National Disability Policy:

A Progress Report

National Council on Disability

October 7, 2016

Technology that enables access to the full opportunities of citizenship under the Constitution is a right.

National Disability Policy: A Progress Report

The views contained in this report do not necessarily represent those of the Administration, as this and
all NCD documents are not subject to the A-19 Executive Branch review process.

National Council on Disability

An independent federal agency making recommendations to the President and Congress to enhance the quality of life for all Americans with disabilities and their families.

Letter of Transmittal

October 7, 2016

President Barack Obama
The White House
1600 Pennsylvania Avenue NW
Washington, DC 20500

Dear Mr. President:

The National Council on Disability (NCD) is pleased to present the 2016 edition of *National Disability Policy: A Progress Report.* Each year, NCD submits a statutorily mandated report to the White House and Congress to offer recommendations on new and emerging issues affecting the lives of people with disabilities. NCD identified one central topic as the core for the 2016 *Progress Report*—technology. The Council decided to focus on information and communications technology (ICT) because of the potential that it holds to transform how people with disabilities experience the opportunities of citizenship in our society. The report also addresses assistive technology that serves to enhance the independence of people with disabilities.

NCD submits this report during an exciting period in time, as we witness the evolution of technology that can engage users by "listening," "learning," and "thinking" in order to meet their needs. Advancements in technology have the potential to transform society and make it more responsive to people with disabilities as they learn, work, receive health care, experience community living, and engage in other activities. Thus, it is essential that the Federal Government demonstrate full support for accessible ICT and assistive technology. Examples of how this can be accomplished include enforcing legislation that prohibits discrimination based on disability; prioritizing accessibility in all federal investments made through contracts and grants; and modeling best practices when using websites, electronic files, videos, and other forms of electronic and information technology to communicate information. Support for accessible ICT and assistive technology can be further reinforced through a Technology Bill of Rights for People with Disabilities to clarify how existing federal legislation applies to ICT and assistive technology.

Issues reflected in the 2016 *Progress Report* have implications for our society as a whole. Addressing the needs of people living with a disability today is of immediate concern. However, it is also important to consider the future needs of those who will acquire a disability at some point in life. This includes the reality that many people in our technology-dependent society will age into disability. As with people who experienced disability earlier in life, aging populations may face extreme hardship navigating a society that is infused with inaccessible technology. The 2016 report highlights the need to design and use technology so that it transforms social, cultural, informational, and physical spaces in a way that allows for people with disabilities to fully engage in society.

NCD appreciates the efforts of policymakers, technology industry leaders, people with disabilities, and others who continue to promote policies and practices that will lead to technology that can be used by all. We invite Congress and the White House to continue this momentum by carefully considering the concerns reflected in the 2016 *Progress Report* and supporting the recommendations.

Respectfully,

Clyde E. Terry
Chairperson

National Council on Disability Members and Staff

Members

Clyde E. Terry, *Chairperson*
Katherine D. Seelman, *Vice Chair*
Gary Blumenthal
James T. Brett
Bob Brown
Lieutenant Colonel Daniel Gade
Janice Lehrer-Stein
Benro T. Ogunyipe
Neil Romano

Staff

Rebecca Cokley, Executive Director
Joan M. Durocher, General Counsel & Director of Policy
Geraldine-Drake Hawkins, Ph.D., Senior Policy Analyst
Amy Nicholas, Attorney Advisor
Ana Torres-Davis, Attorney Advisor
Anne Sommers, Director of Legislative Affairs & Outreach
Phoebe Ball, Legislative Affairs Specialist
Lawrence Carter-Long, Public Affairs Specialist
Lisa Grubb, Management Analyst
Stacey S. Brown, Staff Assistant
Keith Woods, Financial Management Analyst

Dedication

The National Council on Disability dedicates this report to the memory of Dr. "Gerrie" Hawkins, Senior Policy Analyst at NCD for 17 years. Dr. Hawkins was an extraordinary leader and advocate for equal opportunity, full participation, and the empowerment of young people with disabilities around the world. Her vision and spirit live on in this report.

