents on a relative significance scale. [n228] Narin correlated these

ratings with the average number of citations received by each patent.

The findings did not demonstrate conclusively the validity of citation counting. [n229] There were no statistically significant differences between peer and citation ratings for infrequently cited patents. [n230] Significant differences were observed for highly cited patents. [n231] Some patents were rated far more highly by evaluators than their citation counts would support. [n232] The results implied **[*40]** that some technologically significant patents might not be highly cited. [n233]

3. Other Considerations

Analysis of patent trends is complicated by additional administrative and judicial factors, such as bureaucratic shifts at the PTO, changes in the patent law, and the disposition of patent- related actions at the Court of Appeals for the Federal Circuit, the court charged with adjudicating patent disputes. Critics argue that patent bibliometric researchers have not sufficiently addressed these factors.

Another problem relates to patent classification. [n234] The PTO classification system is comprised of over three hundred seventy major invention classes and thousands of related subclasses. [n235] Patents are classified by examiners according to an array of functional and technological principles that bear little relation to discrete industries or products. [n236] This results in odd groupings of inventions. For instance, one scholar has noted that a subclass covering liquid dispensers contains a patent for a water pistol and a holy water dispenser. [n237] In another example, a subclass dealing with solid dispensers contains patents for both manure spreaders and toothpaste tubes. [n238] Even the Burke '739 patent discussed previously was listed in Class 180 - for motor vehicles. [n239]

In the mid 1970's, the Patent Office established the Office of Technology Assessment and Forecasting (OTAF) to coordinate record keeping and patent statistics. [n240] The OTAF received a grant from the NSF to produce patent statistics using the Standard Industrial Classification (SIC) scheme, corresponding to the NSF's applied research and development classification system based on product fields. [n241] The idea was that patents, and patent subclasses, may be classified by their relation to specific indus **[*41]** tries and to their expected end product uses. [n242] In practice, some subclasses that did not unambiguously belong to single SIC industries were counted in all relevant SIC classes (a practice known as double counting). [n243] Making end product determinations was difficult as well. [n244]

The resulting OTAF Concordance was criticized for its apparent arbitrariness in assigning subclasses to various SIC fields and its practice of SIC double counting. [n245] The Concordance offered some improvements, but most of the classification questions remain to be answered. [n246] Researchers continue to develop methods to avoid the problems posed by SIC double counting. [n247]

B. Patents as Indicators of Economic and Technological Activity

Patent data traces inventive activity and the process of technological innovation and diffusion. [n248] When used as an economic indicator, patent data serves as a proxy to help discover trends. [n249] This idea serves as the foundation for the present study, involving the relationship between AT patenting trends and disability legislation.

Economic inferences may be drawn from aggregated patent data. Researchers find that the propensity to patent varies among firms and industries. [n250] Small firms involved in certain technolo **[*42]** gies patent more frequently than large firms and use a higher percentage of their patents commercially. [n251] Attitudes among inventors and firms regarding the use of the patent system have been observed to vary over time. [n252] In addition, there is a relationship between aggregated patent data and business and bureaucratic trends.

As discussed below, patent citations are used to probe activity trends for firms within technological and geographical sectors. [n253] Information may be gathered about stock values, the role of public science in inducing innovation in the private sector, and the significance of specific patents over time. [n254]

1. Patenting and Research and Development

Patents often are used as quantitative proxies for technological change and economic innovation. [n255] There is a strong relationship between research and development spending and patenting activity across firms and industries. [n256] The same rela **[*43]** tionship has been observed within firms. [n257] As a firm changes its research and development expenditures, concomitant changes occur in patenting activity. [n258] As a result, some researchers treat patents as intermediate research and development output indicators, sensitive to consumer market demands.

Over short periods of time, minimal relationships have been shown between research and development spending and patenting activity. [n259] Prior studies suggest that patents are not strong indicators of short-term changes in inventive activity output. [n260] Therefore, comparing patent data from year to year or organization to organization is considered unreliable. [n261]

Individual firm strengths, as reflected in various research and development factors, may be evaluated using patent counts and citation counts. Patent counts, or the number of patents owned by a firm, have been found to predict research inputs. [n262] Researchers have found predictive relationships between the number of times a firm's patents are cited and the firm's financial strength. [n263] Recall that Invacare's research and development budget is matched by forty-plus and fifty-plus patent and product portfolios, respectively. [n264]

2. Public Support of Technology Innovation

Private industries rely on research performed by the government and universities to advance fields of technology. [n265] Reference sections of U.S. patents increasingly contain citations to public science research papers. [n266] Of the research papers cited by United States patents issued in 1993-1994, 73 percent ema **[*44]** nated from public science, [n267] and references to papers written by U.S. researchers tripled between 1987 and 1994. [n268]

This finding suggests that there are strong linkages among industry, public science, and economic development, particularly in areas relating to pharmaceuticals, specialty chemicals, and electronics. [n269] This linkage may be weaker for AT, although the federal government sponsors AT research efforts through a number of agencies, including the National Science Foundation and the Veterans Administration.

3. Patents and Stock Market Values

Stock market values are used as output indicators of the success of the research process. [n270] The stock market rate of return has been observed to be related to unpredictable changes in patents and research and development. [n271] However, the data for these studies exhibit a high degree of variance. [n272]

4. Spillovers and Other Effects

A spillover is the benefit one company or industry receives from the research and development activity of another. [n273] The advances made by Raymond Kurzweil in artificial intelligence and speech synthesis spilled over into the development of text-to- speech readers for the blind, for example. Advances in materials chemistry and composites have spilled over to wheelchair design. The low maintenance wheels developed by Innovations in Composites, Inc. represent a technological and durability leap over the century-old wire-spoke wheel design found on most wheelchairs [n274] - the result of technology originally designed for bicycles. [n275]

[*45] Jaffe and colleagues treated patent citations as a paper trail to show that technological spillovers may be geographically localized. [n276] These researchers found that citations to domestic patents are more likely to be domestic and to come from the same state. [n277] This effect tends to fade over time.

5. Patenting Trends and Bureaucratic Cycles

Bureaucratic changes at the PTO and within patent law influence patenting activity. [n278] The patentability standards discussed in previous sections change over time, in response to perceptions among examiners about what constitutes innovation for specific industries or technologies. [n279] Changes in the resources of the Patent Office also may influence the efficiency of the examination process and the lag time between the time of patent application and issuance. [n280] The number of patents granted has been found to be more strongly associated with fluctuations in the size of the examiners' labor pool than with patent application numbers. [n281]

Patent trends during the 1970's demonstrate the significance of bureaucratic effects on the patent process. [n282] During the 1970's, the number of patents granted dipped dramatically due to budget changes at the PTO. [n283] The trend culminated in a sharp decline in 1979 due to the absence of a publication budget to print approved patents. [n284]

IV. Research Designs of the Present Study

This section examines AT patenting trends. The study begins with several questions:

. How do inventors and their lawyers, as evidenced by their patenting behavior, respond to regulatory shifts in policy as imposed by the federal government?

. Are new laws cited in their patent disclosures?

. Why are they cited?

. If they are cited, what is the context?

[*46] . In a more focused sense, have patentees invoked the ADA or other disability legislation in their applications? And for what types of inventions?

We assumed that patents for inventions designed to accommodate persons with disabilities - at home, school, work, and in public settings - would have the greatest likelihood of invoking disability rights legislation such as the ADA. Thus, the first research goal was to determine whether AT patents may be extracted from the Patent Database. The second was to determine whether AT patents referenced the ADA.

A term word search strategy of the patent database was adopted to identify relevant patents. [n285] Initially, this strategy seemed sub-optimal, but in practice, it avoided many of the patent/SIC classification problems encountered by other researchers. [n286] These problems would have been substantial for AT, an inventive field that cuts across many industry and technology sectors.

Analysis of traditional economic and technological forecasting were considered beyond the study scope. As a result, the study did not adopt citation counting methods for data interpretation. The analytical problems associated with patent bibliometrics were avoided, at least for the present. [n287] Because our intent was to gain a preliminary understanding of AT inventors and patents, much of the collected data relates to demographic characteristics.

A. Findings

The goal of the research was to determine how AT patentees have responded to ADA passage and implementation. This section starts by summarizing utility patent trends at the PTO for the last 20 years. It then focuses on a utility patent subset made up of AT inventions. Utility patent data was obtained from PTO Annual Reports, various OTAF

statistical reports, and the National Science Board Science and Engineering Indicators series. [n288]

[*47]

1. Utility Patent Trends

Annual utility patent application and issuance numbers have increased since 1976. The data are summarized in Table 2 and Chart 1.

[SEE TABLE IN ORIGINAL]

Application and issuance number increases are part of an upward trend in patenting activity at the PTO. In 1976, out of 101,807 applications filed, 75,325 utility patents (approximately 74 percent of the applications) were issued. In 1996, out of 189,979 applications filed, 104,900 utility patents (approximately 55 percent of the applications) issued. The overall percent increase in application and issuance numbers between 1976 and 1996 was 87 percent and 43 percent, respectively. Years that **[*48]**

[SEE CHART IN ORIGINAL] **[*49]** exhibited declines in the number of patents issued reflect concomitant reductions in the size of the examiner workforce, although other organizational or economic factors may be operative. [n289]

Today, more than half of the U.S. patents granted are owned by U.S. inventors. [n290] The number of patents awarded annually to U.S. inventors has increased since the mid-1980s. [n291] In 1980, 37,000 patents were granted to U.S. inventors. [n292] That number increased to 39,000 in 1985. [n293] The rate has increased substantially since 1985, [n294] and in 1989, the 50,000 barrier rate was exceeded in each of the successive years except 1990. [n295]

Most of the patents granted to U.S. inventors are owned by corporate assignees or the government. [n296] Inventors who work for the government or private corporations typically assign ownership of their patents to their employers. [n297] As a result, the owner's sector of employment (whether private corporation, government, independent) is an indication of where the inventive activity took place. [n298]

Prior to 1993, corporations owned between 74 percent and 79 percent of granted U.S. patents. [n299] Since 1993, that value has increased to 80 percent or greater. [n300] Approximately three percent of these came from universities or colleges, entities considered corporations by the PTO. [n301] The federal government maintains a small portion of U.S. origin patents from this group [n302] and individuals account for the remainder. [n303]

Corporate patenting behavior is directed toward several technology growth areas, including new medical and surgical devices, aeronautics, telecommunications, advanced materials, electricity, and biotechnology. [n304] The emphasis on critical tech **[*50]** nologies is reflected in patent statistics for PTO invention classes. [n305]

[SEE TABLE IN ORIGINAL] [n306]

Robust patenting activity occurred mainly in chemical, surgical, and industrial technologies. The most active industrial field concerns the development of electrical components and communications equipment. [n307]

[*51]

2. Assistive Technology Inventive Activity

AT patents form a subset of utility patents. This section summarizes our approach to measuring AT patenting trends. n308 The findings are compared to general utility patenting activity.

a. Term Word Searches: Assistive Technology Patent Trends

The first goal was to extract AT patents from the patent data base. Finding these examples was time consuming because there is no specific PTO invention class pertaining to assistive devices or devices for use by people with disabilities. In addition, a range of industry and technology sectors support AT research and development. The closest the PTO approaches an invention subtype that covers assistive devices is Class 623, for "prosthesis, parts thereof, or aids or accessories therefor." n309

Data were collected from a number of LEXIS and/or WESTLAW term word searches of the PTO database. n310 Efforts focused on identifying reliable search strategies. We were also interested in the terms used to describe AT devices and AT consumers. For instance, patent titles for powered wheelchairs included the following: personal mobility vehicle; n311 utility cart; n312 invalid carriage; n313 power drive scooter; n314 three-wheel vehicle; n315 all-terrain, all-weather wheelchair. n316

[*52] Term word searches involving root words such as "handicap" or "disability" modified by the terms "physical," "visual," and "hearing" and/or "auditory" lead to small numbers of patents. n317 Other phrases, including "assistive technology," "universal design," "adaptive device," "augmentative device," "sensory/motor impairment" also provided unsatisfactory responses. Searches based on the descriptors physical impairment, visual impairment, and hearing impairment will be discussed below. n318

The annual number of patents for products intended for use by consumers with disabilities has increased since 1975. This data is depicted graphically in Charts 2-6. n319 The number of patents for use by individuals with physical, visual, or hearing impairments increased between 1975 and 1997. Chart 2 depicts this data by year.
The number of patents relating to hearing impairments increased from 12 in 1977 to 96 in 1997. Similarly, 4 patents relating to visual impairments issued in 1977, compared to 97 in 1997. Finally, 30 patents relating to physical impairments issued in 1977, as compared to 62 in 1997. Local patent number maxima occurred in 1977-78 and 1987-88. Future efforts will more closely analyze issuance trends in the context of the passage of disability legislation or other policy factors. n320

Chart 3 summarizes the patenting trend data in 5 year increments.

[brr(90) n:wid1,tphf] [vc 1,45]

Chart 3
Patents Issued Between 1970 and 1995 Mentioning Physical, Visual, or Hearing Impairments By 5 Year Increments

[vc1,26] The number of patents citing physical, visual, and hearing impairments increased between the 1976-80 time period and the 1991-95 time period, as depicted in Chart 3. The patenting rate for these three subclasses combined increased four-fold between the 1976-80 and 1991-1995 time periods. n321

Physical impairment patents increased from 118 during the 1976-80 time period to 250 during the 1991-95 time period, representing more than a two-fold increase in the patenting rate. Visual impairment patents increased from 12 to 144 (a 12-fold **[*53]**

[SEE CHART IN ORIGINAL] **[*54]**

[SEE CHART IN ORIGINAL] **[*55]** increase in patenting rate) during the same interval. This was a period of

advancement for text to speech technology. [n322] Hearing impairment patents increased from 38 to 270 - more than a seven-fold increase. This was a period of growth for hearing aid, text telephone, and cochlear implant technology. [n323]

Some of the patents identified by the search strategy were for devices relating to the medical diagnosis, treatment, or the special needs of people living with disabilities. One physical impairment patent was for an eating utensil handle that is easier to hold for individuals with arthritis or multiple sclerosis. [n324] One visual impairment patent was for an eye-tracking system that allows people without the use of their hands to interact with computers. [n325] Sensory impairment patents were for TDDs, [n326] hearing aids, [n327] Braille readers [n328] and computer icons. [n329]

Patenting trends for Class 623 inventions (prosthetic devices, etc.) are also worth mentioning. Since 1975, over 3800 Class 623 patents have issued. Of these, 1893, or 49 percent, came from independent inventors. [n330] Chart 4 depicts data between 1975 and 1995 for Class 623 inventions. [n331] The increase in patent numbers for 623 patents and impairment patents are similar.

[brr(90) n:wid1,tphf] [vc 1,45]

Chart 4
Patents Mentioning Impairments v. Class 623 Patents

[vc1,26] Also noteworthy are patent numbers for inventions relating to aging. These patents were extracted by searching the root terms "geriatric" or "elderly." Chart 5 compares the number of patents relating to aging with Class 623 patents and the sum of impairment related patents.

