October 14, 2002 (10:0AM)

PRE-PRINT DRAFT FOR

Berven, H.M. & Blanck, P.D. (1999). Assistive Technology Patenting Trends and the Americans with Disabilities Act, Behavioral Sciences & the Law, 17(1), 47-71.

Assistive Technology Patenting Trends and the Americans with Disabilities Act

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Running Title:

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Abstract

This article examines the ways in which the growing economic market for assistive technology (AT) may be analyzed in the context of effective implementation of the Americans with Disabilities Act (ADA). It summarizes the results of an ongoing study of patent data from the United States Patent and Trademark Office (PTO). The purpose of the study is to examine how the ADA is fostering innovation and economic opportunity for AT 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 found in the present study.

Assistive Technology and the Americans with Disabilities Act

Heidi M. Berven & Peter David Blanck

I. Introduction

Since the Americans with Disabilities Act (ADA) was passed in 1990, the law has been criticized for supposed economic inefficiencies the law imposes on markets -- for instance, by requiring certain physical modifications to the working environment, and by requiring employers and covered entities to reasonably accommodate workers with disabilities (Blanck, 1998a). Without strong support from research, critics argue that the economic costs outweigh the economic benefits of ADA implementation (for a review, see Blanck, 1998a). Some critics assert that the costs of hiring, accommodating, and retaining workers with disabilities exceed accrued individual or societal benefits. Although the assertion is insufficiently supported by hard study, criticisms of the ADA rooted in cost-benefit terms are frequent.

Estimating the costs and benefits of ADA implementation is a complex undertaking (Baldwin, this issue; Chirikos, this issue). In studying the implementation of the ADA, one of the objectives of the present study has been to examine the economic implications of the ADA that were unforeseen at the time of the law's enactment. The research summarized in this article focuses on one such measurable benefit of the ADA: the stimulation of positive economic activity in the assistive technology market (Bowe, 1995).

Assistive technology (AT) is any item, piece of equipment or product system whether acquired commercially off the shelf, modified, or customized that is used to increase or improve the functional capabilities of individuals with disabilities (Technology Related Assistance for Individuals with Disabilities Act, P.L. 103-218). AT devices include: motorized and customized wheelchairs, augmentative communication devices, vehicle modifications, computer equipment, assistive listening devices, home modifications, work-site modifications,

and classroom modifications (Cook & Hussey, 1996; Galvin & Scherer, 1996; Scherer, 1996).

There is a strong practical and policy oriented tie between the goals of the ADA and the development and provision of AT goods and services. The ADA seeks to remove the physical barriers that hinder the inclusion of persons with disabilities in employment and other social contexts. One of the law's goals is to make society's physical environment accessible to people with disabilities as they affirm their civil rights and pursue educational and employment goals. For many persons with mild and severe disabilities, AT plays a fundamental role in support of this mandate.

This article examines the emerging economic market for AT in the context of ADA implementation and the results of an ongoing investigation of AT patent data from the United States Patent and Trademark Office (PTO). The investigation hypothesizes that patent data can be used in conjunction with market and demographic information to document the impact of the ADA. The findings suggest that ADA implementation is fostering technological innovation and activity in the AT consumer market. 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. Ultimately, patentees may be staking claims in AT because of the promise of future economic benefits.

II. Background and Method of the Present Investigation

Shifts in federal regulatory policy can beneficially impact the process of technology innovation and can induce market activity for technological goods and services. For example, the "technology forcing" components of federal environmental laws helped to create a market for pollution control technology where one had not previously existed. In essence, the regulatory frameworks of laws such as the Clean Air and the Clean Water Act catalyzed the innovation process and compelled inventors to seek formal patent protection for their pollution control devices because of the promise of future economic rewards (Derzko, 1996; Gollin, 1991).

To that end, the market for water quality and wastewater treatment is booming as new regulatory and financial incentives fall into place (Wright, 1998).

A. The Impact of the ADA on the AT Market

The ADA functions in a manner similar to "technology forcing" environmental laws, by requiring covered entities to be accessible or to reasonably accommodate qualified individuals. The ADA builds on and expands the scope of earlier disability rights laws by prohibiting discrimination against individuals with disabilities and by calling for the removal of both physical and attitudinal barriers. AT plays a fundamental role in helping covered entities ("institutional" consumers of AT) to satisfy ADA regulations (Blanck, 1994b). Institutional consumers include employers (title I), municipalities (title II), places of public accommodation such as theaters and restaurants (title III), and telephone service providers (title IV).

Market reports indicate that AT inventors and producers are responding rationally to accessibility and accommodation requirements by innovating in order to compete for profits from title I institutional consumers (Mraz, 1992; Henry, 1993; Blackman, 1991; Cutler, 1993; Tompkins, 1993; Waldrop, 1990; Matthews; 1997). Employers covered by title I are charged with providing accommodations that are "reasonable." The reasonable accommodation requirement is a means by which physical, structural, and attitudinal barriers to the equal employment opportunities of individuals with disabilities are removed effectively and efficiently. 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, such as eyeglasses or hearing aids. Accommodations that are reasonable may include workplace supports such as job coaching or the provision of AT devices such as computer screen magnifiers, sit-stand work stations, or ergonomic keyboards (Blanck 1998a, 1997, 1996).