Acknowledgments

Contents

List of Acronyms

ACA	Affordable Care Act
ACL	Administration for Community Living
ADA	Americans with Disabilities Act
AT	assistive technology
BEP	U.S. Bureau of Engraving and Printing
CMS	Centers for Medicare and Medicaid Services
CRPD	United Nations Convention on the Rights of Persons with Disabilities
CRT	complex rehabilitation technology
CVAA	Century Communications and Video Accessibility Act
DME	durable medical equipment
DOE	U.S. Department of Energy
DOJ	U.S. Department of Justice
DOL	U.S. Department of Labor
EHR	electronic health record
ESEA	Elementary and Secondary Education Act
FAC	Federal Advisory Committee
FCC	Federal Communications Commission
FDA	U.S. Food and Drug Administration
GPII	Global Public Inclusive Infrastructure
HHS	U.S. Department of Health and Human Services
HIT	health information technology
HOH	hard of hearing
ICT	information and communication technology
IDEA	Individuals with Disabilities Education Act
IEP	individualized education program
IoT	The Internet of Things
JAN	Job Accommodations Network
MVT	Marrakesh Treaty to Facilitate Access to Published Works for Persons Who Are Blind, Visually Impaired or Otherwise Print Disabled
NCD	National Council on Disability
NIDILRR	National Institute on Disability, Independent Living, and Rehabilitation Research
NIH	National Institutes of Health
NPRM	Notice of Proposed Rulemaking
NSF	National Science Foundation
OMB	Office of Management and Budget

ONC	Office of the National Coordinator for Health Information Technology (HHS)
PEAT	Partnership on Employment and Accessible Technology
R&D	research and development
RCT	randomized controlled trial
RERCs	Rehabilitation Engineering Research Centers
STEM	science, technology, engineering, and mathematics
WAI	Web Accessibility Initiative
WCAG	Web Content Accessibility Guidelines
WebAIM	Web Accessibility In Mind
W3C	World Wide Web Consortium

Executive Summary

The National Council on Disability (NCD) recognizes that technology is essential to the full realization of citizenship for people with disabilities. Yet our society has not evolved to the point where this population uses technology to the extent needed to enjoy the rights of full citizenship, as recognized by the Constitution. As technology continues to evolve at a rapid pace, it is important to consider factors that can facilitate or impede technology adoption and use by people with disabilities. Thus, NCD has committed the 2016 *Progress Report* to technology. The report focuses on information and communication technology (ICT) but also addresses other forms of assistive technology. To encourage the use and access of technology among all members of society, NCD proposes a Technology Bill of Rights for People with Disabilities.

The 2016 *Progress Report* begins by offering insight on how technology can contribute to the lives of people with disabilities in the areas of education, employment, health and well-being, and independent living. Although the report is limited to these four broad topics, many of the principles described in this report can be applied across different settings. Next, the report identifies and describes common barriers that interfere with the ability of people with disabilities to use ICT and ICT-related

assistive technology. The report then looks to the future of technology. It identifies how people with disabilities, the technology industry, and others can capitalize on the opportunities that accompany emerging and innovative technologies to maximize daily functioning. Federal legislation and international policies that can impact how people with disabilities can benefit from technology are addressed next. Finally, the report offers recommendations to the President, Congress, and federal agencies; the technology industry; and other private and public sector entities on policies and practices that promote opportunities for people with disabilities to experience the full realization of citizenship with the use of technology.

A summary of recommendations to promote the full rights of citizenship through accessible technology follows.

Recommendations for the President, Congress, and federal agencies:

- Congress should establish a Technology Bill of Rights for People with Disabilities that identifies principles to be used for any future technology legislation and clarifies that the current landscape of laws, regulations, and Executive Orders establishes a right to accessible and inclusive technology and ensures equal and fair access for Americans

with disabilities to existing and emerging technology and related services.

- The U.S. Department of Justice should initiate rulemaking that reinforces in plain language that the Americans with Disabilities Act (ADA) relates to the Internet.

- Federal agencies such as the U.S. Department of Justice, the Access Board, and the Office of Management and Budget should immediately finalize and issue any outstanding regulations regarding accessibility to ICT.

- Federal agencies should take aggressive steps to achieve and maintain compliance with Section 508 of the Rehabilitation Act.

- Congress should reauthorize the Individuals with Disabilities Education Act (IDEA) to provide greater access to assistive technology in all educational settings.

- Congress should identify and authorize federal units to develop and implement a funding stream to provide partial or full reimbursement for people with disabilities who rely on technology to enhance functional performance in education, employment, health, community living, and other settings.

- Congress should reauthorize the America COMPETES Act to include language that incentivizes agencies to incorporate a focus on outcomes for, or partnerships with, people with disabilities into the judging criteria.

- Congress should make greater research and development (R&D) investments

that promote accessible information and communication technology (ICT), assistive technology, and future innovations.

- Relevant federal agencies should issue regulations that support engaging people with disabilities in leisure and daily living activities.

- The Senate should provide its advice and consent to the President to support the ratification of the United Nations Convention on the Rights of Persons with Disabilities (CRPD) and the Marrakesh Treaty to Facilitate Access to Published Works for Persons Who Are Blind, Visually Impaired or Otherwise Print Disabled (MVT).