[brr(90) n:wid1,tphf] [vc 1,45]

Chart 5
Aging Patents Compared to Other Patent Types, in Five Year Increments

Chart 5 shows that patent numbers relating to aging or the elderly are markedly greater than for the other two patent types depicted. By the 1990-1995 period, patents relating to aging or **[*56]**

[SEE CHART IN ORIGINAL] **[*57]**

[SEE CHART IN ORIGINAL] **[*58]** the elderly totaled nearly 2,000 - about a 5-fold increase since the 1976-1980 period. Increases for Class 623 and impairment patents were less dramatic. Class 623 numbers increased 3-fold, from about 170 in the 1976-1980 period, to about 600 in 1990- 1995. Impairment patent numbers show similar trends.

The extent to which patent numbers relating to aging or the elderly outpaced impairment patents is illustrated in Chart 6.

[brr(90) n:wid1,tphf] [vc 1,45]

Chart 6
Patents Relating to Disability or Aging Compared to Other Patent Types

[vc1,26] The number of patents relating to aging or the elderly neared 450 in 1995 - almost ten times the number for physical, visual, or hearing impairment patents.

The results relating to inventive activity based on impairment type, prosthetics, or the needs of older consumers parallel the finding that AT use within discrete age groups is increasing at a faster rate than population growth. [n332] Much of the increase may be attributed to the aging of the population. [n333]

The AT use patterns of the elderly are consistent with findings reported in the 1989 National Long Term Care Survey. [n334] As one researcher noted, the increasing use of AT among the elderly "high risk population" will continue to grow, and a marketplace for AT will continue to grow with it. [n335]

AT use patterns vary between age groups. [n336] Among persons who use AT, the majority (52%) are above the age of 65. Older users are more likely to need mobility or hearing technologies than younger users, [n337] while younger users are more likely to use prosthetic devices, braces, adapted typewriters, and computers. [n338]

[*59]

[SEE CHART IN ORIGINAL] **[*60]**

b. Comparison to Overall Utility Patent Trends

As depicted in Chart 1, the number of utility patents increased from 75,000 during 1976 to just over 100,000 in 1995, representing a 74 percent increase. [n339] The rate of patenting for assistive devices, measured between 1975 and 1995, was about five times faster than the general utility patenting rate.

The data suggest a substantial level of AT patenting relative to general utility patenting trends. This empirical finding is noteworthy, because it seems to stand in contrast to assertions that the PTO is not addressing the activity of AT inventors or, by extension, the needs of AT consumers. [n340] However, the findings do not indicate whether AT patenting is occurring at a socially optimal level.

3. Inventive Activity Influenced by Federal Legislation

Examining patenting data for inventions relating to environmental as well as AT is useful because federal environmental and disability policy share some structural similarities. Environmental and disability regulatory policy incorporate performance and specification standards. [n341] The government also attempts to encourage innovation and compliance in environmental and accessible contexts through regulations, economic incentives, and tax credits. [n342]

a. Patents Referencing Environmental Legislation

In the environmental context, the government attempts to improve environmental conditions by encouraging technological innovation legislatively. [n343] It encourages innovation by providing tax incentives, subsidies, and research and development opportu **[*61]** nities for polluters and environmental technology producers. [n344] Polluters and environmental technology producers who implement new technologies are eligible for tax incentives and research and development grants. Federally-sponsored environmental research and development initiatives at academic centers and national laboratories are intended to foster innovation.

A number of patentees directly referenced environmental and occupational health laws in their disclosures, based on preliminary term word searches of the Patent Database. The data are summarized in Table 4 and Chart 7. [n345]

[SEE TABLE IN ORIGINAL]

[*62]

Table 4 and Chart 7 depict the number of patents citing the Clean Air Act, the Clean Water Act, the National Environmental Protection Act (NEPA or EPA), and the Occupational Safety and Health Act (OSHA), relative to the dates of their passage. [n346] Patenting activity relating to the Occupational Safety and Health Act was first observed in 1973 - three years after the law's passage. Lag times are similar relating to the Clean Air Act and the National Environmental Protection Act, also passed in 1970. Patents citing the Clean Water Act, passed in 1972, began to appear in 1978. Reference to OSH and NEPA is more frequent than to the other laws. In the case of NEPA, a dramatic increase

in patent grants occurred in 1989-1990.

These patenting trends may be artifacts of the technology forcing goal of environmental regulatory mandates. [n347] Empirical data from the OTAF and independent researchers support this conclusion. [n348] To that end, four times as many patents were issued for Class 210 landfill leachate controls in the 1982-1990 period, after passage of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) [n349] and Resource Conservation and Recovery Act (RCRA), [n350] than were issued in the 1969-1981 period. [n351]

b. Patents Referencing Disability Legislation

In a manner complementary to environmental and occupational regulations, disability laws aimed at improving accessibility seek to force innovation. The accessibility regulations promulgated in the ADA and related laws are intended to make public, working, and eductaional settings barrier-free. The legislative history of the ADA suggests that the drafters wanted to avoid discouraging innovation in barrier-free design by requiring absolute adherence to rigid standards. [n352] Tax incentives, subsidies, and **[*63]**

[SEE CHART IN ORIGINAL] **[*64]** research opportunities related to AT development encourage innovation. Small businesses and other entities covered by the ADA are eligible for tax incentives and related supports to improve accessibility and adopt accommodation policies. [n353] Federally-sponsored disability research and development projects are intended to improve AT design and support services. [n354]

Reference to disability rights legislation in patents is rare, in contrast to the trends identified for environmental legislation. [n355] No patents were found that referenced the Rehabilitation Act of 1973; the Architectural Free Barriers Act; or the Technology- Related Assistance for Individuals with Disabilities Act of 1994. In total, 125 patents made direct reference to the ADA. Descriptive attributes for these patents were recorded and tabulated. [n356] Results are summarized in the subsequent Charts and Tables.

i. Invention Profiles

Chart 8 illustrates that the number of patents citing the ADA has increased annually since the law was passed in 1990. [n357]

Chart 8 records annual numbers of patents by application date and issuance date. Annual issuance numbers rose through 1996. A reduction of patent applications was recorded for the same time period, after maximum application years in 1994 and 1995.

The average time for an application to proceed through the examination process was approximately 1.7 years, with a maxi **[*65]**

[SEE CHART IN ORIGINAL] **[*66]** mum of 3.6 years and a minimum of about three months. This compares favorably with the analogous values for utility patents. [n358]

Inventor characteristics are summarized in Charts 9 and 10 and in the appendices to this article.

[brr(90) n:wid1,tphf] [vc 1,45]

Chart 9
Applications by Inventor Type: 1991-1997

[vc1,26] [brr(90) n:wid1,tphf] [vc 1,45]

Chart 10

Issued Patents by Inventor Type: 1991-1997

[vc1,26] Individual inventors accounted for 58, or about 46 percent of the 125 issued ADA patents, while the remainder were assigned to corporations and other entities (67 patents, or 56 percent). This value is roughly three times the one recorded for utility patents, where non-affiliated inventors accounted for about 15 percent of the general utility patents that were issued in 1995. [n359]

The concentration of independent inventors in the AT area is indicated in the higher proportion of unassigned patents that mention ADA. [n360] AT patents may remain unassigned and unlicensed because they are for devices that are targeted for small, specific groups within the disability community and are viewed by corporations as unprofitable to manufacture and market. [n361] Companies frequently are unwilling to risk time and capital on products without large potential markets. [n362] This trend may be true for the ADA and impairment patents. [n363]

Appendix 1 lists patents by corporate assignees. Major corporations patenting in the assistive technology sector included Minnesota Mining & Manufacturing (3M), Fisher Hamilton Scientific, American Standard, and Texas Instruments. A number of patents came from firms specializing in AT, such as American Tactile, Aging Technologies, A-Solution, and Care Concepts. Some of the firms appear to be affiliated with federally sponsored research centers. Academic assignees included North Carolina State University and the Georgia Institute of Technology Research Corporation.

Table 5 indicates that inventors are from a wide cross-section of the country.

[*67]

[SEE CHART IN ORIGINAL] **[*68]**

[SEE CHART IN ORIGINAL] **[*69]**

[SEE TABLE IN ORIGINAL]

Based on Patent Office Data, most utility patents come from inventors residing in California, New York, or Texas. [n364] In the present study, there was no relation between inventor type (individual or corporate assignee) and invention state. Approximately 60 percent of the ADA patents came from seven states, **[*70]** including: California (10); Connecticut (12); Illinois (17); Massachusetts (8); New York (8); Ohio (14); and Virginia (6). [n365]

As Table 6 indicates, the PTO granted patents for a wide distribution of devices, based on PTO classifications. [n366]

[SEE TABLE IN ORIGINAL]
[*71]

[SEE TABLE IN ORIGINAL]

The majority of the inventions support multiple users (universal devices) and did not appear to be designed for sole users (customized devices). [n367] About three-quarters of the patents described inventions that were for direct use by consumers with disabilities. The remaining patents were for manufacturing processes used to assemble adaptive devices, including signs.

Charts 11-16 depict alternative classifications schemes for the inventions. [n368] According to Chart 11, the majority of the patents were for "general access" inventions - devices designed **[*72]** to improve general accessibility for persons with disabilities in a variety of contexts.

[SEE CHART IN ORIGINAL]

"General accessibility" devices include a range of items such as personal care aids, eating utensils, bathroom fixtures, handrails, handicap-accessible door levers, modular ramps, and universally designed workstations. "Communication devices" include telecommunications components and Braille-coded signs. "Transportation devices" include vehicle lifts and other mobility- related components. Individual inventors and corporate assignees accounted for approximately equivalent contributions to each category depicted in Chart 11.

The majority of the patents (62, or 64%) were for general access inventions. Of these, 26 were filed by individual inventors and 36 by corporate assignees. Communications-related inventions accounted for 41, or 32% of the patents granted. Fifteen of these were filed by individual inventors. Transportation inventions accounted for 4% of patents.

Similar results were observed under the alternative classification protocol, depicted in Chart 12.

[*73]

[SEE CHART IN ORIGINAL]

Chart 12 shows that 57 patents, or 59 percent of the issued patents, were related to improving "Public Access." This category included ramps, accessible doors, and slip-proof surfaces. Corporate assignees accounted for 36 of the 57 "public access" patents. Devices that lead to "Improved Home or School" experiences, including communication devices and accessible workstations, accounted for 25 patents, or 26 percent of the issued patents. Corporate assignees accounted for twelve of these. The remaining patents included five for "personal" devices, covering personal care aids. Miscellaneous devices accounted for five of the patents. Ten patents were classified as "other," which included methods or processes for making a product, and for various measuring devices.

The patents also were classified by impairment type, as depicted in Chart 13.

[*74]

[SEE CHART IN ORIGINAL]

Chart 13 indicates that 70 percent of the patents were for devices that were intended for use by individuals with mobility impairments, and 27 percent were for individuals with sensory impairments. The remaining three percent of the patents were for use by people with neurological, behavioral and mental impairments.

Charts 14 and 15 illustrate the mobility and sensory impairments patents by subtype.

[SEE CHART IN ORIGINAL]

[*75]

Chart 15
Patents by Impairment Type: Sensory Impairments

Chart 14 shows that 72 percent of the mobility impairment patents were for individuals who use wheel chairs. The wheelchair patents included wheel chair-accessible fixtures for home, work, and other public settings, as well as for lifts, transport devices and portable ramps. Individuals with hand-arm impairments were the focus of 18 percent of the patents. These patents were for various "easy-grip" or ergonomic devices for use in the home, workplace, and other public settings. Eight percent of the mobility patents were for individuals who have trouble walking or standing. The patents classified as "other" were for devices to measure strength and flexibility - for instance, to determine the stand and lift capabilities of employees with and without disabilities.

Chart 15 indicates that the 74 percent of the sensory patents were for individuals with visual impairments; 23 percent were for individuals with hearing impairments, and 3 percent were for individuals with speaking and augmentative impairments.

Chart 16 classifies the patents by the ADA Title which they reference.

[*76]

[SEE CHART IN ORIGINAL]

Most (82%) of the patents explicitly mentioned the public accommodation provisions of Title II, and the ADA Accessibility Guidelines in justifying the social utility for their inventions. Others identified the need for improved access under Title II or the reasonable accommodation requirement under Title I.

Finally, all of the patents listed more than one patent as pertinent prior art. About half of the patents listed international patents as prior art references. Other references were for product catalogues or related advertisements. Few of the patents cited scientific papers as references. This last finding may indicate a "weak" linkage between scientific research and assistive technology development. Such a finding would be typical of patent practice in the mechanical arts generally, of which AT is part. [n369]

ii. Context in Which the ADA is Referenced

Patents referencing the ADA emphasized that the law has imposed accommodation and accessibility responsibilities on a range of societal groups. [n370] The ADA was invoked in the patents, perhaps in recognition of the regulatory framework that it introduces, with respect to accessibility and accommodation issues. While some references seemed laudatory, the majority identify the practical implications of ADA passage for business **[*77]** owners, property managers, and employers. [n371] Examples are provided in Appendix II.

Some patentees invoked broad interpretations of the law. One patent for a workstation support noted that "with the passage of the [ADA]..., employers are required to make workstations available and accessible to all employees." [n372] This is not, strictly speaking, a correct interpretation of Title I. [n373] In this case, the patentee may have been trying to demonstrate "utility" and "unmet need," and, in the process, overstated the statutory limits of Title I. [n374]

The ADA is mentioned tentatively in other disclosures. A video display terminal accessible to visually impaired persons invoked the ADA, and "the legal concept of reasonable accommodation." [n375] Patentees identified home and workplace safety requirements suggested by the ADA as utility justifications for their inventions. [n376] Others emphasized the importance of developing low- cost approaches to achieving accessibility and provid **[*78]** ing accommodations, [n377] and expressed an entrepreneurial attitude about assistive technology. [n378]

A patent for a remotely operated road sign provided a far- fetched citation to the ADA. [n379] This patentee noted that there was "a growing interest" in finding jobs in the construction industry for persons with disabilities. The device, the inventor argued, may accommodate a range of physically handicapped road crew workers. [n380]

B. Discussion of Core Findings

The findings of the study deserve examination in broader social, economic, and policy dimensions. This section highlights the significance of the core findings.

1. Increasing Assistive Technology Patent Numbers

Patents relating to the needs of consumers with disabilities are increasing in number. For individuals with disabilities and other purchasers of assistive technology, this may indicate that design innovations and improvements will continue

to characterize and drive market activity in the AT sector.

A number of social and economic factors - most notably, those relating to technological advances and changes in technology policy - account for the increase. Scholars have argued that technology policy in the United States has shifted focus from industry innovation to technology innovation. [n381] This shift in focus may have already led to greater levels of innovation for a variety of industries that use similar technologies. [n382] The process of technological "spillover," from telecommunications and microelectronics technology made advances in TDD technology possible, for instance. [n383]

[*79] Another contributing factor is the fundamental shift in disability policy that has occurred over the last thirty years. Knowledge and understanding of laws like the ADA diffuse from immediate ADA stakeholding groups to remote social groups. The present findings trace this process of diffusion.