Related market reports indicate a similar trend for institutional consumers under titles II and III (Bowe, 1995). Title II institutional consumers, including governmental and municipal entities, are required to provide certain kinds of augmentative devices and services

ranging from curb cuts to auxiliary aids. Examples of auxiliary aids and services include telephone handset amplifiers, listening devices, assistive listening systems, telephones compatible with hearing aids, closed caption decoders, open and closed captioning, videotext displays, taped texts, audio recordings, brailled materials, large print materials. The Department of Justice has emphasized that this open-ended list of auxiliary devices is not exhaustive, and to attempt to provide a complete list would omit devices that will become available through emerging technology.

Institutional consumers under title III -- places of public accommodation such as restaurants or theaters -- are charged with making reasonable modifications in policies, practices, or procedures when they are necessary to accommodate individuals with disabilities. As under title II, accommodations may include providing auxiliary aids and removing architectural barriers. Covered entities are charged with implementing available technologies that offer readily achievable solutions for people with limitations, unless doing so would fundamentally alter the nature of the goods or services being offered, or would pose an undue burden.

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 mandates. Title IV represents the culmination of 50 years of telecommunications legislation aimed at achieving universal service. Nationwide adoption of text telephone technology is central to the goals of Title IV. The aim of title IV is to encourage the optimal use of existing communications technology for persons with disabilities and to avoid discouraging or impairing the development of improved technology.

1. Measuring the Effects of ADA Implementation with AT Patent Data

The aim of the present investigation was to determine whether patent data could be used to probe the link between ADA implementation and activity in the AT market. We hypothesized that AT developers would respond rationally to market forces in seeking patent

protection for their inventions. Patents grant the right to exclude competitors from making or using an invention for a term of up to twenty years (Chisum & Jacobs, 1997). Thus, to secure future profits, an AT inventor will more likely seek patent protection in a competitive AT market than in a non-competitive market.

Patents are legal documents that provide unique snapshots of AT inventors and inventions; as such, they are an under-utilized source of data. Patents are designed to mark the limits of an inventor's intellectual property rights, but they also reflect how societies view and define the concept of invention (Israel & Rosenberg, 1991; Reingold, 1960). The way a patent describes or depicts a device often transcends legal significance by contributing to enhanced social or cultural understanding of inventors and inventions (Reingold, 1960). How inventors describe AT devices, for example, is significant. Whether an inventor refers to a wheelchair as a "personal mobility device" (as did one inventor in U.S. Patent 4,570,739) or as an "invalid carriage" (as did another in U.S. Patent 4,798,255) reflects how society views and values people with disabilities.

As a preliminary matter, AT inventors must follow the same procedures as other inventors seeking patent protection. Inventors or their assignees (usually the inventor's employer) submit patent applications to the PTO for a basic filing fee. 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. The front page of a patent lists demographic information, including: patent title and number, application date, issuance date, inventor and assignee identity, inventor's home state or country, how the invention is classified, and "prior art" references that were evaluated by the examiner in determining whether the claimed invention deserves patent protection (Hildreth, 1993).

AT patent applications are evaluated by governmental examiners, who are divided into various art groups based on their areas of technical expertise -- such as chemistry, electronics, materials science, and genetics. Patent examiners determine whether claims are

patentable according to standards promulgated in the 1952 Patent Act (described in the Code of Federal Regulations) and the Manual of Patent Examination Procedure. Examiners focus on the "specification" and "claims" sections that describe the invention to make their determination.

2. Limitations in Using Patents and Patent Data in Research

In the aggregate, patents and patent statistics are employed in technology and economic forecasting, for instance, as quantitative proxies to measure technological innovation and economic change (Basberg, 1987; Pavitt, 1988; Simmons & Lambert, 1993; Kaufer, 1989; Papadakis, 1993; Basberg, 1988; Narin & Olivastro, 1988; Pavitt, 1982; Pavitt, 1985; Griliches & Pakes, 1986; Acs & Audretsch, 1989), to gauge spillover effects between firms and technologies (Jaffe, Trajtenberg, & Henderson, 1993), and to track research and development trends (Lepkowski, 1997). The quest for technology indicators that help to predict technological innovation trends and economic growth with accuracy has led to the development of a number of patent research methods based in statistics and bibliometrics. Bibliometrics, or the study of publication-based data, is used to track progress in scientific and technological disciplines through citation analysis (Narin, 1994; Melkers, 1988; Albert, Avery, Narin, & McAllister, 1991). Patent citation data is used for similar purposes (Narin, 1994). The present study uses patent data to track recognition of the needs of individuals with disabilities and of the ADA among AT inventors.