Recommendations for the technology industry:

- Apply Web Content Accessibility Guidelines (WCAG) 2.0 Level AA standards when designing websites and web-based software.

- Engage people with disabilities to participate in user experience research when developing new technology.

- Provide technology developers with ongoing professional development on accessible design.

- Expand training opportunities and information resources to educate consumers on how to use access features to enhance the user experience with technology devices.

- Make greater investments in R&D of accessible technology.

Recommendations for the private sector and local and state public sectors:

- All sectors should establish and implement procurement criteria and procedures that ensure the acquisition of accessible technology.

- All sectors should ensure that technology used by job candidates and employees is accessible to people with disabilities.

- All sectors should access federally funded resources such as the Partnership on Employment and Accessible Technology (PEAT) and the Job Accommodations Network (JAN) for guidance on assistive and accessible technology in the workplace.

- Local education agencies and institutions of higher education should assess science, technology, engineering, and mathematics (STEM) curricula to identify and correct accessibility barriers that would preclude participation among students with disabilities.

- Local education agencies and institutions of higher education should include learning standards related to accessible design in all STEM curricula.

- State health and human services agencies should provide support to the health care industry so that it can implement the final rules of the nondiscrimination requirements in health programs and activities reflected in Section 1557 of the Patient Protection and Affordable Care Act (ACA) and the U.S. Access Board standards for accessible medical diagnostic equipment.

- State health and human services agencies should incentivize insurers to increase coverage for additional habilitative and rehabilitative services and devices beyond those covered by the essential health benefits and the benchmark plan.

> Technology that enables access to
> the full opportunities of citizenship
> under the Constitution is a right.

(Official White House photo, used with permission)

Introduction

Background

Technology that enables access to the full opportunities of citizenship under the Constitution is a right. This is reflected in federal legislation such as the Americans with Disabilities Act (ADA); the Individuals with Disabilities Education Act (IDEA); the Rehabilitation Act of 1973, as amended (Rehabilitation Act); the Patient Protection and Affordable Care Act (ACA); the 21st Century Communications and Video Accessibility Act (CVAA); and a series of technology-related laws. Major improvements in the accessibility of technology have occurred through the efforts of government, industry, advocacy groups, and people with disabilities themselves. These efforts promote access to education, employment, health care, and independent living opportunities among this population. Nonetheless, many people with disabilities continue to face barriers accessing the Internet, enjoying media, and engaging in other forms of technology. A number of factors contribute to these barriers, such as the complexity and lack of training to enable use, limited resources committed to innovation, and cost. In addition, the implementation of regulations that guide access standards often lag behind the rapid pace of technology, which can interfere with technology access.

The barriers that people with disabilities face in accessing technology are especially troubling because technology has the potential to transform how this population lives in a society designed for those with no functional differences. These barriers limit the ability of people with disabilities to participate in and contribute to society by reducing options to access important services that are available to people without disabilities. By expanding access to technology to everyone, people with disabilities will be able to take advantage of services that are intended to enhance the lives of all people in our society.

Making technology accessible to people with disabilities will not only make our society more inclusive but will also serve to maximize the potential ability of a powerful but often excluded population to contribute to society. For example, technology can improve educational experiences, facilitate job tasks, provide better health care, and facilitate independent living. Additionally, technology that benefits people with disabilities benefits the larger society. For example, closed captioning, originally instituted for those who are Deaf and hard of hearing (HOH), benefits hearing people in noisy venues such as airports, health and fitness clubs, and restaurants. In addition, accessible technology can help information and communication technology (ICT) companies remain competitive in the global marketplace (Econometrica Inc. 2015).

People with disabilities are a part of mainstream America. ICT is essential to how mainstream society functions. Whether it be computers, smartphones, kiosk machines, or the Internet, ICT serves as a gateway to activities such as learning, working, staying in touch with family and friends, purchasing products and services, facilitating travel, keeping up-to-date with world events, and enjoying entertainment. The use of ICT to access and perform such activities has become so ingrained in our society that it has become a need and an expectation. It is a way of life that many people experience without a single thought. Because of the daily reliance on ICT to perform a myriad of tasks, it is essential that people with disabilities have access to the same technology. Many people with disabilities also rely on assistive technology to enhance functional performance. Assistive technology can manifest in multiple formats, such as orphan technology that is highly specialized and used by a small population of people with disabilities (Seelman 2005); specialized hardware and software that work with technology designed

for the masses to provide access for people with disabilities; and mainstream ICT that contains accessibility features, coincidentally or by design. For example, a tablet, which is a commonly used ICT device, may serve as assistive technology when someone who is nonverbal uses the built-in speech-to-text capability to facilitate communication. Prosthetic technology is an example of orphan technology that can be used by those who have lost a limb to enhance physical functioning. Screen readers are an example of a common assistive technology that converts written text to audio output.