The first subgroup is made up of the legal system, which is responsible for enforcement of the ADA, and the disability advocates who sought passage of the law. The second is made up of AT inventors, who responded to shifts in policy originating from the first group because of perceived economic opportunities. [n384] The third group is represented by the patent management system, and thus the rules of the PTO. The patent management system mediates between individual inventors and society. [n385] The system overlaps and draws on the legal system, economic system, and political system. [n386] To a certain extent, the patent management system defines invention and influences what particular inventors choose to invent. [n387]

2. Significance of Patents Citing the ADA

Patents citing the ADA are significant on a number of levels. At a minimum, assistive technology patentees were willing to go through the time and expense of seeking formal patent protection for their inventions at a rate that significantly outpaces the general increase in utility patenting. [n388] AT inventors initiated the patent process because of the promise of future economic returns based on consumer demand.

On another level, the motivation of inventors and their patent lawyers in citing the ADA is worth considering. Passage of the ADA introduced new regulations relating to accessibility requirements for individuals with disabilities. The present study found that patented devices frequently were presented by inventors as meeting ADA accessibility specifications. Invoking the ADA may have been part of a strategy to meet the novelty, utility, and non- obviousness patentability standards. [n389]

The notions of "induced innovation" or "technology forcing" that may be operative in environmental contexts may be **[*80]** operative in the disability context as well. [n390] As indicated earlier, some environmental regulations are intended to force, or induce, innovation in workplace safety or pollution control technology. [n391] In the past, provisions of the Clean Air Act, the Clean Water Act, the Occupational Safety and Health Act, and the Toxic Substances Control Act detailed incentives for corporate pollution control strategies. In these examples, regulatory shifts demanding compliance were intended to force technological innovation, directly, and through a series of tax and other incentives. [n392]

Whether technology forcing has encouraged innovation in the environmental context is still debated. Yet studies suggest that regulations have a positive impact on the process of innovation - a finding that may prove operative in the disability/accessibility context. [n393]

3. Diversity of Assistive Technology Inventors

Individual inventors accounted for over half of the ADA AT patents. For utility patents in general, most inventors assign their **[*81]** patent rights to their employers - corporate or academic entities. This result suggests a strong entrepreneurial spirit among AT inventors. Alternatively, the result could indicate a shortage of corporate and academic

AT design initiatives. The continued interest of corporations to invest in AT development will be critical to growth in the AT market.

4. Diversity of Assistive Technology Consumers

AT patents were for devices designed for consumers with a range of impairments. Consumers with physical or sensory impairments collectively stand to gain from the activity of assistive technology inventors. The present study suggests that passage of the ADA is helping inventors and manufacturers identify other potential markets for AT. n394

Prior to the passage and implementation of the ADA, persons with disabilities were considered the primary consumers for assistive technology inventions. Other consumer groups, including the elderly and the chronically ill, now are recognized as participating in the AT market. n395 After implementation of the ADA in 1992, persons with disabilities, their employers, property owners, communications companies, and municipal transport authorities, became consumers of AT. Engineering trade journals and popular literature reflect an understanding of the implications of ADA implementation. They view compliance with the ADA program of national accessibility as a potential source of profit. n396

[*82] Overall, AT has relevance to implementation of each ADA Title and plays a critical role in achieving ADA goals. n397 Federal regulations requiring ADA compliance appear to be having a beneficial effect on AT purchasing by covered entities. n398 Title I employment entities charged with providing accommodations have purchased a wide variety of work-related products. n399 The effect of the regulations has been to encourage AT firms to innovate in order to compete in the AT market. The AT market is responding to Title I employer-consumers, in part because of the flexibility of EEOC accommodation guidelines. n400 Regulatory flexibility thus fosters innovation.

The effects of ADA passage have been beneficial for entities covered by Titles II and III as well. n401 As indicated, Department of Justice (DOJ) guidelines for Title II and III entities require certain kinds of services, but do not detail product specifications. Title III requires covered entities to implement available technologies that offer "readily achievable" solutions for people with limitations. The result has been to encourage the search for commercially viable technologies to meet Title III requirements. One author has noted that Title III has stimulated research in captioning technology for movie theaters - a full fifteen years after captioning technology was developed for television. n402

5. Promise of Economic Benefits for Assistive Technology Inventors

The results of the present study suggest a range of conclusions for AT inventors. First, inventors have successfully guided their inventions through the patent process. In many cases they **[*83]** have carried them to the consumer market, where demand for AT continues to grow.

Estimates suggest that there are approximately 2000-3000 businesses that manufacture AT devices. n403 Many of these are small operations or sole inventors, marketing a maximum of one or two devices. n404 Some are Fortune 500 companies, like 3M, that develop and manufacture diverse product lines for a range of consumer groups. Others, like Henter-Joyce or LC Technologies, market computer technology for disabled consumers. These companies are developing AT product lines to capitalize on market opportunities, and their success is substantial. Henter-Joyce has tripled its workforce. n405 LC Technologies has recorded sharp increases in orders in the last six months. n406 The market for some AT products - for instance, for speech to text products - continues to grow. n407 The market is projected to reach $ 410 million in 1997. It should exceed $ 4.3 billion by 2001. n408

The "push-pull" of disability policy also is fostering the research initiatives of individual and corporate inventors. n409 The regulatory "push" introduced by the ADA is expanding the market for AT to include a range of consumer groups, including persons with disabilities, their employers, and public, municipal, and governmental entities. n410 At the same time the "pull" provides research and development incentives to AT inventors. n411

Viewed in light of AT market growth and the findings of the present study, proposals to modify patent policy to further accommodate AT inventions require careful analysis. Verzani's proposal - whereby AT patent applications are eligible for a Modified Petition to Make Special upon a showing that they are designed to serve consumers covered by the ADA - would be difficult to implement. Examiners would be required to master the Title 42 definition of disability to weigh the veracity of inventors' claims that their devices were for use by individuals with disabili **[*84]** ties. This responsibility would be in addition to evaluating the patentability of inventions.

The findings of the present study suggest that the patent system does not need to be modified to encourage AT patenting. AT patenting rates are not disproportionately small relative to general utility patenting rates. To the contrary, AT patenting appears to be increasing at a substantial rate. The findings support the notion that the patent process is "working" for AT: AT inventors are patenting their inventions and marketing their goods.

V. Implications

Several implications arise from the present study. First, taken with other factors, the ADA patenting data presented indicate that unanticipated economic benefits are accruing from the law. Activity in the AT consumer market is a positive economic benefit that has heretofore been overlooked by ADA critics. Prior conclusions regarding ADA cost-effectiveness have been based on incomplete data or misinformation, rather than on evidence of the law's working in practice. [n412] The continued lack of empirical data hinders balanced evaluation of the ADA. The present study illustrates, in its approach and scope, that study is needed to gauge the successes and failures of ADA implementation.

The present study also indicates that inventors are attempting to meet the needs of consumers with disabilities. Consumers with disabilities will continue to need improved AT devices to fully participate in school, work, and the marketplace. Work remains in achieving the inclusion and participation of individuals with disabilities in society. State and national policy initiatives must continue to support universal design technology strategies. Including individuals with disabilities in the AT research and design process will lead to more "user friendly" products. Finally, funding for AT is needed for many other populations, particularly living in poverty.

A. Avoiding Rushed Judgment of the ADA

The findings of the present study indicate that unforeseen economic benefits are arising from ADA implementation. These include direct gains accruing to AT inventors and producers, who cater to the needs of a highly diversified and rapidly **[*85]** expanding AT market. Direct gains are also accruing to AT consumers - individuals with disabilities, the elderly, owners of public accommodations, and employers - who exercise their preferences and spend less on AT because of competition in the AT market. The law is also generating indirect economic benefits to ADA stakeholders. Employers economically benefit by drawing on the largely untapped productive workforce of persons with disabilities who become productive employees because of AT. Taxpayers benefit when capable workers leave the welfare rolls. These direct and indirect economic benefits should be reflected in cost-benefit evaluations of the ADA.

1. Incorporating Unforeseen Economic Benefits in ADA Cost- Benefit Evaluations

Scholars argue that the economic costs of ADA implementation far outweigh economic benefits accruing to society. [n413] This is particularly true for the ADA's employment provisions, which are set forth in Title I of the law. Title I seeks to ensure that "qualified individuals with disabilities" [n414] have equal access to the job market, [n415] and, where appropriate, that employers provide accommodations to individual workers who can perform essential job functions. [n416]

The shortcomings of cost-benefit paradigms [n417] are reflected in judicially constructed evaluations of the ADA and its Title I. **[*86]** Courts have focused on a narrow range of cost-benefit factors. [n418] As applied to the "reasonable accommodation" provision found in Title I, the cost-benefit scale adopted by some courts allows employers to weigh the direct costs of providing accommodations for qualified disabled individuals against the benefits associated with the

accommodation. [n419]

Cost-benefit paradigms are being applied by courts to questions of "undue hardship" faced by employers. Covered entities are not required to provide accommodations that impose undue hardships. [n420] Employers invoking Title I's undue hardship **[*87]** defense have argued that the costs of accommodations are too high relative to an employee's salary. [n421] By tying "reasonableness" to cost-benefit determinations, courts are "opening the door" to judicial interpretations of the ADA's "undue hardship" provision favoring employers who argue that accommodation costs should be capped by an employee's salary. [n422] This would make it easier for an employer to argue that providing a high-tech, high cost AT accommodation for a minimum wage worker poses an undue hardship.

In passing the ADA, Congress considered and rejected an amendment that would have placed a ten percent ceiling on accommodation costs based on an employee's salary. [n423] The EEOC has stipulated that the employer's resources - not the employee's salary, position, or status in the company - determine the cost that must be spent on accommodations. [n424]

2. Economic Benefits Accruing to Title I Stakeholders

A range of direct and indirect economic benefits are accruing to ADA stakeholders. This study indicates that patent and innovative activity are one indicator of economic benefits accruing to AT inventors and consumers.

For employers, the gains may include the addition of effective, productive employees to their workforce because of the adoption of AT and universal design strategies.

Some employers have been unwilling to make accommodations because of perceived or actual expense. Some argue that the cost of supplying AT as an accommodation to a worker with a disability places financial burdens and administrative costs on business operations. [n425] The costs of accommodations may be especially high for large employers who are held accountable for extensive modifications due to their greater financial resources. [n426]

These arguments often are made without reliance on data. The findings of the present study show that the AT inventions **[*88]** typically were "low tech," inexpensive, and represent "capital improvements" from which all employees may benefit. The low direct costs of accommodations for employees with disabilities has been shown to produce substantial economic benefits to companies, in terms of increased work productivity, injury prevention, reduced workers' compensation costs, and workplace effectiveness and efficiency. [n427]

This trend is reflected in data collected from a series of studies conducted at Sears, Roebuck and Co. from 1978 to 1997. Nearly all of the 500 accommodations sampled at Sears required little or no cost. [n428] During the years 1993 to 1996, the average direct cost for accommodations was $ 45, and from 1978 to 1992, the average direct cost was $ 121. [n429] Other studies have produced similar findings. [n430]

Accommodations involving universally designed and advanced technology have been shown to enable groups of employees with and without disabilities to perform jobs produc **[*89]** tively, cost-effectively, and safely. [n431] The studies at Sears suggest that the direct costs associated with many technologically-based accommodations (e.g., computer voice synthesizers) enabled qualified employees with disabilities to perform essential job functions. These strategies created an economic "ripple effect" throughout the company. [n432]

The Sears findings suggest that the direct costs attributed to universally designed accommodations may be lower than predicted, particularly when their fixed costs are amortized over time. [n433] They also suggest that the costs and benefits of workplace accommodation require continued examination in a number of contexts, including: the type, effectiveness and cost of accommodations at large and small organizations; the direct and indirect costs and benefits of accommodations; [n434] and accommodation trends in the national aggregate. [n435]

B. Removing Physical and Communications Barriers

AT plays a fundamental role in achieving the ADA's goal of reshaping employment, public accommodations, and public attitudes toward individuals with disabilities. [n436] Continuing to develop AT for home, school, and work will help abolish physical and communication barriers that confront many individuals with disabilities.

1. Assistive Technology and Universal Design Initiatives

A report by the National Council on Disability notes that as the population ages, state and national initiatives will need to **[*90]** continue to further the adoption and implementation of universal design of technologies, particularly in the communications realm. [n437] The Telecommunications Act of 1996 requires telecommunications equipment to be accessible to individuals with disabilities. [n438] Under the law, the Federal Communications Commission is required to issue accessibility guidelines for telecommunications equipment. [n439] The Act mandates the continued development of telemedicine systems and services.

Telemedicine programming will help meet the healthcare delivery needs and options of people with disabilities, particularly in rural areas. [n440] Telemedicine relies on telecommunications for medical diagnosis and patient care. [n441] Modern telemedicine systems rely on microwave transmission technology, including satellite transmissions, and electronic computer based transmissions. [n442] The least complex telemedicine systems use one-way visual technology to transmit still images, supplemented by telephone consultation. Sophisticated systems have one-way video and one-way audio capability. [n443] The most sophisticated systems simulate full remote examinations of patients and are based on interactive teleconferencing systems. [n444] They transmit two-way video and audio signals and may be configured to transmit the electronic output of diagnostic instrumentation, such as sonograms, electrocardiograms, and electroechograms. [n445]

In a related vein, advanced telecommunications technology will continue to improve the classroom experiences of students with disabilities. Advanced computer and video technology offers alternative access systems that have strong appeal to students, with and without disabilities. [n446] Creating "schools without walls" **[*91]** using advanced telecommunications technology will help to prepare students with disabilities for employment. [n447]

To improve Internet access for people with disabilities, the Web Accessibility Initiative was launched in early 1997. [n448] Corporate activities in this area are also noteworthy. [n449] IBM and Sun Microsystems are developing software to make Java-based technology accessible to Internet users who are disabled. [n450] Microsoft has released technology that allows Windows applications to communicate with adaptive equipment, including screen readers. [n451]

2. Participatory Design

The inclusion of persons with disabilities in the design process is a significant indicator of changing attitudes about disability and technology within engineering research and development sectors. In the past, the social and historical context for disability was characterized by a dominant society that created a clear distinction between normal and abnormal. [n452] The technology justified by these disability stereotypes include life-ending technology, restraining technology, punishing technology, cure technology, medical technology, and simple and safe technology. [n453]

[*92] Individuals with disabilities were excluded from the assistive technology design process and found themselves dependant on public programs for decisions regarding technology. [n454] Dominant models and definitions of disability, based on medical, economic and minority paradigms characterized disability in the context of particular institutional systems. [n455] Each provided an incomplete picture of the meaning and consequences of disability. [n456]

The last 25 years have introduced changes. Inventors like Raymond Kurzweil sought knowledge from blind readers early in the design process. [n457] This has led one author to assert that technology developers should try to incorporate social knowledge (i.e., the experiences of persons with disabilities) in their development practices prior to innovation and market establish-

ment. [n458]

Historical disability models are giving way to less stigmatizing, proactive variants. [n459] In the "human variation" model of disability, problems faced by disabled individuals are seen as a consequence of the failure of social institutions to consider the full range of variation within a population. [n460] Thus, "individuals whose mobility, communication, medical needs, or cognition diff **[*93]** ers from social norms find themselves confronting institutions not well suited to their abilities and potential." [n461]

Viewing disability as an issue of human variation has contributed to improved AT design and practice. [n462] The rise of human factors engineering [n463] and the development of universal and transgenerational design principles to meet the needs of an aging population have led to improved AT devices for persons with disabilities, as well as the general population. [n464]

3. Paying for Assistive Technology

Many of the participants in the NCHS survey mentioned above reported a need for AT. [n465] Of the 2.5 million persons who had an unmet need for AT, [n466] about 1.2 million persons were of working age (25-64). [n467] Poor people were about twice as likely as non-poor people to say they needed an AT device. [n468]

Consumers who can afford AT have a choice among different products and designs. For these individuals, a competitive AT market continues to lead to improved quality and lower prices. Individuals who live in poverty, including persons with disabilities, the elderly, and the chronically ill, are shadow consumers of these new technologies. [n469]

[*94] Sources of funding for AT are inadequate. People who need and would benefit from AT are forced to self-finance. [n470] This means that many individuals go without AT, because the majority of persons with disabilities live in poverty. [n471] The fact that many persons with disabilities must pay for their own assistive devices discloses the inadequacies of existing assistive technology delivery systems, including third party insurance carriers who refuse to cover assistive technology. [n472] Although the Technology Related Assistance for Individuals with Disabilities Act was reauthorized in 1994 to address many of these failings, work still remains.