Using patent data for economic and social science research can be complicated by a number of factors. One problem is incompleteness in the patent data set. Many inventions are not patented because patenting philosophy and the motivation to patent varies between firms and industries (Papadakis, 1993; Basberg, 1988; Narin & Olivastro, 1988; Pavitt, 1982; Pavitt, 1985; Griliches & Pakes, 1986; Acs & Audretsch, 1989. Simmons & Lambert, 1993). Patents play a significant role in protecting intellectual property portfolios in fields with high research and development expenditures, such as pharmaceuticals, medical devices, microelectronics, or computer technology (Kaufer, 1989). In industries where research and development costs are

relatively low or aggressive market behavior is important, patents play a less significant role (Levin,). The perceived cost of litigation also influences the decision to patent (Lerner, 1998).

Patents also 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 patents. Conducting patent bibliometric research without taking claim scope and type into consideration may give rise to misleading results (Simmons & Lambert, 1993). This concern -- a fear of grouping significant patents with insignificant patents -- is rectified through citation counting and related weighting methods.

Analysis of patent trends is complicated by additional administrative or judicial factors. Bureaucratic shifts at the PTO, changes in the patent law, and in the disposition of patent-related actions at the Court of Appeals for the Federal Circuit (the court charged with adjudicating patent disputes) influence patenting behavior. The PTO classification system, comprising over 370 major invention classes and thousands of subclasses, also makes accurate analysis of patent data and trends difficult. Patents are classified by examiners according to a byzantine array of functional and technological principles that bear little relation to discrete industries or products, resulting in odd groupings of inventions (Griliches, 1990; Schmookler, 1972).

B. Approach of the Present Study

The present investigation began with several questions: Are laws or regulations related to the rights of individuals with disabilities referenced in patent disclosures? In a more focused sense, how have patentees invoked the ADA or other disability legislation in their applications? For what types of inventions?

A term word search strategy of the patent database, available through WestLaw or LEXIS was adopted to identify relevant AT patents for use by individuals with *mobility*, *hearing*, and *visual* impairments. The search strategy -- a variant of co-word analysis involving the

assignment of words or keywords to papers or articles (Melkers, 1988) was extended to patent disclosures because inventors are required to identify uses or functions for their devices to meet patentability standards. If an invention is intended for use by a wheelchair user, the patent disclosure will likely mention "mobility impairment" or identify some aspect of the needs of people with mobility impairments. The research method seemed sub-optimal because it couldn't be relied upon to capture the complete set of relevant patents. But its straight-forward approach made it possible to avoid many of the analytical problems encountered by other researchers (Griliches, 1990).

References to federal disability rights legislation were then searched. Patentees might mention various laws to meet patentability standards, to demonstrate utility (or usefulness) or societal need (Chisum & Jacobs, 1998). Reference to disability rights legislation other than the ADA, such as the Rehabilitation Act, the Individuals with Disabilities in Education Act, and the Technology Related Assistance for Individuals with Disabilities Act were not identified. This trend stands in contrast to references to environmental legislation, where a number of patents were identified that cite legislation such as the Clean Air Act, the Clean Water Act, the National Environmental Protection Act (NEPA or EPA), or the Occupational Safety and Health Act (OSHA)) (Berven & Blanck, 1998). One hundred thirty nine patents referencing the ADA issued between 1990 and June, 1998, however.

III. Results and Discussion

A. Core Findings

Because our intent was to gain understanding of AT inventors and patents rather than to rigorously forecast technology and economic trends within the AT market, the findings of the present study are descriptive, relating to a range of demographic factors about AT inventors and inventions. The core findings emerging from the study include:

- Assistive technology patent numbers have shown annual increases since 1976.

- In addition, the inventors who acknowledge the ADA are a diverse group, many unaffiliated with large corporations
- Reference to other civil rights legislation has been atypical of patent records. But from January, 1990 until December, 1997, the number of patents citing the ADA has increased substantially.
- From 1990-1997, patents were granted for a wide range of assistive devices with uses for a wide array of consumers with disabilities.

The core findings are consistent with AT market reports and needs surveys: ADA implementation is affecting the AT consumer market in economically positive ways and is creating profit-making opportunities for inventors and manufacturers (Berven & Blanck, 1998).

1. Increasing Assistive Technology Patenting Rate

Annual patent application and issuance numbers have increased since 1976. This data is summarized graphically in **Chart 1**.

Insert Chart 1:
General Utility Patent Trends, 1976-1997

Application and issuance number increases are part of an overall trend in patenting activity at the PTO. In 1976, out of 101,807 applications filed, 75,325 patents for mechanical devices, chemical compositions, or related processes (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 40 percent, respectively. Years that exhibited drops in the number of patents issued may be related to concomitant reductions in the size of the examiner workforce, although other organizational or economic factors may be operative (Griliches, 1990).