Technology that enables access to the full opportunities of citizenship under the Constitution is a right. Disability is a natural part of human diversity that requires adjustments in social, cultural, informational, and physical spaces to enable people to enhance specific functional performance and fully engage in society. In many cases, these adjustments may include technology. As a forward-thinking body, NCD is concerned not only with the rights of people who live with disabilities today but also with the rights of people who will transition into disability in the future because of injury or a medical condition. As our technology-dependent society grows older, this report is also relevant to those who will live long enough to age into disability.

Despite existing legislation that serves to preserve these rights, there is an urgent need for a Technology Bill of Rights that will recognize the role technology plays in enabling full citizenship. A recognition of the body of technology rights enshrined in one place could serve as a central resource for people who currently experience disability, and for those who will transition into disability, to understand the rights that are guaranteed to them by federal legislation. It would also function as a resource for all levels of

government, the technology industry, businesses that serve the public, employers, educators, and even people with disabilities to understand their role in promoting technology that enables people with disabilities to engage in full citizenship.

The 2016 NCD *Progress Report*

NCD affirms the need for a Technology Bill of Rights for People with Disabilities. This need is reflected throughout the 2016 *Progress Report*, which places an emphasis on ICT and assistive technology, much of which may be used in conjunction with mainstream ICT to facilitate access. Combined or used separately, these technologies maintain or increase functional performance. Without accessible ICT and assistive devices, it is virtually impossible for many people with disabilities to benefit from all that society has to offer, and to contribute to society as well. Furthermore, it is crucial to emphasize that ICT devices and platforms should be *born accessible*—or accessible from their inception—and not merely retrofitted to meet the needs of people with disabilities.

The 2016 *Progress Report* benefits from input from youth and young adults with disabilities, most of whom were born into a digital society. NCD solicited this perspective via a crowdsourcing activity that involved a Twitter chat. This crowdsourcing activity generated more than 500 original and retweeted responses to questions about technology and people with disabilities. Select responses from participants of the Twitter chat appear throughout the report to illustrate the role that technology plays in the lives of people with disabilities. A synthesis of the Twitter chat appears in Appendix A.

The 2016 *Progress Report* updates the White House and Congress on policy issues related to people with disabilities and technology. However,

NCD expects the 2016 *Progress Report* to also resonate with people with disabilities who need accessible ICT and assistive technology to facilitate participation in daily life activities. It is also NCD's hope that people outside of the disability field will use this report to understand how their professional practices may have a positive or negative impact on the lives of the 56 million Americans with disabilities (Stoddard 2014). For example:

- Federal policymakers may use the 2016 *Progress Report* for guidance on reauthorizing existing legislation and initiating and supporting partnerships, which aim to reap the benefits of advancements in technology accessibility through the development of technology innovation.

- The technology industry (both mainstream technology and assistive technology) may use this report to gain a better understanding of the needs of people with disabilities who rely on accessible technology and the needs of their customers in the public and private sectors who have a legal responsibility for providing accessible technology.

- Professionals in the public and private sectors may use the 2016 *Progress Report* to understand how technology can support and provide new opportunities for the stakeholders with disabilities whom they serve and employ. It also offers insight to those working in the public and private sectors on their legal obligations to provide accessible technology.

A glossary of terms is provided in Appendix B to offer clarification on how the 2016 *Progress Report* uses terms that may be unfamiliar to some readers.

Chapter 1. Improving the Lives of People with Disabilities with Technology

This chapter illustrates technology's potential to contribute to education, employment, health and well-being, independence, and activities of daily living. The number of topics of importance regarding technology and people with disabilities extends far beyond the reach of this report. Thus, these topics are only intended to help illustrate the need for accessible and inclusive technology. NCD's website contains a comprehensive list of topic areas that readers can reference to learn more about issues that affect the lives of people with disabilities.

Education

NCD recognizes that technology has the potential to equalize access to education opportunities for students with disabilities, contributing to independent, productive, prosperous, and fulfilling lives. Despite advancements in education policy and enhanced opportunities to access education, students with disabilities continue to face educational disparities and barriers to full and meaningful participation in learning (Wahl 2016).