Current AT policy continues to raise a host of equity issues. [n473] These include: [n474]

. Who has access to technology?

. Which technology is available?

. Who decides on the technology?

. Who controls or determines allocation of AT?

The results of a 1982 Office of Technology Assessment Report on the lives of people with disabilities is still relevant today. The report stated that "despite the existence of numerous important problems related to developing technologies, the more serious problems are social ones, [not technological]." [n475]

High cost makes AT inaccessible for many individuals. According to an NCD Report, governmental agencies, including the Health Care Financing Administration, need to "address the dearth of publicly subsidized assistive technology... " [n476]

C. Effective ADA Implementation and Assistive Technology FundingPolicy

Effective ADA implementation requires coordination with other disability, welfare, and health policy reforms. Economic incentive programs encourage businesses to hire persons with disabilities and to purchase assistive devices for qualified employees in need. [n477] AT provision and service programs through the **[*95]** Tech Act and related programs are designed to meet the information and other needs of AT consumers. Federal support of AT research and development holds the promise of improved AT design. Small business loans encourage entrepreneurs, many of whom are individuals with disabilities, to carry their AT designs from conception through production to consumers.

As indicated above, whether individuals with disabilities can afford the new devices that AT inventors produce is another matter. Disability funding policy requires harmonization with respect to AT. A recent needs assessment survey showed that AT funding was the most significant problem experienced by consumers and service providers over other need areas. [n478] Funding for AT devices and services is available through a complex network of federal and state disability programs, including: SSDI, SSI, Medicaid, Medicare, and a variety of federal and state vocational rehabilitation and AT programs. [n479] The interpretation of disability standards under each of these laws varies. [n480] Third party payment of AT is the norm under most of the programs.

According to the NCHS AT survey mentioned above, third party funders made complete or partial payments for more than half (52 percent) of AT users' devices. [n481] About 48 percent of the people who used AT or their families paid for devices with no help from social service agencies or third parties. [n482] More than three-quarters of the persons with home modifications or accessibility features paid for them out of pocket. [n483]

VI. Conclusion

The provision of AT goods and services plays an essential role in evolving disability law and policy. [n484] Based on AT patenting trends, the ADA has had a measurable economic effect on the patenting activity of AT inventors. AT inventors responded rationally to the passage of the ADA and to the economic opportunities that the law has created through regulatory shifts relating to accessibility.

[*96] The ADA is succeeding in unanticipated ways, creating unanticipated benefits for ADA stakeholders and others. Knowledge of the ADA has reached AT inventors and has influenced their inventive activity. Yet the recent words of Professor Stanley Herr continue to ring true: "For all the glamour and the appeal of new technologies, we still need the old virtues of listening, of remedying the injustices that we encounter...of communicating with those we hope to help." [n485]

The achievement of the ADA's promise of full inclusion and equal participation requires more than advancing AT. It requires a recognition of underlying attitudes and behaviors toward individuals with disabilities in all parts of American society.

[*97]

ADA STUDY: APPENDICES

[SEE TABLE IN ORIGINAL] **[*98]**

[SEE TABLE IN ORIGINAL]

[*99]

[SEE TABLE IN ORIGINAL]

[*100]

APPENDIX I
CORPORATE ASSIGNEES OF ADA PATENTS

[SEE TABLE IN ORIGINAL] **[*101]**

[SEE TABLE IN ORIGINAL]

[*102] [vcr(90)]

APPENDIX II
PATENTS CITING THE AMERICANS WITH DISABILITIES ACT
1990-1997

[SEE TABLE IN ORIGINAL]

[*103]

[SEE TABLE IN ORIGINAL] **[*104]**

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Legal Topics:

For related research and practice materials, see the following legal topics:
Patent LawDate of Invention & PriorityGeneral OverviewPatent LawInequitable ConductGeneral OverviewTransportation LawPrivate VehiclesWheelchairs

FOOTNOTES:

n1. See Pub. L. No. 103-218, 108 Stat. 50 (1994) (codified as amended at 29 U.S.C. 2201-2288 (1994 & Supp. I 1995).

n2. See Peter D. **Blanck,** Communications Technology for Everyone: Implications for the Classroom and Beyond, in Annenberg Washington Program Reports 17 (1994) (discussing conference proceedings).

n3. See id.

n4. See id.

n5. See id.

n6. See Bureau of the Census, U.S. Dep't of Commerce Census Bureau, News (visited Apr. 20, 1998) <http://www.census.gov/Press-Release/cb97- 148.html>.

n7. In the Tech Act, Congress found that "disability...in no way diminishes the right of individuals to...enjoy full inclusion and integration in the economic, political, social, cultural, and educational mainstream of American society." Technology Related Assistance for Individuals with Disabilities Act, 29 U.S.C. 2201(a)(1)(E) (1994 & Supp. I 1995); see also Rehabilitation Act of 1973, Pub. L. No. 93-112, 87 Stat. 355 (codified as amended at 29 U.S.C. 701-797b (1994)) (mandating reasonable accommodation and least restrictive environments in federally funded employment and higher education and requiring provision of assistive technology device and services to individuals with disabilities); Education for All Handicapped Children Act of 1975 (EAHCA), Pub. L. No. 94-142, 89 Stat. 773 (codified as amended at 20 U.S.C. 1401-1461 (1994)) (extending reasonable accommodation and least restrictive environment provision of the Rehabilitation Act to those aged five to twenty-one in education and noting that assistive technology played a major role in gaining access to educational programs); Handicapped Infants and Toddlers Act, Pub. L. No. 99-457, 100 Stat. 1145 (1986) (codified as amended at 20 U.S.C. 1471-1485 (1994)) (extending EAHC to infants and children up to five years and expanding the emphasis on education-related assistive technology); Rehabilitation Act Amendments of 1986, Pub. L. No. 99-506, 100 Stat. 1807 (codified as amended at 29 U.S.C. 716-717, 794d, and 42 U.S.C. 2000d-7 (1994)) (requiring states to include provisions for assistive technology services in plans for each disabled client and mandating equal access to all electronic equipment in federal workplaces); Americans with Disabilities Act of 1990 (ADA), Pub. L. No.

101- 336, 104 Stat. 327 (codified as amended at 42 U.S.C. 12101-12213 (1994)) (extending sections 503, 504, and 508 of the Rehabilitation Act to all citizens with regard to employment, communications, and transportation); Education of the Handicapped Act Amendments of 1990, Pub. L. No. 101-476, 104 Stat. 1103 (codified as amended at 20 U.S.C. 1400 (1994)) (extending assistive technology device and service definitions to education).

n8. As noted by Congress in the findings of the Tech Act, "For some individuals with disabilities, assistive technology devices are necessary to enable the individuals to...have greater control over their lives...." 29 U.S.C. 2201(a)(1)(A).

n9. See 42 U.S.C. 12101. For a discussion of the goals of the ADA, see Implementing the Americans with Disabilities Act: Rights and Responsibilities of All Americans (Lawrence O. Gostin & Henry A. Beyer eds., 1993) [hereinafter Implementing the Americans with Disabilities Act].

n10. See 42 U.S.C. 12101(b).

n11. Title II of the ADA prohibits discrimination against qualified individuals with disabilities in public services, activities, and transportation. See 42 U.S.C. 12131-12161. Title III covers public accommodations and services operated by private entities, see id 12181-12189, and Title IV covers telecommunications services. See 47 U.S.C. 225 (1994).

n12. See 42 U.S.C. 12112; see also John Parry, Title I - Employment, in Implementing the Americans with Disabilities Act, supra note 9, at 57, 57-74 (discussing Title I terms and provisions); The ADA Mandate for Social Change (Paul Wehman ed., 1993) (same).

n13. The Findings Section of the ADA recognizes the "discriminatory effects of architectural, transportation, and communication barriers...[and the] failure to make modifications to existing facilities and practices." 42 U.S.C. 12101(5).

n14. AT is defined as "any item, piece of equipment or product system whether acquired commercially off the shelf, modified, or customized, that is used to increase, maintain, or improve functional capabilities of individuals with disabilities." Technology Related Assistance for Individuals with Disabilities Act, 29 U.S.C. 2202(2) (1994). Assistive technology devices include: motorized and customized wheelchairs; augmentative communication devices; vehicle modifications; computer equipment; assistive listening devices; home modifications; work-site modifications; and classroom modifications. See id. For detailed descriptions of assistive technology principles, see Albert M. Cook & Susan M. Hussey, Assistive Technologies: Principles and Practice (1996); Evaluating, Selecting, and Using Appropriate Assistive Technology (Jan C. Galvin & Marcia Scherer eds., 1996); Marcia J. Scherer, Living in a State of Stuck: How Technology Impacts the Lives of People with Disabilities (2d ed. 1996).

n15. See supra note 14.

n16. See generally Christopher Button & Rachel Wobschall, The Americans with Disabilities Act and Assistive Technology, 4 J. Vocational Rehabilitation 196 (1994) (describing the implications of the ADA on assistive technology policy).

n17. See 42 U.S.C. 12111(9) (defining reasonable accommodation); id. 12112(b)(5)(a) (barring discrimination based on not making reasonable accommodations).

n18. See Regulations to Implement the Equal Employment Provisions of the Americans with Disabilities Act, 29 C.F.R. 1630.9 (1998).

n19. See id.

n20. See Nondiscrimination on the Basis of Disability in State and Local Government Services, 28 C.F.R. 35.104 (1998).

n21. See id.

n22. See id.

n23. See Americans with Disabilities Act, 42 U.S.C. 12182 (1994); Nondiscrimination on the Basis of Disability by Public Accommodations and in Commercial Facilities, 28 C.F.R. 36.302-36.308 (1998).

n24. See 28 C.F.R. 36.303.

n25. See id. 36.304.

n26. See id. 36.304(a).

n27. See id. 36.302(a).

n28. See Americans with Disabilities Act, 47 U.S.C. 225 (1994).

n29. See Karen Peltz Strauss, Title IV - Telecommunications, in Implementing the Americans with Disabilities Act, supra note 9, at 155, 155-172 (discussing text telephone technology).

n30. See id.

n31. See Parry, supra note 12, at 57-74 (comparing Title I with other civil rights laws).

n32. Consistent with the first installment in this series of reports, this article attempts to examine some economic implications of the ADA expressed by economists in utilitarian cost-benefit terms. The adoption of this approach is not meant to suggest that non-utilitarian views of the ADA based in other disciplines are either less valid or useful for assessing the law's impact on society in general and the lives of persons with disabilities in particular.

n33. See generally **Blanck,** supra note 2 and references cited therein (discussing criticisms of the ADA).

n34. See id.

n35. See Frank G. Bowe, Is It Medically Necessary? The Political and Economic Issues that Drive and Derail Assistive Technology Development, Generations, Spring 1995, at 37 (discussing the effect the ADA has had on the assistive technology market).

n36. ADA Accessibility Guidelines specify standards for the design, construction, and alteration of public and commercial buildings and facilities. See Americans with Disabilities Act Accessibility Guidelines for Buildings and Facilities, 36 C.F.R. pt. 1191, App. A (1998). The text of Guidelines is posted on the Internet at <gopher://trace.wisc.edu/00/ftp/ PUB/TEXT/ADA INFO/REGS/ATBCB.TXT>.

n37. See Joseph P. Shapiro, No Pity: People with Disabilities Forging a New Civil Rights Movement 211-257 (1993) (discussing the role assistive technology plays in empowering persons with disabilities); Shirley K. Chandler et al., Provisions of Assistive Technology: Bridging the Gap to Accessibility, in The ADA Mandate for Social Change, supra note 12, at 117, 118 (noting that the movement toward

implementation of assistive technology is consistent with the concept that persons with disabilities can and should be fully functioning, integrated members of society); Scherer, supra note 14 passim (describing how assistive technology enables participation for people with disabilities).

n38. Persons with disabilities are primary stakeholders in the law. Secondary stakeholders may include employees, schools, and places of public accommodation. More remote stakeholders may include AT inventors, producers and providers.

n39. See infra notes 288-411 and accompanying text (discussing results of empirical study).

n40. See infra notes 248-287 and accompanying text (discussing the use of patent data to forecast technology and innovation trends).

n41. See Michael A. Gollin, Using Intellectual Property to Improve Environmental Protection, 4 Harv. J.L. & Tech. 193, 232, n.182 (1991) (noting that patent statistics are useful to policymakers and regulators attempting to determine the overall level of innovation) (citing Richard B. Stewart, Regulation, Innovation, and Administrative Law: A Conceptual Framework, 69 Cal. L. Rev. 1259, 1368-69 (1981)).

n42. See id.

n43. See id.

n44. For an examination of how patent data is used in research, see infra notes 199-247 and accompanying text.

n45. See infra notes 308-340 and accompanying text.

n46. See infra notes 352-363 and accompanying text.

n47. See infra notes 352-356 and accompanying text.

n48. See infra notes 359-365 and accompanying text.

n49. See infra notes 366-369 and accompanying text.

n50. See infra notes 403-411 and accompanying text. See generally Erich Kaufer, The Economics of the Patent System (1989) (discussing motivation behind innovation process); see also Carolyn C. Cooper, Social Construction of Invention through Patent Management: Thomas Blanchard's Woodworking Machinery, 40 Tech. & Culture 960, 961 (1991) (citing material reward and fame as motivating the act of invention). Other motivations for invention include fun, service to mankind, and the "instinct of workmanship." Id. at 961, n.1. For a general description of the American Patent System, see Donald S. Chisum & Michael A. Jacobs, Understanding Intellectual Property Law 2 (1992).

n51. Research and development, production, and sales are parts of a market that caters to assistive technology consumers.

n52. For a discussion of empirical and policy implications, see Parts III-IV and accompanying notes.

n53. See infra notes 413-424 and accompanying text.

n54. See infra notes 425-435 and accompanying text.

n55. See infra notes 6-15, 31-37 and accompanying text.

n56. See Nicholas A. Ashford & Charles C. Caldart, Technology, Law, and the Working Environment 251-52 (2d ed. 1996). Ashford's discussion is in the context of improving the safety of the work environment. We extend them here to improving the accessibility of the work environment to persons with disabilities.

n57. See Ellen Paris, The Perils of Being Too Successful, Forbes, Feb. 9, 1997, at 88, 88.