The number of patents relating to the needs of consumers with disabilities also are part of an upward trend in patenting activity based on the results of the present investigation. The set of AT patents intended for use by individuals with physical, visual, or hearing

impairments represents a very small fraction of the total patents issued between 1977 and the present. However, the substantial patenting rate increases summarized in **Chart 2** seem noteworthy. **Insert Chart 2:**

Patents Mentioning Physical, Visual or Hearing Impairments, 1977-1997

Chart 2 suggests that the impairment patenting rate has increased substantially. The number of patents relating to hearing impairments increased eight fold, from 12 in 1977 to 96 in 1997. Similarly, 4 patents relating to visual impairments issued in 1977, compared to 97 in 1997, representing a twenty-four fold increase. Finally, 30 patents relating to physical impairments issued in 1977, as compared to 62 in 1997 (a two fold increase). Measuring the significance of this result will be the subject of future empirical investigation. Patent number local maxima occurred in 1977-78 and 1987-88. The maxima may be due to a combination of social and economic, as well other administrative factors (Berven & Blanck, 1998).

The utility patents collected in the present investigation were for devices relating to the medical treatment as well as to the daily needs of people with disabilities. One physical impairment patent was for a utensil handle that is easier to hold for individuals with arthritis or multiple sclerosis (U.S. Patent 5,680,676). Another was for an eye-tracking system that allows people without the use of their hands to interact with computers (U.S. Patent 5,481,622). Sensory impairment patents included telephone equipment for individuals with hearing impairments (U.S. Patent 5, 710,816) hearing aids (U.S. Patent 5,706,351); braille readers (U.S. Patent 5,685,721) and computer icons (U.S. Patent 5,565,888).

The findings suggest that an increasing rate in AT patenting activity is characteristic of a dynamic, market-responsive industry in which design innovations and improvements are defining features. Other social and economic factors may also contribute to AT patenting rate increases. A recent National Center for Health Statistics (NCHS) AT needs survey identified technology advances -- in microelectronics, microcomputers, and the development of composite materials -- that have lead to improved AT design, characterized by devices that are lighter, safer, stronger, easier to use, and in some cases, less expensive.

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. This twenty year span is characterized by rapid differentiation of the wheelchair industry (Palmeri, 1993; Berven & Blanck, 1998). Visual impairment patents increased from 12 to 144 (a 12 fold increase in patenting rate) during the same interval (Felton, 1997). This was a period of advancement for text to speech technology. Hearing impairment patents increased from 38 to 270 -- more than a seven-fold increase. This result also was a period of growth for hearing aid, text telephone, and cochlear implant technology (Levitt, 1995).

The patent findings are also consistent with the NCHS survey results regarding AT use patterns (Russell, Hendershot, LeClere, & Howie, 1997). The survey estimated that over 17 million Americans use AT. Approximately 7.4 million persons used AT devices for mobility impairments, 4.6 million, for orthopedic impairments, 4.5 million, for hearing impairments, and 0.5 million, for vision impairments. The data indicated a positive relation between increasing age and the prevalence rate of device usage (Russell, Hendershot, LeClere, & Howie, 1997).

The NCHS survey noted that changes in the size and composition of the population is one important factor that has influenced AT use trends. The rate of device usage among persons aged 65 or older is four times the rate of the total population. Aging baby boomers are also becoming active consumers in the AT market. Over two million persons aged 25-44 use some form of AT, while one million live in homes with adaptive or accessibility features. Accommodating this population group presents a range of market opportunities for AT developers, for instance, in making packaging easier to open, improving the accessibility of homes and offices, and simplifying appliances (The Boomer Report, 1994). Consistent with this NCHS observation, the present study found that patents for AT devices or medical products intended for use by older persons to improve their daily lives increased dramatically, from 76 in 1977, to 424 in 1997, representing nearly a six-fold increase. This finding is depicted in **Chart 3**.

Insert Chart 3:
Elderly Patents Compared to Impairment Patents: 1977-1997

Finally, shifts in national technology policy regarding technology and the rights of individuals with disabilities may also be influencing AT patenting rate increases. Scholars have argued that technology policy in the United States has shifted focus from industry innovation to technology innovation (Chiang, 1993). This change in focus may have led to greater levels of innovation for a variety of industries that use similar technologies. The process of technological "spillover," from telecommunications and microelectronics technology, made advances in telephone technology for the deaf possible.

2. Proof of Inventive Activity after Passage of the ADA

Between 1990 and mid-1998, the present study identified 139 patents that referenced the ADA. **Chart 4** records the frequency of ADA-AT patents relative to other AT patents. Annual issuance numbers for the ADA-AT patents rose through 1996, then dropped in 1997, whereas AT patents relating to the elderly and to the combined impairment patents discussed earlier continued to increase. Whether this development is significant remains unclear. A number of factors that are difficult to measure may be contributing to the observed findings. AT inventors (through their patent attorneys) may have determined that the strategy of referencing the ADA does not relax patenting requirements or expedite the examination process. The result also could be due to changes in the size or profile of the patent examination corps, to the economic health of AT firms, or to research and development spending.