n58. See id; see also Robert Teitelman, De-handicapping the Handicapped, Forbes, Sept. 24, 1984, at 196, 197 (suggesting that once E & J had its design down, it became unresponsive to changing marketplace and public attitudes toward individuals with disabilities).

n59. See Paris, supra note 57, at 88.

n60. See id.

n61. See Teitelman, supra note 58, at 197.

n62. See id.

n63. See id.

n64. See U.S. Const. art. 1, 8, cl. 9. Article I, Section 8, Clause 8 grants to Congress the power to "promote the Progress of Science and useful Arts, by securing for limited Times to Authors and Inventors the exclusive Right to their respective Writings and Discoveries[.]" U.S. Const. art. 1, 8, cl. 8. For a discussion of intellectual property law policy within the constitutional federal system, see Chisum & Jacobs, supra note 50, 1D.

n65. The Patent Act of 1952 details the procedural and substantive requirements of the patent system. Patent Act of 1952, Pub. L. No. 82-593, 66 Stat. 792 (codified as amended at 35 U.S.C. 1-376 (1994)). Accordingly, "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 ...." 35 U.S.C. 101 (1994). An amendment to the Patent Act changed the patent term from 17 years from the date of invention to 20 years from the date of filing. See Pub. L. No. 103-465, 108 Stat. 4809, 4976 (1994) (codified at 35 U.S.C. 154 (1994 & Supp. II 1996)).

n66. A patentee can exclude others from making, using, or selling a patented invention. See 35 U.S.C. 154. The performance of any of these acts during the patent term constitutes direct infringement. See id. 271. Indirect infringement is an unauthorized sale of specially designed parts or components for use in a patented combination or process. See id.

n67. See generally Chisum & Jacobs, supra note 50.

n68. See 35 U.S.C. 111 (describing disclosure requirement).

n69. See 35 U.S.C. 283 (describing infringement remedies).

n70. See id. (suggesting that the expectation of economic rewards provides innovation incentives); see also John F. R. Harter, The Propensity to Patent with Differentiated Products, 61 S. Econ. J. 195 (1994) (discussing patent system economic justifications); Chisum & Jacobs, supra note 50, 1[C] (describing intellectual property law and the patent system in terms of utilitarian and moral tensions - incentive versus competition, and property versus monopoly).

n71. See Harter, supra note 70, at 195.

n72. See id.

n73. See id.

n74. See id.

n75. See id.

n76. See Kaufer, supra note 50, at 19-20 (describing the expectation of economic benefits as a motivation behind the decision to patent); Cooper, supra note 50, at 961 (same).

n77. See Charles Butler, Mal Bonding: Mal Mixon, CEO of Invacare, Sales & Marketing Mgmt., July 1995, at 66, 66 (quoting an Invacare executive: "We're not in business for any other reason...[than] to come up with better products and beat our competitors.").

n78. See Kaufer, supra note 50, at 19-20.

n79. See Natalie Derzko, Using Intellectual Property Law and Regulatory Processes to Foster the Innovation and Diffusion of

Environmental Technologies, 20 Harv. Envtl. L. Rev. 3, 7 (1996) ("Innovators are often discouraged from producing...new ideas because ideas have 'public good' characteristics that allow people to pirate their technology.") (citing Intellectual Property Rights and Capital Formation in the Next Decade 46 (Charles E. Walker & Mark A. Bloomfield eds., 1988). Professor Mark Janis provided useful comments on this point. The idea is that when placed in the public domain, unprotected intellectual property goods are susceptible to competitive use, simultaneously, without depletion. This makes intellectual property goods fundamentally different from personal property goods.

n80. See id. Not all firms pursue profit maximization. One example of this phenomenon is the cooperation among manufacturers across national boundaries to provide wheelchairs to those individuals who need them. Estimates indicate that 20 million people need wheelchairs worldwide but cannot afford them. See Ralf D. Hotchkiss, Groundswell on Wheels: Appropriate Technology Could Bring Cheap, Sturdy, Wheelchairs to twenty Million Disabled People, Sciences, July-Aug. 1993, at 14. In this situation, the emphasis has been on sharing knowledge in a global sense to achieve inexpensive design and manufacturing innovations. See id.

n81. See id. at 14; see also Maria Papadakis, Patents and the Evaluation of R&D, in Evaluating R&D Impacts: Methods and Practice 99, 103 (Barry Bozeman & Julia Melkers eds., 1988) (citing other sources that argue that the degree to which inventors capture the profits of their inventions are determined primarily by invention design properties and the strength of the patent system).

n82. See generally Ashford & Caldart, supra note 56 (noting that technological change is a general term that encompasses technological innovation, invention, diffusion, and technology transfer, and defining these terms); Derzko, supra note 79; Robert Teitelman, Profits of Science: The American Marriage of Business and Technology (1994) (discussing the relationship between science, technology, and capital and the cycle of innovation); Innovation: A Cross-Disciplinary Perspective (Kjell Gronhaug & Geir Kaufmann eds., 1988) (discussing the same relationship).

n83. See sources cited supra note 82. Technological innovation encourages economic growth, by permitting the achievement of greater outputs from given quantities of inputs. Through technological innovation, the economy becomes more productive beyond corresponding increases in capital, labor, and material inputs. Economic growth is caused by the accumulation of inputs and technological innovation. Inputs that may expand a nation's productive capacity include labor, primary and intermediate materials, and the stock of plants and equipment.

n84. See Kaufer, supra note 50, at 19-22 (providing an overview of patent system economics and citing other sources).

n85. See id. at 19.

n86. See id.

n87. See id. at 20.

n88. See id; see also Harter, supra note 70, at 200 (describing the tension between innovators choosing to patent and non-innovating competitors).

n89. See Kaufer, supra note 50, at 20.

n90. See id; see also Papadakis, supra note 81, at 104-105 (noting that the ability to invent around is an indicator of the imperfectness of the patent system).

n91. See id. (citing other sources).

n92. See In re Burke, Inc., No. 95-1145, 1996 WL 137527, at *1 (Fed. Cir. Mar. 27, 1996).

n93. See id.

n94. See Sidney G. Winter, Patents in Complex Contexts: Incentives and Effectiveness, in Owning Scientific and Technical Information: Value and Ethical Issues 41, 45-50 (Vivian Weil & John W. Snapper eds., 1989) (describing patent effectiveness as perceived by research and development executives) (citing Richard C. Levin et al., Appropriating the Returns from Industrial Research and Development, in 1987 Brookings Papers on Economic Activity 783 (1987)).

n95. See id.

n96. See Kaufer, supra note 50, at 21.

n97. See id. at 20-21.

n98. See id.

n99. See generally Teitelman, supra note 82.

n100. See Wheelchairs, Medical and Healthcare Marketplace Guide 282-84 (1996).

n101. See id.

n102. See generally James S. Hauger, Reading Machines for the Blind: A Study of Federally Supported Technology Development and Innovation (1995) (unpublished Ph.D. dissertation, Virginia Polytechnic Institute & State University) (on file with the Virginia Polytechnic Institute & State University Library).

n103. See id.

n104. See id.

n105. See Bruce Felton, Technologies That Enable the Disabled, N.Y. Times, Sept. 14, 1997, at C11.

n106. See Harry Levitt, Processing of Speech Signals for Physical and Sensory Disabilities, 92 Proc. Natl. Acad. Sci. 9999, 10000 (1995).

n107. See id. at 10002.

n108. See id. at 10003.

n109. Current fees established by the Patent and Trademark Office are posted on the Internet at <http://www.uspto.gov/web/offices/ac/qs/ope/fees.html>. The basic filing fee is $ 770. Small entities pay $ 385. The contents of patent applications are kept confidential until issuance. See 35 U.S.C. 122 (1994). The PTO will only release information on pending applications

to applicants, their attorneys or agents, or assignees of record. See 37 C.F.R. 1.14(a) (1998). This confidentiality policy extends to abandoned patent applications. See id. 1.14(b).

n110. See 35 U.S.C. 112 (1994).

n111. A patent is classified by its subject matter according to PTO and international classification systems.

n112. The field of search indicates the classification fields searched by the examiner in determining if the claimed subject matter is patentable.

n113. These are the references evaluated by the examiner in determining whether the claimed invention is distinct over earlier inventions.

n114. For an overview of the patent application and examination process, see Ronald B. Hildreth, Patent Law: A Practitioner's Guide (2d ed. 1993); Irving Kayton, Patent Practice (5th ed. 1993).

n115. See 35 U.S.C. 1-376 (1994); 37 C.F.R. 1.1-1.825 (1998); U.S. Patent & Trademark Office, U.S. Dep't of Commerce, Manual of Patent Examination Procedure (6th ed. 1994) [hereinafter Manual of Patent Examining Procedure].

n116. See 35 U.S.C. 101-103, 111-112 (listing patentability requirements).

n117. See id. 101 (defining patentable subject matter); see also id. 161- 164 (concerning plant patents); id. 171-173 (concerning design patents).

n118. See id. 101, 103.

n119. For a discussion of non-patentable subject matter, see Chisum & Jacobs, supra note 50, 2[C]1(f).

n120. See 35 U.S.C. 101-102 (describing novelty, utility, and non- obviousness requirements).

n121. To meet the section 101 utility requirement, 1) a claimed product or process must be useful; 2) a person must have discovered the invention's utility to achieve a reduction to practice; and 3) the inventor must disclose how to use the invention. See Chisum & Jacobs, supra note 50, 2[C]2.

n122. Courts have interpreted Section 101 as establishing a minimal utility standard. See id.

n123. See id. (citing United States Steel Corp. v. Phillips Petroleum Co., 865 F.2d 1247 (Fed. Cir. 1989); Ex parte McKay, 200 U.S.P.Q. (BNA) 324 (P.T.O. Bd. App. 1975) (noting that only potential usefulness is required)).

n124. See id. 2[C]2 (case citations omitted).

n125. See 35 U.S.C. 102 (1994).

n126. Section 102 defines novelty and describes various "statutory bars" to validity. Id. A patent grant is barred if the claimed invention is known, used or sold by someone other than the inventor before the claimed invention date, see id. 102(a), (b), patented or published by anyone, including the inventor, more than a year before the effective filing date for the application, see id. 102(b), (d), abandoned by the inventor, see id. 102(c), or made or disclosed in the patent application, see id. 102(e), (g). Section 102 also requires patent applicants to be the actual inventors of claimed inventions. See id. 102(f).

n127. See id. 102(b).

n128. See Chisum & Jacobs, supra note 50, 2[C]3 (discussing the 35 U.S.C. 101 utility requirement).

n129. See 35 U.S.C. 103 (1994). Section 103 comes into play only when a claimed invention "is not identically disclosed or described as set forth in section 102[.]" Id. 103(a). Thus, section 103 comes into play after an invention has met the section 102 threshold.

n130. See id. 103(a). The one "of ordinary skill in the art" standard varies between industries and technologies.

n131. Prior art searches of patent records are used to evaluate the "validity" of patent applications. The PTO maintains a comprehensive library of issued patents. Complete patent disclosures are available through a number of services, including the DIALOG Patent Database through LEXIS and WESTLAW.

n132. See Chisum & Jacobs, supra note 50, 2[C]4.

n133. 383 U.S. 1, 17-18 (1966).

n134. Id. at 17.

n135. See id. at 17-18.

n136. See 37 C.F.R. 1.14(c) (1998).

n137. See 35 U.S.C. 181 (1994).

n138. See id.

n139. See id.

n140. See id.

n141. This may be construed as an effort to correct market imperfections and inefficiencies. See Derzko, supra note 79, at 7-9.

n142. " Applications will not be advanced out of turn for examination or for further action except as provided...[by] order of the [PTO] Commissioner" if the application is "deemed of peculiar importance to some branch of the public service ...." See 37 C.F.R. 1.102(a) (1998).

n143. See id.

n144. See id.

n145. Petitions to Make Special are granted in nine situations:

a) a person or company exists that will manufacture the invention provided the application is allowed or a patent issues; b) an infringer is using the invention covered by the patent; c) the applicant is in poor health or is near death; d) the applicant is age 65 or greater; e) the invention is designed to enhance environmental quality; f) the invention provides energy savings; g) recombinant DNA is involved; h) the applicant submitted an Information Disclosure Statement and a previous search was made; and i) the invention advances superconductivity technology. See Manual of Patent Examining Procedure, supra note 115, 708.02.

n146. See id.

n147. See id.

n148. See id.

n149. See id.

n150. See id.

n151. See id.

n152. See Derzko, supra note 79, at 8-11 (arguing that environmental patenting is limited because the patent process may be failing to offer innovation incentives); Gollin, supra note 41, at 210-11 & n.101 (pointing to low numbers of Petitions received and granted in arguing that the Petition has failed to foster rapid issuance of environmental technology patents).

n153. See Gollin, supra note 41, at 212, 217-226 (arguing that the Petition has failed to accelerate the application process for environmental patents). Gollin suggests that the trend may not indicate the patent system's failure; rather, it may reflect the willingness of some applicants to accept delays for non- commercialized inventions.

n154. See id.

n155. See id. at 212 n.102 (analyzing the proposed modification).

n156. See Derzko, supra note 79, at 14 (advocating the formation of the "environmental patent").

n157. See e.g., Marc Verzani, The Orphan Patent Act, 77 J. Pat. & Trademark Off. Soc'y 5 (1995).

n158. See id. at 5-8.

n159. See id. Verzani argues that AT patent applications should be disclosed to the public before issuance, contrary to current patent office policy. See id. at 11-12. He also advocates a mandatory one year examination cap. See id. Like the environmental technologies proposals, the Orphan Patent Act proposal inadequately addresses the nature or extent of the patent system's apparent failure to process AT patent applications.

n160. The American Intellectual Property Law Association (AIPLA) Annual Report of Economic Survey provides data on the costs associated with patent prosecution. The median cost to file a utility application of minimal complexity was $ 3,725 ($ 4,997 at the 75th percentile; $ 2,998 at the 25th percentile), based on 1094 firms reporting. The median cost for filing a more complicated utility patent application was $ 7,500 ($ 9,981 at the 75th percentile; $ 5,506 at the 25th percentile). Median costs for filing disclosures and amended applications were $ 241 and $ 1,100-$ 2,000, respectively. Appeals to the Board of Patent Examiners had a median cost of $ 3,000. The costs of patent litigation, which can be high, are not even considered in these figures. See generally American Intellectual Property Law Association, Report of Economic Survey 1996 (1996) [hereinafter Report of Economic Survey 1996]. The AIPLA mailed survey questionnaires to its membership. Data is based on 1545 out of 8700 members responding.

n161. See supra notes 117-20.

n162. See generally Chisum & Jacobs, supra note 50; see also Michael A. Epstein, Modern Intellectual Property 5.04(C)(1) (3d ed. 1995) (case citations omitted).

n163. See Epstein, supra note 162, 5.04(C)(1).

n164. See id.

n165. See id.

n166. Dominant firms try to maintain their markets by controlling innovation. Innovating competitors may be sued for patent infringement by dominant firms. The goal primarily may be to force competitors out of business through the expense of protracted litigation, and secondarily, to capture intellectual property through licensing agreements and company buy- outs. See generally Teitelman, supra note 82.

n167. United States Patent No. 2,592,449 'Removable Footrest for Wheelchairs' (the '449 patent) (Apr. 8, 1952).

n168. Infringement can be either direct or indirect. See supra note 66. To find direct infringement under the current patent law, the party alleging infringement must demonstrate that a competitor has made, used or sold an infringing product during the patent term. See 35 U.S.C. 154, 271 (1994). Indirect infringement is the unauthorized sale of a specially designed component for use in a patented combination or process.

n169. A patent claim may be invalid for lack of novelty, the occurrence of a statutory bar, obviousness, or inadequate disclosure. See supra notes 116-35 and accompanying text. A patent is presumed valid, and challengers carry the burdens of persuasion and production. To make a prima facie case of unpatentability, challengers must present clear and convincing evidence of invalidity. See 35 U.S.C. 282 (1994).

n170. See Everest & Jennings, Inc. v. Colson Corp., 371 F.2d 240, 242 (7th Cir. 1967); see also supra notes 125-28 and accompanying text (discussing statutory bars). Another way of expressing that the patent was invalid for the stated reasons would be to say that it was "anticipated" by the prior art.

n171. See supra note 134 and accompanying text; see also Everest & Jennings, 371 F.2d at 243.

n172. See Everest & Jennings, 371 F.2d at 243. The district court added that the invention represented "no more than the mere choice and selection of size and shape among old devices, with the result of but small increased or changed efficiency and convenience." Id.

n173. See id.

n174. See Hotchkiss, supra note 80, at 14.

n175. See Erwin Frand, The Perils of Preeminence, Res. & Dev. Mag., June 1993, at 57, 57 (discussing complacency as a source of downfall for firms with dominant market shares); Teitelman, supra note 58, at 197 (suggesting that once E & J had its design down, "time essentially stood still," despite changing marketplace and public attitudes toward individuals with disabilities).

n176. See United States v. Everest & Jennings, Int'l, No. Civ. 77-1648-R, 1979 WL 1596 (C.D. Cal. Feb. 9, 1979). The final judgment of the court enjoined and restrained E & J from blocking wheelchair exports from competing firms to the United States and from refusing to sell to any person within the United States.

n177. See supra note 175 (discussing business complacency). The United States successfully brought suit against Everest & Jennings for a variety of antitrust violations.

n178. See Paris, supra note 57, at 88.

n179. See id.

n180. See id.; see also Butler, supra note 77, at 69; Christopher Palmeri, Wheel-to-Wheel Combat. (Invacare Corp.), Forbes, Feb. 15, 1993, at 62, 62 (noting that in 1992, Invacare earned $ 17 million on sales of $ 308 million).

n181. See Paris, supra note 57, at 88. Today the wheelchair market is "comprised of standard, lightweight, ultralight, powered and scooter segments." Wheelchairs, Medical and Healthcare Marketplace Guide, supra note 100, at 283.

n182. See Paris, supra note 57, at 88.

n183. See id.

n184. See id.

n185. See id.

n186. See In re Burke, Inc., 786 F. Supp. 1537, 1538 (C.D. Cal. 1992).

n187. United States Patent No. 4,570,739 'Personal Mobility Vehicle' (the '739 patent) (Feb. 18, 1986).

n188. See Burke, 786 F. Supp. at 1539.

n189. See id.

n190. See Denise Smith Amos, 121 Lose Jobs in Cutbacks at E & J: Wheelchair Maker Enticed Here by State Aid in '92, St. Louis Post-Dispatch, June 21, 1996, at 1C.

n191. See id.

n192. The deal was estimated to be worth $ 20.2 million. See Graham Field Amends Purchase Agreement, N.Y. Times, Aug. 15, 1996, at C4.

n193. See supra notes 177-84 and accompanying text.

n194. See The Worldwide Market for Wheelchairs Is Forecast to Reach $ 1.1 Billion in 1996, in Wheelchairs, Medical and Healthcare Marketplace Guide, supra note 100, at 282-85.

n195. See Mitchell P. LaPlante et al., U.S. Dep't of Health & Human Services, Assistive Technology Devices and Home Accessibility Features: Prevalence, Payment, Needs, and Trends 1 (1992).

n196. See id. at 3

n197. See id. at 5.

n198. See id.

n199. Paul Israel & Robert Rosenberg, Research Note, Patent Office Records as a Historical Source: The Case of Thomas Edison, 32 Tech. & Culture 1094, 1101 (1991) (citing Nathan Reingold, Research Note, U.S. Patent Office Records as Sources for the History of Invention and Technological Property, 1 Tech. & Culture 156, 166 (1960)).

n200. See Carolyn C. Cooper, Making Inventions Patent, 32 Tech. & Culture 837, 838 (1991) (noting that scholars "view patent records as sources of information about inventions and inventors, both as collectivities and as individuals").

n201. See id; see also Israel & Rosenberg, supra note 199, at 1094-1095 (describing scholarly use of patents).

n202. See Israel & Rosenberg, supra note 199, at 1095.

n203. See 35 U.S.C. 101-103 (1994); see also supra notes 126-135 and accompanying text (describing validity requirements).

n204. See Cooper, supra note 200, at 838; Reingold, supra note 199, at 166.

n205. See infra note 311 and accompanying text.

n206. See infra note 313 and accompanying text.

n207. For an overview of empirical studies involving patent data, see Part IV of this article.

n208. Bibliometrics, or the study of publication-based data, is used to track progress in scientific and technological disciplines through citation analysis. See Julia Melkers, Bibliometrics as a Tool for Analysis of R&D Impacts, in Evaluating R&D Impacts: Methods and Practice, supra note 81, at 43 (describing the scope and history of bibliometric analysis); F. Narin, Patent Bibliometrics, 30 Scientometrics 147, 147-149 (1994) (discussing the development of bibliometric techniques for analyzing scientific and patent literature); see also M.B. Albert et al., Direct Validation of Citation Counts as Indicators of Industrially Important Patents, 20 Res. Pol'y 251 (1991) (describing same in the context of an empirical study). Science Citation Index, which tracks how frequently the published work of individual scientists is cited by others, is compiled according to citation bibliometric methods. Patent citation data is used for similar purposes. For example, the data compiled in the U.S. National Science Board's Science & Technology Indicators Annual Reports are based on patent citation measurements.

n209. See Albert et al., supra note 208, at 251-252.

n210. See id.

n211. See id.

n212. See id. at 258.

n213. See id.

n214. See Edlyn S. Simmons & Nancy Lambert, Comparing Grapes and Watermelons, Chemtech, June 1993, at 51, 51-52. (describing shortcomings of statistical analytical methods as applied to patent data).

n215. See Kaufer, supra note 50, at 21.

n216. See infra notes 219-22 and accompanying text.

n217. See Levin et al., supra note 94, at 793-98 (describing empirical results).

n218. See Papadakis, supra note 81, at 106.

n219. See generally Zvi Griliches, Patent Statistics as Economic Indicators: A Survey, 28 J. Econ. Literature 1661 (1990) (describing problems associated with predicting the economic value of specific patents and with using patent data as the basis for economic indicators); see also Albert et al., supra note 208, at 258 (describing results of an empirical study).

n220. See Simmons & Lambert, supra note 214, at 51 (describing variations between patent claim scope).

n221. See id.

n222. See id.

n223. See id.

n224. Weighting methods are used to determine which patents are the most technologically or scientifically significant, as opposed to determining which patents have been cited the most.

n225. See supra notes 207-13 and accompanying text (describing theory behind bibliometric analysis).

n226. See Albert et al., supra note 208, at 251 (testing the validity of patents as economic indicators experimentally).

n227. See id. The experiment developed in the course of a consulting agreement between CHI Industries, Inc. and Eastman Kodak Corporation.

n228. See id. The 20 respondents who were chosen for the study were asked to rate the relative significance of photographic technology patents.

n229. The outcome may reflect imperfect experimental design. Many of the respondents dropped out during the course of the study. See id. at 256.

n230. See id. at 258.

n231. See id.

n232. See id.

n233. See id.

n234. See Griliches, supra note 219, at 1666-1670 (describing complications associated with patent classification).

n235. Current patent classifications are posted by the Patent and Trademark Office on the Internet at <http://patents.uspto.gov/CLASSES/classes.html>.

n236. See Griliches, supra note 219, at 1666 (citing Jacob Schmookler, Invention and Economic Growth (1966).

n237. See id.

n238. See id. at 1667.

n239. See supra note 187 (citing Burke '739 patent).

n240. See Griliches, supra note 219, at 1667.

n241. See id.

n242. See id.

n243. See id.

n244. See id.

n245. See id.

n246. See id. (citing F.M. Scherer, The Office of Technology Assessment and Forecast Industry Concordance as a Means of Identifying Industry Technology Origins, 4 World Pat. Info. 12, 12-17 (1982).

n247. See id. at 1667-69.

n248. There is a difference between inventions and innovations. See generally Ashford & Caldart, supra note 56 (defining terms); Bjorn L. Basberg, Patents in the Measurement of Technological Change, in Innovation: A Cross-Disciplinary Perspective, supra note 82, at 457, 460-61 (same). According to Ashford:

technological innovation is the first commercially successful application of a new technical idea. By definition, it occurs in those institutions, primarily private profit-seeking firms, that compete in the marketplace. Innovation should be distinguished from invention, which is the development of a new technical idea, and from diffusion, which is the subsequent widespread adoption of an innovation by those who did not develop it.

Nicholas A. Ashford et al., Using Regulation to Change the Market for Innovation, 9 Harv. Envtl. L. Rev. 419, 419 n.1 (1985); see also sources cited supra note 82.

n249. See sources cited supra note 248.

n250. See Basberg, supra note 248, at 457, 457-58 (discussing the use of patent statistics as technology indicators); Papadakis, supra note 81, at 99 (providing a summary of the methods and appropriateness of patent analysis); see also Zvi Griliches et al., The Value of Patents as Indicators of Inventive Activity (National Bureau of Econ. Research Working Paper No. 2083., 1986) (concluding that patent data represents a valuable resource for the analysis of technological change, and indicating that patents are a fairly good indicator of differences in inventive activity across firms); Zoltan J. Acs & David R. Audretsch, Patents as a Measure of Innovative Activity, 42 Kyklos 171 (1989) (arguing that reasonable inferences can be drawn from the reliability of patent data as a proxy for innovative activity); Francis Narin & Dominic Olivastro, Technology Indicators Based on Patents and Patent Data, in Handbook of Quantitative Studies in Science and Technology 465, 465-507 (A.F.J. van Raan ed., 1988) (noting that patents are a rich resource for indicators analysis); Keith Pavitt, R&D, Patenting, and Innovative Activities, 11 Res. Pol'y. 33 (1982) (noting that statistics on patenting activities give important clues about the rate and direction of innovative activity); K. Pavitt, Patents as Indicators of Innovative Activities: Possibilities and Problems, 7 Scientometrics 77 (1985) (noting statistics on patenting activity); see also Griliches et al., supra (examining propensity to patent across firms and industries).

n251. See supra note 250.

n252. See Papadakis, supra note 81, at 99-101.

n253. See infra notes 273-77 and accompanying text.

n254. See Papadakis, supra note 81, at 100-01.

n255. See generally Bjorn L. Basberg, Patents and the Measurement of Technological Change: A Survey of the Literature, 16 Res. Pol'y 131 (1987); Keith Pavitt, Uses and Abuses of Patent Statistics, in Handbook of Quantitative Studies of Science and Technology, supra note 250, at 509, 509-35.

n256. See Griliches et al., supra note 250, at 23 (finding that while the propensity to patent differs significantly across industries, the relationship between research and development and patents is close to proportional, especially for firms above a minimal size); see also Griliches, supra note 219, at 1673.

n257. See Griliches, supra note 219, at 1673.

n258. See id. at 1674.

n259. See id.

n260. See Francis Narin & Elliot Noma, Patents as Indicators of Corporate Economic Strength, 16 Res. Pol'y 143, 154 (1987) (reporting results of a study of 17 pharmaceutical companies that showed a correlation between overall corporate technological strength and patent data).

n261. See generally Griliches et al., supra note 250.

n262. See id.

n263. See Francis Narin & Dominic Olivastro, Status Report: Linkage Between Technology and Science, 21 Res. Pol'y 237 (1992) (describing linkage between science and technology for seven product fields and major research and development countries).

n264. See supra note 77 and accompanying text.

n265. See Narin & Olivastro, supra note 263, at 248-49.

n266. See id.

n267. See Will Lepkowski, Public Science Drives Innovation, Chemical & Engineering News, Sept. 1, 1997, at 24, 24 (citing research studies).

n268. The number of references increased from 17,000 in 1987 to over 50,000 in 1994. See id.

n269. See id.

n270. See Griliches, supra note 219, at 1682 (describing the use of stock market values as an output indicator of research process).

n271. See id. at 1683.

n272. See id.

n273. See id. at 1688 (discussing difficulty in tracing spillovers); Adam B. Jaffe et al., Geographic Localization of Knowledge Spillovers as Evidenced by Patent Citations, 108 Q.J. Econ. 577 (1993) (comparing the geographic location of patent citations with cited patents).

n274. See Roger Renstrom, FRP Propels Wheel Past Its Predecessors, Plastics News, Jul. 1, 1996, at 23.

n275. See id.

n276. See Jaffe et al., supra note 273, at 595.

n277. See id.

n278. See Griliches, supra note 219, at 1690 (discussing patent trends and bureaucratic effects).

n279. See Simmons & Lambert, supra note 214, at 51-53.

n280. See Griliches, supra note 219, at 1690-92.

n281. See id. at 1691.

n282. See id.

n283. See id. at 1690.

n284. See id.

n285. The search strategy is a variant of co-word analysis, involving the assignment of words or keywords to papers or articles. Papers which have the same keywords or sets of words can be linked and mapped. The data can be used to understand how documents and researchers are related. See Melkers, supra note 208, at 47-48; see also Ronald N. Kostoff, Co-Word Analysis, in Evaluating R&D Impacts: Methods and Practice, supra note 81, at 63.

n286. See Griliches, supra note 219, at 1690-92.

n287. See supra notes 208-13.

n288. See U.S. Patent & Trademark Office, U.S. Dep't of Commerce, 1996 Annual PTO Review (last modified June 26, 1997) <http://www.uspto.gov/web/offices/ com/annual/1996> (providing patent statistics); U.S. Patent & Trademark Office, U.S. Dep't of Commerce, Technology Assessment and Forecast Program (last modified Feb. 4, 1998) <http://www.uspto.gov/web/offices/ac/ido/oeip/taf/tafp.html> (providing same)); National Science Board, Science & Engineering Indicators: 1996, at 6(1)-8(32) [hereinafter Science & Engineering Indicators] (describing economic and social significance of Scientific and Engineering Research).

n289. See Griliches, supra note 219, at 1690.

n290. See Science & Technology Indicators, supra note 288, at 6(19).

n291. See id.

n292. See id.

n293. See id.

n294. See id.

n295. See id.

n296. See id.

n297. See id.

n298. See id.

n299. See id.

n300. See id.

n301. See id.

n302. See id.

n303. The remainder share of U.S. origin patents that fluctuates from 23% to 27%. See id.

n304. See id. at 6(21)-6(24).

n305. See id.