Insert Chart 4:
Annual Frequency of Patents Citing the ADA Related to Other AT Patents

The number of ADA-AT patents that were identified in the present investigations is small compared to the total volume of issued patents.. The total number of patents issued between 1990 and 1997 exceeded 1.2 million, while the number of impairment patents and patents relating to the AT needs of the elderly totaled 1,297 and 2,714, respectively. The 139 patents referencing the ADA between 1990 and mid 1998 represents a minute share (approximately 0.01 percent) of the total volume of issued patents. The result seems significant

because it suggests that knowledge of the ADA is diffusing to stakeholder groups that were not identified at the time of the law's passage. These groups include AT inventors, producers, and their patent attorneys.

The AT-ADA patents are significant on a number of other levels. At a minimum, AT patentees were willing to go through the time and expense of seeking formal patent protection for their inventions. AT inventors initiated the patent process, perhaps because of the promise of future economic returns based on consumer demand.

On another level, the notion of "induced innovation" or "technology forcing" that may be operative in the environmental context as discussed earlier, may be also operative in the disability patent context (Ashford, 1994, 1985; Derzko, 1996). Generally, innovation occurs because firms respond to consumer demands in the marketplace. In the case of environmental technology, the market for pollution control devices has been created artificially through government regulation. 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 incentives (Hamrin, 1982).

Whether technology forcing has successfully encouraged innovation in pollution control technology remains a subject for debate, but studies suggest that some regulations have positively impacted the process of innovation (Gollin, 1991; Stewart, 1981). This finding may extend to the ADA's impact on AT development. By invoking accommodation and accessibility requirements on covered entities, the ADA and supporting regulations are increasing demand for new AT among institutional consumers.

3. Diversity of AT Inventors

Over two-thirds of inventors typically assign their patent rights to their employers -- usually corporate or academic entities. In the present investigation, individual inventors

accounted for more than fifty percent of the ADA-AT patents. This observaiton deserves comment, given that individuals working outside of corporate or university settings generally face more difficulty in developing and commercializing their inventions. Because of the difficulties faced by non-affiliated AT inventors and small firms, companies such as the Buffalo, New York based Aztech were created to help individual inventors bring their products to the marketplace. Aztech began as a collaborative effort between University of Buffalo researchers and the Center for Independant Living. To date, Aztech has helped nine inventors to license or commercialize their AT ideas (Drury, 1998).

The lower proportion of corporate inventors might indicate a lack of interest in the AT market. Potential AT market growth and profitability may be perceived to be low because of the limited buying power of traditional AT consumers -- individuals with disabilities who have limited financial resources. Today, however, the pool of AT consumers is substantially larger because of the requirements the ADA imposes on institutional consumers. The number of consumers with disabilities who can pay for AT is substantially larger as well, in part because of population dynamics (i.e., aging baby boomers with financial resources).

In response to these developments, both large and small corporations are pursuing opportunities in the AT market. For instance, 3-M holds a number of patents for making tactile signs for people who are blind or visually impaired (U.S. Patent 5,246,757). Schlage holds patents for door levers that can be manipulated by people with mobility impairments (U.S. Patent 5,687,507).

Other large companies not part of the present investigation are beginning to address the needs of computer and Internet consumers with sensory impairments. IBM, Microsoft, and Apple Computer have expressed their commitment to improving accessibility for people with disabilities. Apple incorporated “Mouse Keys” in its Macintosh computers that allow users to move the cursor one pixel at a time in any direction. This allows individuals with mobility impairments to precisely position the mouse on the screen. The Mouse Key feature is an example of an accessible or universal design that has the added feature of increasing the

functionality of users who are not disabled. In general, when products or environments are made more accessible to persons with disabilities, they become easier for everyone to use (Vanderheiden, 1990; Trace Research Institute, 1998).

A number of smaller firms develop products specifically for consumers with disabilities. Estimates suggest that there are approximately 2000-3000 businesses that manufacture AT devices (Mraz, 1992). Many of these are small operations or sole inventors, marketing a maximum of one or two devices. Some, like Henter-Joyce or LC Technologies, market computer technology exclusively for disabled consumers. Henter-Joyce has tripled its workforce since it was formed several years ago (Felton, 1998). LC Technologies has recorded sharp increases in orders in the last six months. The market for some assistive technology products -- for instance, for speech to text products -- continues to grow. The market was projected to reach $410 million in 1997. It should exceed $4.3 billion by 2001 (Felton, 1997).