n306. See id. In 1993, the 15 classes most emphasized by U.S. inventors included: wells; mineral oils processes and products; surgery (patent classes 603 and 604); chemistry (hydrocarbons); special receptacle or packaging; surgery (light, thermal, and electrical applications); chemistry (analytical and immunological testing); fluid handling; liquid purification and separation; error detection/ correlation and fault detection; illumination; chemistry (natural resins or derivatives); receptacles; and amusement devices and games.

n307. See id. Major U.S. industry sectors include computers; electrical components and communications systems; industrial machinery, aircraft and parts; motor vehicles and equipment; and radio and television technology. Patent activity has increased in each area since 1990. The most active field has been electrical components and communications equipment design.

n308. WESTLAW or LEXIS term word searches were employed to identify relevant patents.

n309. U.S. Patent & Trademark Office, U.S. Dep't of Commerce, Patent Classifications (visited May 2, 1998) <http://patents.uspto.gov/CLASSES/classes.html>.

n310. Utility Patents are available on LEXIS (LEXPAT; UTIL) or WESTLAW (PATENTS-US), from 1970 to the present.

n311. United States Patent No. 4,570,739 'Personal Mobility Vehicle' (the '739 patent) (Feb. 18, 1986) ("There is a degree of social stigma attached to wheelchairs such that wheelchair occupants are sometimes shunned as "handicapped.").

n312. United States Patent No. 4,750,578 'Dismantlable and Collapsible Utility Cart' (June 14, 1988) ("Various types of portable and powered carts have heretofore been provided for the short distance transportation of a person or articles such as luggage.").

n313. United States Patent No. 4,798,255 'Four-Wheeled T-Handlebar Invalid Carriage' (Jan. 17, 1989) ("The... carriage is deliberately designed for the senile and the invalid.").

n314. United States Patent No. 5,020,624 'Power Drive Scooter' (June 4, 1991) ("Power drive scooters of the type described above provide an excellent means of transportation, especially for some physically disabled people ....").

n315. United States Patent No. 5,074,372 'Knock Down Motorized Three- Wheeled Vehicle' (Dec. 24, 1991) ("In recent years, with the aging of the population in this country...there has been an increased demand for vehicles which can be conveniently used by the elderly....").

n316. United States Patent No. 5,518,081 'All-Terrain, All-Weather Wheelchair' (May 21, 1996) ("It would be desirable for a motorized wheelchair to be suitable for use in 'off road' or rural environments").

n317. This is probably because the words did not have specific enough meanings for the purposes of patenting.

n318. An effort was made to use phrases and term words that were part of common language usage.

n319. Tables and charts incorporate data through December, 1997.

n320. See supra note 76 and accompanying text (asserting that many factors influence the decision to patent and the patenting process).

n321. See sources cited supra note 288 (noting patent statistics reports available or downloadable from the PTO website).

n322. See supra notes 102-05 and accompanying text.

n323. See supra notes 106-08 and accompanying text.

n324. United States Patent No. 5,680,676 'Kitchen Utensil Handle' (Oct. 28, 1997).

n325. United States Patent No. 5,481,622 'Eye Tracking Apparatus and Method Employing Grayscale Threshold Values' (Jan. 2, 1996).

n326. United States Patent No. 5,710,816 'Method and Apparatus for Ensuring Receipt of Voicemail Messages' (Jan. 20, 1998).

n327. United States Patent No. 5,706,351 'Programmable Hearing Aid with Fuzzy Logic Control of Transmission Characteristics' (Jan. 6, 1998).

n328. United States Patent No. 5,685,721. 'Refreshable Braille-Cell Display Implemented with Shape Memory Alloys' (Nov. 11, 1997).

n329. United States Patent No. 5,565,888 'Method and Apparatus for Improving Visability and Selectability of Icons' (Oct. 15, 1996).

n330. See U.S. Patent & Trademark Office, U.S. Dep't of Commerce, Patent Counts by Class by Year, January 1977-December 1996, at 8 (1997).

n331. See Griliches, supra note 219, at 1690.

n332. See LaPlante et al., supra note 195, at 5.

n333. See id.

n334. Reliance on personal assistance only declined. Dependence on equipment - by itself or in combination with personal assistance - increased. See Kenneth G. Manton et al., Changes in the Use of Personal Assistance and Special Equipment from 1982 to 1989: Results from the 1982 and 1989 NLCTS, 33 Gerontologist 168, 175 (1993).

n335. See Charles F. Longino, Jr., Myths of an Aging America, Am. Demographics, Aug. 1994, at 36, 41-42. As Longino notes, "unless there is some kind of interdependence that preserves self-respect and self- determination, dependency on family members or others will be a far less attractive alternative than technically supported self-care for those who can afford it." Id. at 41.

n336. See LaPlante et al., supra note 195, at 3-5, 7-8.

n337. For example, for persons between the ages of 25 and 65, the proportion of persons using mobility or hearing technologies is 23 and 15 percent, respectively. For persons aged 75 and above, the proportions are 67 and 40 percent, respectively. See id. at 3-4, 8.

n338. A significant proportion of users are under age 25 in the following categories: foot braces (38%); artificial arms or hands (35%); adapted typewriters or computers (25%); leg braces (24%). See id. at 3-7.

n339. See U.S. Patent & Trademark Office, U.S. Dep't of Commerce, 1996 Annual PTO Review tbl.5 (last modified June 26, 1997) <http://www.uspto.gov/ web/offices/com/annual/1996/pg102.gif>.

n340. See generally Verzani, supra note 157.

n341. A performance standard requires the attainment of an objective without specifying the method. A specification standard specifies a method, equipment, etc.: i.e., adoption of the specification is the objective. A performance standard mandated by the ADA would be the duty to reasonably accommodate. A specification standard would be door dimensions for new buildings specified by the Architectural Compliance Board.

n342. The patent system itself is an example of a government policy that encourages innovation and creativity. See supra notes 70-72 and accompanying text.

n343. Examples of this type of government interventions are environmental and occupational regulations designed to remove pollution and protect workers from hazardous materials.

n344. These methods of environmental regulation are less coercive than standard means of securing compliance such as fines or penal sanctions because they encourage innovation.

n345. Based on LEXIS or WESTLAW term word searches of the specific names of the legislative enactments listed.

n346. See generally Ashford, supra note 248 (discussing the role that technology forcing may play in the innovation/invention cycle for pollution control technology as function of shifts in environmental regulations).

n347. See id.

n348. See Gollin, supra note 41, at 232 n.182 (describing patenting trends after passage of CERCLA and RCRA).

n349. 42 U.S.C. 9601-9675 (1994). CERCLA imposes strict liability for the costs of responding to releases or to threatened releases of hazardous substances. See id. 9607; see also United States v. Alcan Aluminum Corp., 990 F.2d 711 (2d Cir. 1993).

n350. 42 U.S.C. 6901-6992k. RCRA regulates the transportation, treatment, and disposal of hazardous (solid) waste.

n351. See Gollin, supra note 41, at 233.

n352. See Arnold & Porter Legislative History, 101st Cong., 2d Sess., Prepared for the Committee on Education and Labor U.S. House of Representatives on Pub. L. No. 101-336 (The Americans with Disabilities Act of 1990) 176, 403, 697, 713, 750 (Comm. Print 1990).

n353. Section 44 of the Internal Revenue Code allows a tax credit for small businesses. See I.R.C. 44 (1994 & Supp. III 1997). Section 190 of the Internal Revenue Code allows a tax deduction for all businesses. See I.R.C. 190 (1994 & Supp. III 1997); see also Internal Revenue Service, IRS Tax Credits and Deductions (visited Nov. 7, 1997) <http://www.usdoj.gov/crt/ada/taxcred.html>.

n354. Research funds are available from the National Institute on Disability and Rehabilitation Research, among other agencies. For information about federally funded programs related to assistive technology, see Federally Funded Programs Related to AT (last modified Feb. 18, 1998) <http://www.asel.udel.edu/at-online/programs/>. An example of a university assistive technology research initiative is the Archimedes Project at Stanford University. See Archimedes Project (visited Oct. 20, 1997) <http://csli-www.stanford.edu/arch/intro97.html>.

n355. Based on LEXIS and WESTLAW term word searches of the specific names of legislative enactments.

n356. The Statistical Package for the Social Sciences (SPSS) was used to tabulate results.

n357. This number includes divisional and continuation applications. Data was analyzed by both application and issuance dates.

n358. See U.S. Patent & Trademark Office, U.S. Dep't of Commerce, All Technologies Report, January 1963-June 1997, at A1 (1997).

n359. See id.

n360. See id.

n361. See id.

n362. See generally Joseph P. Shapiro, No Pity: People with Disabilities Forging a New Civil Rights Law (1994) (noting that mouthsticks were developed by Arthur Heyer, a quadriplegic engineer).

n363. See id. (noting that most hand controls for cars are made and designed by paraplegics).

n364. See U.S. Patent & Trademark Office, U.S. Dep't of Commerce, 1996 Annual PTO Review tbl.10 (last modified June 26, 1997) <http://www.uspto.gov/web/offices/com/annual/1996/pg105.gif>.

n365. See U.S. Patent & Trademark Office, U.S. Dep't of Commerce, 1996 Annual PTO Review tbl.10 (last modified June 26, 1997) <http://www.uspto.gov/web/offices/com/annual/1996/pg105.gif>. Scholars have studied the geography of innovation and knowledge spillovers between industries using the Small Business Administration Innovation Database. See David B. Audretsch & Maryann P. Feldman, R&D Spillovers and the Geography of Innovation and Production, 86 Amer. Econ. Rev. 630 (1993) (examining the geographic relationship between centers of production and innovative activity).

n366. See Griliches, supra note 219, at 1666-1670. In total there are over 400 separate PTO invention classes, and thousands of related subclasses. See id.

n367. This finding seems to support recent design trends favoring universal and transgenerational design. While inventions designed to improve communication (augmentative devices), like the Dragon Dictate system, are probably technically more sophisticated and innovative, they are directed toward a rather small consumer base. New universal and transgenerational designs are designed for much larger groups of potential users and consumers.

n368. The classification schemes were developed by the authors.

n369. See Narin, supra 208, at 147-49 (discussing science and technology linkages).

n370. See Chart 11, infra.

n371. See, e.g., United States Patent No. 5,596,648 'Infrared Audio Transmitter System' (Jan. 21, 1997) (noting the ADA requires public places to provide assistive listening systems); United States Patent No. 5,592,744 'Eating Utensil' (Jan. 14, 1997) (suggesting that restaurants should keep a stock of adaptive eating utensils to meet the needs of handicapped persons under the ADA); United States Patent No. 5,589,021 'Method of Producing a Sign' (Dec. 31, 1996) (noting the comprehensive and sweeping signage requirements imposed by the ADA).

n372. United States Patent No. 5,605,311 'Upper Torso Support for a Workstation' (Feb. 25, 1997).

n373. Under Title I, determinations of disability and the "reasonableness" of accommodations are considered on a case by case basis. A person must first be found to be disabled under the statute. The person must next be found to be a qualified individual with a disability who can perform essential job functions. The individual must inform the employer of the disability and request an accommodation. The employer is not required to provide accommodations that pose undue hardships. See supra notes 17-19 and accompanying text (discussing statutory requirements of Title I).

n374. See Chisum & Jacobs, supra note 50, 2[C] (discussing validity requirements for patentable subject matter).

n375. See United States Patent No. 5,580,251 'Electronic Refreshable Tactile Display for Braille Text and Graphics' (Dec. 3, 1996) (also noting that "to some degree the law compels businesses, schools, libraries...to recognize this invention as de facto a reasonable accommodation.").

n376. See United States Patent No. 5,587,218 'Surface Covering' (Dec. 24, 1996) (buildings must meet safety requirements); United States Patent No. 5,577,834 'Light Emitting Device' (Nov. 26, 1996) (improving safety conditions in home and workplace).

n377. See United States Patent No. 5,587,218 'Surface Covering' (Dec. 24, 1996) (noting importance of minimizing costs of accommodation).

n378. United States Patent No. 5,554,685 'Method of Making a Sign Having Raised Characters' (Sept. 10, 1996) (noting that "quite simply, the ADA has created a niche in the signage industry which did not previously exist.").

n379. United States Patent No. 5,422,638 'Stand for a Remotely Operated Road Sign' (June 6, 1995).

n380. See id.

n381. See Jong-Tsong Chiang, From Industry Targeting to Technology Targeting: A Policy Paradigm Shift in the 1980s, 15 Tech. in Soc. 341 (1993) (noting federal laws promoting technology development).

n382. See id.

n383. See id. at 345 (noting that "technology policy is intended to benefit a large number of firms and many industries without explicitly designating winners and losers, and without affecting the relative commercial competitiveness of commercial firms.").

n384. See Cooper, supra note 50, at 961.

n385. See id.

n386. See id.

n387. See id.

n388. See generally Report of Economic Survey 1996, supra note 160.

n389. See supra notes 126-135 and accompanying text (providing an overview of patent validity requirements).

n390. See supra notes 347-48 and accompanying text (describing the concept of technology forcing).

n391. Many authors have written about technology forcing in the context of environmental regulation. See, e.g., Derzko, supra note 79, at 3-4 (arguing that in the environmental context, "one of the ways to achieve sustainable development is through the continuous and diffusion of improved environmental technologies"). As Derzko noted:

generally, innovation occurs because firms respond to consumer demands in the marketplace. However the situation is different with environmental technology. The market for environmental technology innovation has been created artificially through government regulation. That is, without environmental regulation, firms would not protect the environment and so would not have an incentive to create or purchase new environmental technology.

Id. at 6 n.16.; see also Ashford et al., supra note 248, at 419 n.1; Ashford & Caldart, supra note 56 (noting that technology forcing refers to the use of regulation to spur technological change); Nicholas A. Ashford, An Innovation- Based Strategy for the Environment, in Worst Things First? The Debate Over Risk-Based National Environmental Priorities 275, 275-314 (Adam M. Finkel & Dominic Golding eds., 1994) (noting that the internal structure of regulations may alter the general climate [for] innovation). Elements of that structure include the form of the regulation (product versus process regulation), the mode (performance versus specification standards), the time for compliance, the uncertainty, the stringency of the requirements, and the existence of other economic incentives that complement the regulatory signal. See id.

n392. See Robert Hamrin, Environmental Regulations and Technological Innovation, in Managing Innovation 148, 152-153 (Sven B. Lundstedt & E. William Colglazier eds., 1982).

n393. See id.

n394. See generally supra notes 35-38 (identifying expanding market for assistive technology goods and services).

n395. See Margaret A. Wylde, If You Could See it Through My Eyes: Perspectives on Technology for Older People, Generations, Spring 1995, at 5 (discussing technology needs of aging population); Margaret A. Wylde, How to Size Up The Current and Future Markets: Technologies and the Older Adult, Generations, Spring 1995, at 15 (discussing technology needs of the population living with chronic conditions).

n396. See Stephen J. Mraz, Designing Around Disabilities, 64 Machine Design 60, 62 (1992) (noting that since ADA Title I implementation, engineers and companies must design technologies that will make workplaces more accessible); Anne Henry, A Universal Approach to an Ever-Changing Universe, 50 Appliance 34, 35 (1993) (indicating that the rapidly swelling ranks of consumers with special needs is causing profound changes in the way companies approach their markets); Ann Blackman, Machines that Work Miracles, Time, Feb. 18, 1991, at 70 (same); Blayne Cutler, Hot Gadgets for Disabled Workers, Am. Demographics, Jan. 1993, at 23 (noting that both the working disabled and their employers will be consumers of new assistive technology devices); Neville C. Tompkins, Tools that Help Performance on the Job, HR Mag., Apr. 1993, at 33 (noting that the entrepreneurial business community has noted a significant market in the disabled community); Judith Waldrop, From Handicap to Advantage, Am. Demographics, Apr. 1990 (noting that in the 1990s, "technological advances, demographic trends, and changing attitudes will pull more disabled Americans into the workforce."); see also Jay Mathews, Opening Doors by Enabling the Disabled: Entrepreneurs Find a Niche in Providing Services to Meet the Demands of the Disabilities Act, Wash. Post, Mar. 3, 1997, at F5 (noting that persons with disabilities are also taking an entrepreneurial business approach).

n397. See Button & Wobschall, supra note 16, at 197-99 (describing the implications of the ADA for assistive technology policy).

n398. See Bowe, supra note 35, at 38 (citing J.J. Lazarro, Adaptive Technologies for Learning and Work Environments (1993)).

n399. See id.

n400. See id. (noting that EEOC guidelines do not identify specific devices or spell out exacting details for reasonable accommodations, but merely provide "illustrative examples").

n401. See id. Title II covers state and local municipalities. See supra note 11. Title III covers places of public accommodation. See supra note 11.

n402. See id.

n403. See Mraz, supra note 396, at 62-64 (discussing role of small businesses and individual inventors in developing assistive technology).

n404. See id.

n405. See Felton, supra note 105, at C11 (describing Henter Joyce, a company specializing in computer screen reading devices for the blind).

n406. See id. (describing the success of LC Technologies, a small company that makes eye-activated computers).

n407. See id.

n408. See id.

n409. See supra notes 296-98 and accompanying text.

n410. See supra notes 394-96 and accompanying text.

n411. Assistive technology inventors are eligible for financial support from a number of federal agencies. See supra notes 353-54 and accompanying text.

n412. For criticisms of the ADA based on anecdotal examples or incomplete information, see generally Walter K. Olsen, The Excuse Factory (1997).

n413. See generally Peter David **Blanck,** The Economics of the Employment Provisions of the Americans with Disabilities Act: Part I - Workplace Accommodations, 46 DePaul L. Rev. 877 (1997).

n414. The ADA covers persons who: a) have a physical or mental impairment that substantially limits major life activities; b) have a record of a physical or mental condition; or c) are regarded as having such an impairment. See 42 U.S.C. 12102(2) (1994). A qualified individual with a disability can meet job prerequisites, and can perform essential job functions. See 29 C.F.R. 1630.2(m) (1997).

n415. See 42 U.S.C. 12111(8) (defining qualified individual with a disability). See also **Blanck,** supra note 413, at 887-889 (noting that Title I does not require an employer to hire or retain individuals with covered disabilities over equally or more qualified individuals without disabilities). For a general overview of ADA Title I terms and provisions, see Parry, supra note 12, at 57-74.

n416. See 42 U.S.C. 12111(8)-(9) (covering the concept of essential job functions and defining reasonable accommodation). A reasonable accommodation may include making existing facilities accessible to workers with disabilities, acquiring adaptive technology, job restructuring, part-time or modified work scheduling, reassignment to a vacant position, or the provision of support services, including interpreters and job coaches. See id. 12111(9)(A)-(B).

n417. Cost-benefit analysis has become the dominant method to evaluate a range of government programs and policies. According to theory, cost benefit analysis:

. Enumerates all positive and negative consequences that might arise from the implementation of a government policy;

. Estimates the probability of each consequence occurring;

. Estimates in monetary terms the net social costs or benefits of each consequence occurring individually and in sum.

Using the method as a decision-making tool presents a number of advantages. Accordingly, cost-benefit analysis:

. Clarifies decisionmaking by identifying choices in a rational and systematic manner;

. Fosters an open and fair decisionmaking process by explicitly estimating monetary costs and benefits and identifying the assumptions upon which estimates are based; and

. Allows the total impact of a policy to be expressed in common terms.

The shortcomings of cost-benefit analysis as applied to social policy issues has been examined in a range of contexts. In practice:

. Cost-benefit analysis is not well suited to measure social policy effects, particularly those relating to quality of life factors.

. Pre-existing market imperfections are generally reflected in market- based cost-benefit estimates.

. The method is subject to bias and politicization.

See Ashford & Caldart, supra note 56, at 246-48 (discussing cost benefit analysis in the context of occupational safety and health regulation).

n418. Narrow in the sense that they emphasize direct costs and benefits to employers. See, e.g., Vande Zande v. Wisconsin Dep't of Admin., 44 F.3d 538, 542 (7th Cir. 1995) (noting that the costs of accommodation for employers should not be disproportionate to benefits).

n419. See id.; Monette v. Electronic Data Sys., 90 F.3d 1173, 1183 n.10 (6th Cir. 1996) (noting that whether an accommodation is reasonable requires a factual determination of reasonableness, perhaps through cost-benefit analysis); Borkowski v. Valley Cent. Sch. Dist., 63 F.3d 131, 138 (2d Cir. 1995) (stating that for an employer to successfully argue that an accommodation is unreasonable because of cost, it must demonstrate the costs of the accommodation relative to the benefits); see also David K. Fram, Complex Reasonable Accommodation Issues Under the ADA, in National Employment Law Institute Report for the Industry Labor Council (1997) (on file with the authors) (citing case law).

n420. See 29 C.F.R. 1630.2(p) (1997). Factors to be considered in determining undue hardship include: the nature and cost of the accommodation and the character, size, and overall financial resources of the employer. See id. 1630.2(p)(2).

n421. See Fram, supra note 419, at 52.

n422. See id. (citing Vande Zande, 44 F.3d at 538; Borkowski, 63 F.3d at 131). Fram notes that Congress considered and rejected an amendment that would have limited reasonable accommodation costs faced by employers to 10 percent of the salary of the workers in question. See id.

n423. See id.

n424. See id.

n425. See generally Implementing the Americans with Disabilities Act, supra note 9 (reviewing Title I provisions).

n426. See Thomas H. Barnard, The Americans with Disabilities Act: Nightmare for Employers and Dream for Lawyers?, 64 St. John's L. Rev. 229, 251-52 (1990).

n427. See Peter David **Blanck,** Communicating the Americans with Disabilities Act, Transcending Compliance: 1996 Follow-up Report on Sears, Roebuck and Co., in Annenberg Washington Program Reports 42-43 (1996) [hereinafter Sears II]; see also Francine S. Hall & Elizabeth L. Hall, "The ADA: Going Beyond the Law", 8 Acad. Mgmt. Executive Rev. 17, 17-26 (1994).

n428. 72% required no cost, 17% cost less than $ 100, 10% cost less than $ 500, and only 1% cost more than $ 500, but not more than $ 1,000. See Sears II, supra note 427, at 17. Effective accommodations include assistive technology, physical access, changed schedules, assistance by others, and changed job duties. See Mary C. Daly & John Bound, Worker Adaptation and Employer Accommodation Following the Onset of a Health Impairment, 51 J. Gerontology S53 (1996).

n429. See Sears II, supra note 427, at 16-24.

n430. See id. The savings associated with accommodations included lower job training costs and insurance claims, increased worker productivity, and reduced rehabilitation costs after injury on the job. The Job Accommodation Network (JAN) reports that every dollar invested in an effective accommodation by the companies sampled lead to an average of $ 50 in benefits. See id. Likewise, the results of a 1995 Harris Poll showed that more than three-quarters of the more than 400 executives surveyed reported minimal increases in costs associated with the provision of accommodations (e.g., median direct cost for accommodations was $ 233 per covered employee), and from 1986 to 1995, the proportion of companies providing accommodations rose from 51 percent to 81 percent. See id. (citing President's Committee on Employment of People with Disabilities, Job Accommodation Network (JAN) Reports 10 (1994)). Other studies indicate that accommodations for employees with disabilities gave rise to cost-effective applications that increased the productivity of employees without disabilities. The JAN demonstrated that more than two-thirds of effective accommodations implemented as a result of a JAN consultation cost less than $ 500. Approximately two-thirds of the accommodations studied resulted in company savings in excess of $ 5,000.

n431. See Peter David **Blanck,** Communicating the Americans with Disabilities Act, Transcending Compliance: A Case Report on Sears, Roebuck and Co., in Annenberg Washington Program Reports 14-17, 26-29 (1994) [hereinafter Sears I]; Sears II, supra note 427, at 35-36; S.F. Wilson et al., The Center for Community Change Through Housing and Support, A Technical Assistance Report on Consumer and Ex-Patient Roles in Supported Housing Services 31-33 (1991) (the effect of hiring people with psychiatric disabilities was to improve the level of individual attention and accommodation to all employees, thus creating a more positive working environment). See also **Blanck,** supra note 2, at 15; Deborah Kaplan et al., World Institute on Disability, Telecommunications for Persons with Disabilities: Laying the Foundation 43-45 (1992).

n432. See Sears I, supra note 431, at 16-17.

n433. See **Blanck,** supra note 413, at 902-03 (citing other sources and noting that universally designed accommodations may reflect more efficient way to undertake production and improve productivity of co-workers).

n434. See id.

n435. See id.

n436. See **Blanck,** supra note 2, at 5.

n437. See ADA Watch: A Report to the President and the Congress on Progress, in National Council on Disability, Implementing the Americans with Disabilities Act 26-27 (1993) [hereinafter ADA Watch].

n438. See generally Peter David **Blanck,** The Americans with Disabilities Act and the Emerging Workforce of the Next Century: Employment of People with Mental Retardation - Empirical Study from 1990 to 1996 (forthcoming 1998) (citing Peter David **Blanck,** Celebrating Communications Technology for Everyone, 47 Fed. Comm. L.J. 185-91 (1994)).

n439. See id.

n440. See id.; see also Heidi Berven, Is There a Doctor on the Net? Cyberspace, Telemedicine, and the Virtual Physician-Patient Relationship in Vietnam, nn.14-17 (visited May 5, 1998) <http://www.uiowa.edu/cyberlaw/cls97/stupaper/berven.html>.

n441. See Berven, supra 440, at nn.14-17 and accompanying text.

n442. See id. at n.14

n443. See id.

n444. See id at nn.15-16.

n445. See id.

n446. See **Blanck,** supra note 2, at 6.

n447. See id. at 12.

n448. See id.

n449. See ADA Watch Year One, supra note 437, at 26-27.

n450. See id.

n451. See id. at 11.

n452. Katherine D. Seelman, Assistive Technology Policy: A Road to Independence for Individuals with Disabilities, 49 J. Soc. Issues 115, 121 (1993). Seelman writes: "depending on the stereotype, the abnormal identity may be subhuman, satanic/sinful, impaired/sick, and infantile. Public officials may use these stereotypes to deny ... assistive technology resources... People with disabilities may have incorporated these stereotypes into their identities...." Id.

n453. See id. To exemplify the technologies justified by disability stereotypes, see United States Patent No. 851,851 'Preventive Apron' (Aug. 14, 1979), issued in 1979 for "a preventive apron, used to control human sexual conduct, especially among the mentally retarded." Id. The patentee equates mental retardation with sexual deviancy and violence:

There are presently a large number of retarded people in the United States. The degree of mental retardation varies but there is a substantial number who have IQs in the range of idiot, moron, and imbecile....It has been difficult to control the sexual conduct of such people in social settings... The presence of such conduct is undesirable, and of course is disruptive when it occurs in a group setting, and can be dangerous when an individual is attacked by a retarded person...

Also, as noted by Galvin & Scherer, if assistive technology devices are effective but carry the aura of stigma, and thus create interpersonal barriers for the people who use it, they are design failures. See Evaluating, Selecting, and Using Appropriate Assistive Technology, supra note 14, at 28; see also Donald A. Norman, The Psychology of Everyday Things (1988).

n454. See Seelman, supra note 452, at 117. Excluding persons with disabilities from the design process may have actually impeded assistive technology advancements. See Scherer, supra note 14, at 29 (discussing the integral role of people with disabilities in the design process); Evaluating, Selecting, and Using Appropriate Assistive Technology, supra note 14, at 28 (same).

n455. See Seelman, supra note 452, at 117.

n456. See id.

n457. See Hauger, supra note 102 (discussing development of Kurzweil reader and inclusion of blind persons in the design process).

n458. See id.

n459. See P. Minaire, Disease, Illness, and Health: Theoretical Models of the Disablement Process, 70 World Health Org. Bull. 373 (1992) (discussing the biomedical, WHO-ICIDH, situational, and quality of life model of the disease and disablement process); see also Cook & Hussey, supra note 14, at 5 (adopting the WHO-ICIDH model); Scherer, supra note 14, at 52 (discussing models in the context of the distinction between "normalization" and "normality"); see Richard K. Scotch & Kay Schriner, Disability as Human Variation: Implications for Policy, 549 Annals Am. Acad. Pol. & Soc. Sci. 148, 148-159 (1997) (discussing the minority, economic, and medical models of disability); see also Seelman, supra note 452, at 117 (discussing medical model).

n460. See Minaire, supra note 459.

n461. See id.

n462. For instance, the Human Adaption Assistive Technology (HAAT) model tries to take into account social and cultural factors as well as environmental and physical conditions. See Cook & Hussey, supra note 14, at 50. This generally leads to better designs. See id.

n463. See Henry Petroski, The Evolution of Useful Things 33 (1992) (discussing human factors engineering).

n464. See Henry, supra note 396, at 34 (defining universal design as "creating spaces and products that are acceptable and usable by the highest possible number of people, whether abled or disabled"). Transgenerational design concerns the specialized needs of the aging population. See id; see also Mraz, supra note 396, at 60 (noting that the design process that goes into products for disabled people is no different than the design process behind any product).

n465. See LaPlante et al., supra note 195, at 4 (discussing unmet AT need).

n466. See id.

n467. See id.

n468. 1.9% as opposed to 1%. See id.

n469. See id. at 147. For assistive technology funding problems see James R. Sheldon & Ronald M. Hager, Funding Assistive Technology for Persons with Disabilities: The Availability of Assistive Technology Through Medicaid, Public School Special Education Programs, and State Vocational Rehabilitation Agencies, Clearinghouse Rev., May-June 1997, at 50.

n470. See Steve Kaye, Disability Rights Advocates and Disability Statistics Ctr., Disability Watch: Status Report on the Condition of People with Disabilities 2-4 (1996) [hereinafter Disability Watch] (noting that poverty defines the lives of many individuals with disabilities).

n471. See id.

n472. See sources cited supra note 469.

n473. See generally Seelman, supra note 452.

n474. See id.

n475. See id.

n476. See ADA Watch Year One, supra note 437, at 26-27.

n477. See supra note 353 (citing IRS tax incentives).

n478. See generally Lisa M. Erhart et al., Technical Assistance Needs Survey: Virginia Assistive Technology System, 2 J. Vocational Rehabilitation 74 (1992).

n479. See Seelman, supra note 452, at 125-129 (discussing federal and state assistive technology initiatives).

n480. See id.

n481. See LaPlante et al., supra note 195, at 4 (discussing AT funding statistics).

n482. See id.

n483. See id.

n484. See supra notes 394-402 and accompanying text.

n485. See **Blanck,** supra note 2, at 18-19.