4. Diversity of AT Products and Consumers

The present findings indicate that the ADA is helping inventors and manufacturers to identify other potential consumers of AT besides individuals with disabilities. Prior to the passage and implementation of the ADA, persons with disabilities may have been considered the sole, principle for AT. The elderly, aging baby boomers, and the chronically ill are now also recognized as direct consumers of AT (Wylde 1995a, 1995b). After implementation of the ADA institutional consumers -- employers, property owners, and municipal transport authorities -- became AT purchasers in order to meet the needs of employees, customers, or others with disabilities (Mergenhagen, 1997; Cutler, 1993).

Engineering trade journals and popular literature reflect an understanding of the potential economic implications of ADA implementation for a wide range of AT developers (Mergenhagen, 1997; Mraz, 1992; Henry, 1993; Blackman, 1991; Cutler, 1993; Tompkins, 1993 Waldrop, 1990; Matthews; 1997). In essence, institutional consumers are seen as a potential source of profit. This trend is reflected in the types of devices that are part of the ADA-AT

patent set. **Chart 5** depicts a classification scheme for the inventions. Most of the patents were for "general access" inventions -- devices that would improve accessibility for persons with disabilities in a variety of contexts.

Insert Chart 5:
Classification by Type

"General accessibility" devices cover a wide range of items and include 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, among others. "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 5**.

Most of the devices represented in the ADA-AT patent set support multiple users in public or work settings. Many (118, or 85 percent of the 139 ADA-AT patents) appeared to be designed to meet title II and title III accessibility requirements. The patents were for devices such as light/sound alarm systems (U.S. Patent 5,577,834) or signage with raised characters (U.S. Patent 5,403,189). Some represent safety modifications that benefit individuals both and without disabilities in private as well as public settings, such as insulated plumbing fixtures (U.S. Patent 5,341,637) or non-slip floor surfaces (U.S. Patent 5,385,770). Seven, or five percent of the patents represented title I workplace accommodations such as sit-stand stations. The remaining fourteen, or ten percent, of the patents were for title IV telecommunications devices

B. Implications for ADA Stakeholders

A shortage of empirical data continues to hinder cost-benefit evaluations of the ADA. The present study illustrates that a range of viewpoints from multiple disciplines are needed to gauge the successes and failures of ADA implementation. Prior conclusions regarding ADA cost-effectiveness that have that been based on incomplete data or misinformation must be

reassessed (Olsen, 1997). The ADA patenting data suggest that unrecognized economic benefits are accruing from the law (Blanck, 1998a), including AT market growth and related benefits to discrete ADA stakeholding groups, including inventors, individuals with disabilities, employers, and other entities covered by the law.

1. AT Researchers and Developers

The present study documents a range of findings regarding AT inventors. First, the results are consistent with market data that indicate that inventors and producers face robust competition for AT consumers. Second, inventors are successfully guiding their inventions through the patenting process, and in many cases, have carried them to the consumer market, where demand for AT continues to grow.

The "push-pull" of disability policy may be fostering the research initiatives of individual and corporate inventors. The regulatory "push" introduced by the ADA expanded the market for AT to include a range of consumer groups, including persons with disabilities, their employers, and other public, municipal, and governmental entities. At the same time, financial incentives and related programs (the "pull") provided research and development opportunities to AT inventors and producers. Financial support of AT research and development is available through the following federally-sponsored programs:

- *Consumer Assistive Technology Transfer Network (CATN)*. Funded by the National Institute on Disability and Rehabilitation Research (NIDRR), the program identifies linkages to resources for consumers regarding difficult to solve AT needs and problems. CATN also helps researchers and engineers to identify development and commercialization resources for AT prototypes and technology applications.

- *Rehabilitation Engineering Research Centers Program (NIDRR)*. The program is funded by the National Institute on Disability and Rehabilitation Research (NIDRR) and the U.S. Department of Education. The programs focuses on research and development of new AT as well as information dissemination and educational activities.

- *NIDRR Utilization Projects*. Funded by the NIDRR, the programs support activities that will ensure that rehabilitation knowledge generated from

projects and centers funded by the NIDRR will be utilized to improve the lives of individuals with disabilities.

- *NIDRR Tech Act Program*. Funded by the NIDRR as part of the Technology Related Assistance Act (Tech-Act), the programs focus on improving public awareness, public access to information, funding for AT devices and services, training and technical assistance, and coordination of statewide activities.

- *National Science Foundation Programs*. The National Science Foundation sponsors a number of programs focused on people with disabilities.

According to a recent report from the National Academy of Sciences' Institute of Medicine (NAS-IM), increased financial support through these and other research and development programs is necessary to ensure continued improvements in AT design. Inadequate research funding from the federal government and lack of coordination among disability programs continues to hamper efforts to improve provision and funding of AT (Brandt & Pope, 1997).

One solution to overcome limited federal funding and coordination shortcomings may be to increase support for programs that encourage small business AT research and development in the private sector. For instance, the Small Business Innovation Research (SBIR) Program was created to foster innovation among small firms. The Program requires federal agencies with outside research and development budgets exceeding $100 million to set aside at least 2.5 percent of that amount for small businesses. At a recent hearing of the Senate Committee on Small Business, Senator Christopher Bond introduced legislation to improve small business participation in AT research and development, "to encourage the development and production of actual products for the marketplace of AT endusers" (Bond, 1998).

At a deeper level, information is lacking on the ways "environmental" factors affect disability. The NAS-IM report concluded that individual characteristics conjointly with the environment -- defined in terms of cultural, psychological, economic, and political factors -- determine disability. The NAS-IM report calls for increased federal funding for basic

rehabilitation science research, to probe the relationship between the environment and disability. The Report also advocated increased federal funding for applied rehabilitation science and AT research and called for a commitment to improving technology transfer mechanisms so that AT researchers and developers could reach AT consumers (Brandt & Pope).

2. Employers and Other AT Institutional Consumers

AT plays a fundamental role in achieving the ADA's goal of reshaping employment, public accommodations, and public attitudes. Continuing to develop AT for work and other settings will help to remove the physical and communication barriers facing many individuals with disabilities. The present study suggests that patent and innovative activity will benefit title I, as well as title II and title III institutional consumers. For employers, the gains may include the addition of effective, productive employees to their workforce because of the adoption of less expensive and more efficient AT and universal design strategies.

Yet some employers have been unwilling to make accommodations because of perceived or actual expense (Blanck, 1998b). They 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 (Gostin & Beyer, 1993). The costs of accommodations may be especially high for large employers who are held accountable for extensive modifications due to their greater financial resources (Barnard, 1992; Chirikos, this volume). These arguments often are made without reliance on data.

The present study suggests that AT were typically "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 (Blanck, 1998a; Hall & Hall, 1994).

One research group has found that a number of factors influence corporate

willingness to adopt AT, universal design, and related accommodation strategies. In a study co-sponsored by the U. S. Department of Education and the National Institute for Disability and Rehabilitation Research (NIDRR), the Trace Research Institute at the University of Wisconsin surveyed 22 companies about universal design implementation (Vanderheiden, 1990; Trace Research Institute, 1998). The study found that corporate size is not predictive of universal design adoption, although firms subject to state or federal regulation like the ADA title I are more likely to adopt accessibility and universal design strategies. Firms were also concerned about AT cost (Vanderheiden, 1990; Trace Research Institute, 1998).

This trend is also reflected in data collected from a series of studies conducted at Sears, Roebuck and Co. from 1978 to mid-1998 (Blanck, 1996). Nearly all of the 500 accommodations sampled at Sears required little or no cost. Effective accommodations included AT, improved physical access (such as closer parking spaces), changed schedules, assistance by others, and changed job duties (Daly & Bound, 1996). During the years 1990 to 1997, the average direct cost for accommodations was less than $45.

Accommodations involving universally designed and advanced technology have been shown to enable groups of employees with and without disabilities to perform jobs productively, cost-effectively, and safely (Vanderheiden, 1990; Trace Research Institute, 1998). Sies 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 (Blanck, 1996).

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 (Blanck, 1998b). 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; and accommodation patterns at the national

aggregate (Blanck, 1996).

3. Individuals with and without Disabilities

The findings of the present study indicate that many of the ADA-AT patents relate to improving accessibility for individuals with as well as without disabilities. The general accessibility patents that mentioned the ADA were typically for "low-tech" items that were intended for multiple users.

The non-disabled population will continue to be ancillary beneficiaries of the ADA because of the adoption of universal design and accessibility strategies, individuals with moderate to severe disabilities who need AT to function in home and work settings frequently go without. According to a 1992 NCHS AT needs survey, of the 2.5 million persons who had an unmet need for assistive technology, about 1.2 million persons were of working age (25-64) (LaPlante, 1992). Poor people were about twice as likely as non-poor people to say they needed an AT device. Non-whites were more likely than whites to have an unmet need for AT. Coupled with these findings, the results of a 1998 Harris Survey suggests that much work remains. The survey indicated that almost one third of individuals with severe disabilities between the ages of 18 and 64 live in households with incomes of $15,000 or less. Only 29 percent of individuals with disabilities of working age work full or part time, as compared to 79 percent of the non-disabled population (Harris Poll, 1998).

Consumers who can afford AT will continue to have a choice between different products and designs. For these individuals, a competitive AT market should continue to lead to improved quality and lower prices. Individuals with disabilities who live in poverty must rely on public sources of AT funding. Because public funding is poorly coordinated and inadequate, these individuals with disabilities who lack financial resources remain largely shadow consumers of advanced AT (Sheldon & Hager, 1997). People who need and would benefit from AT often must self-finance or go without. This means that most individuals who live in poverty live without the benefit of AT. The fact that many must pay for their own assistive devices discloses

the inadequacies of existing delivery systems, including third party insurance carriers who refuse to cover AT.

Disability policy requires harmonization with respect to AT funding. A recent needs assessment survey showed that AT funding was the most significant problem experienced by consumers and service providers, over other need areas (Erhart, 1992). Funding for AT devices and services is available through a complex network of federal and state disability programs, including: Social Security Disability Insurance (SSDI), Social Security Insurance, Medicaid, Medicare, and a variety of federal and state vocational rehabilitation and assistive technology programs (Seelman, 1993). The interpretation of disability standards under each of these laws varies.

Third party payment of AT is the norm under most of these programs. According to the 1992 NCHS AT needs survey, third party funders made complete or partial payments for more than half (52 percent) of AT users' devices (LaPlante, 1992). 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. More than three-quarters of the persons with home modifications or accessibility features paid for them out of pocket.

In the face of the inadequate funding for AT goods and services, questions remain about the reauthorization of the Technolgy Related Assistance for Individuals with Disabilities Act (Tech Act). The Tech Act was passed in 1988 with a ten year time limit to provide support for state AT funding and distribution programs. The law was re-authorized in 1994, in part because most states were slow in adopting the administrative apparatus to implement the requirements of the Act. If the Tech Act expires in 1999 as mandated, only nine states will have received funding for the full ten year period.

At a Congressional Hearing to reauthorize the Act, Judith Heumann, Assistant Secretary in the Department of Education's Office of Special Education and Rehabilitative Services, advocated continued federal support of the law in order to bridge gaps in AT funding, provision, and services. It is likely that the Tech Act will be reauthorized in some form, but the

size and target of the appropriation remains undecided, and is currently slated to be less than the $36 million fiscal year 1997 appropriation (Education Technology News, 1998).

V. Conclusion

Competition within the market for ADA institutional consumers will continue to drive AT innovation and development. It is possible that technology improvements for institutional AT that can support multiple users may ultimately spillover to customized AT design. Individuals with and without disabilities increasingly will benefit from improved AT and from the universal design strategies championed by the ADA. Yet individuals with severe disabilities continue to face significant obstacles to obtaining the AT that will allow them to live independently and productively.

Improvements in AT design without concomitant changes in existing disability initiatives and related employment programs will do little to ensure the promise of the ADA for individuals who are disempowered financially or socially. President Clinton realized the fundamental role that work plays in empowering individuals with disabilities by signing Executive Order 13078 (EO-13078). The Order is aimed at increasing the rate of employment for adults with disabilities to a rate comparable to the general population (U.S. Newswire, 1998). To achieve this goal, EO-13078 calls for the creation of a national task force that is charged with expanding public education regarding the rights and requirements of the ADA, particularly for under-served stakeholding groups in rural and economically disadvantaged urban areas.

EO-13078 emphasizes the essential role the Medicaid Option may play in removing the disincentive for individuals with disabilities to work caused by a fear of losing health insurance coverage. To this end, the Senate is considering legislation that seeks to offer workers with disabilities the opportunity to buy Medicaid on a sliding scale payment plan (Washington Press Wire, 1998).

In addition, while provision of AT through the Individuals with Disabilities Education Act and other laws will continue to enrich the school experiences of many children

and young adults with disabilities, much work remains in improving their employment prospects. Programs such as High School High Tech play a critical role in enhancing the employment options of young adults with disabilities (Washington Press Wire, 1998).

Continued improvements in distance education as mandated by laws such as the Telecommunications Act of 1996 promise to benefit individuals with disabilities who live in underserved rural areas. Individuals with disabilities largely remain outsiders in their own communities. EEOC Commissioner Paul Steven Miller recently reflected on the exclusion of persons with disabilities from society (Blanck, 1994). Miller noted that for years, the physical environment, including buildings, worksites, public places, and schools, were constructed without regard to people with disabilities. Disabled people were sheltered away from participation. Not ignored, stressed Miller, but invisible (Blanck, 1994a).

The invisible community of persons with disabilities numbers over 50 million Americans by Census Bureau estimates. The ADA and related federal legislation seek to provide workers and consumers with disabilities access to the goods and services that allow them to participate equally in society. AT plays a fundamental role in achieving this goal. As noted by Congress in the findings of the Tech Act, "[f]or some individuals with disabilities, AT devices are necessary to enable the individuals to . . . have greater control over their lives."

Based on the patenting trends discussed in this article, the ADA has had a measurable effect on the 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. The findings illustrate that the ADA is succeeding in heretofore unanticipated and unrecognized ways, creating unanticipated benefits for ADA stakeholders and others. Knowledge of the ADA has reached AT inventors and to have influenced their inventive activity.

Yet the recent words of Professor Stanley Herr may continue to ring true: "[F]or all the glamour and the appeal of new technologies, we stll need the old virtues of listening, of remedying the injustices that we encounter . . . of communicating with those we hope to help

(Blanck, 1994a)." The achievement of the ADA's promise of full inclusion and equal participation requires more than advancing AT. It requires careful study of underlying attitudes and behaviors toward individuals with disabilities in all parts of American society.

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