Tech such as #Braille displays and screen readers helps our members live the lives they want at home, school, work, & play.
—Twitter Chat Participant

These students constitute approximately 13 percent of public school children and, in the 2012 to 2013 school year, they had a high school graduation rate of 62 percent compared with a national graduation rate of 81 percent of all students (inclusive of students with and those without disabilities) (Diament 2015). In the realm of higher education, approximately 11 percent of undergraduate students report having a disability (Kena et al. 2016). Among students with learning disabilities, 94 percent of those in high school receive support, but only 17 percent of those in college receive support. Only 34 percent of these students graduate with a four-year degree within eight years after completing high school, compared with 56 percent of those without learning disabilities, who graduate with a four-year degree within six years after graduating from high school. It is important to note that many students with invisible disabilities such as learning disabilities choose not to disclose this information to their institutions and thus do not receive the support services that may be available to them (Lightner, Kipps-Vaughan, Schulte, and Trice 2012).

Just as the Individuals with Disabilities Education Act (IDEA), Section 504 of the Rehabilitation Act, and the Americans with Disabilities Act (ADA) opened the physical doors to colleges, universities, schools, and classrooms for students with disabilities, technology can provide access to the actual content of instruction in ways that were not formerly possible. For example, speech-to-text software and digitization of text provide access to education curricular materials for students who are blind or visually impaired and for those who have a specific learning disability and cannot effectively read printed materials. NCD's crowdsourcing activity illustrates this point, which asked youth and young adults with disabilities about their experiences with accessible technology. Multiple respondents noted that they could not have reached their level of educational attainment without access to assistive technologies such as text-to-speech software and braille display.

Individualized assistive devices are not the only way that technology has impacted students with disabilities. Today, technology has been incorporated into everyday lessons and classroom experiences for all students throughout schools. More specifically, the use of educational technology is particularly beneficial for students with disabilities because it often offers students additional ways to both engage with information and communicate to instructors what they have learned. In traditional classroom settings, educators are increasingly using

> *Technology has given me a voice. Because I cannot "speak verbally" it helps the world hear AND value my voice! Technology has given me not just a voice, but a venue to share my knowledge with others, reflect and react.*
>
> *—Twitter Chat Participant*

adaptive learning software to teach discrete skills by using information gathered through integrated formative assessments of student knowledge and understanding. When using these systems, students log into their individual accounts and are presented with content in a format and at a pace matching their individual needs. The teacher is able to monitor each student and circulate in the classroom, providing individualized support. These programs help to create a seamless experience for students with different learning needs by collecting data on their progress and adjusting the content according to their needs. Other examples of technology that supports better integration of students with disabilities into the classroom involve cloud computing services. These web-based programs enable collaboration among peers, provide options for private communication with teachers, and offer toolbar add-ons to present the information in accessible formats. Students who may have previously been removed from general education classrooms can now receive similar types of supplemental or modified instruction, spend more of their time with peers, and be included in the general classroom environment.

In addition to programs that can be used in a whole-classroom setting, there are a number of widely available educational games that have been developed specifically to teach social and emotional skills to students with disabilities. Given estimates that 75 percent of students with learning disabilities have difficulties with

Official White House photo, used with permission.

social skills and almost one-third need additional social skills training past high school, social skills instruction is especially important for students with disabilities (Center for Implementing Technology in Education n.d.; Elksnin and Elksnin 2003). Virtual environment technology and simulations can be helpful in providing students with disabilities such as autism with opportunities to practice social interactions.

Recent advances in robotics enable students who cannot physically attend school to participate virtually. This is made possible through the use of a simple robot that is, in essence, a tablet enabled with two-way video capabilities and Internet access, mounted on a remote-controlled motor. This robot streams two-way video between a home-based student and the classroom, and the student controls the robot's mobility through an application (app). This enables the student to stay connected socially, as he or she remotely traverses the halls with peers. The mobility of the devices also means that the virtual experiences are not limited to one classroom or teacher with specialized equipment; the student has the opportunity to participate in the full academic and social experience.

Emerging technologies can be very beneficial to students with disabilities, but there are barriers to their access and use. It is important to consider whether computer programs intended to support learning and skill development are compatible with assistive technologies such as screen readers or include captioning for all audio elements so that they can be accessible for

students with sensory disabilities. Furthermore, the costs and parties responsible for paying for technology in the education setting must be considered. Section 504 of the Rehabilitation Act requires colleges and universities to provide reasonable accommodations to students with disabilities, which includes auxiliary aids and services, unless doing so would fundamentally alter the nature of the educational services provided or if it would cause an undue financial or administrative burden on the institution. IDEA stipulates that assistive technology should be considered for students with disabilities by the individualized education program (IEP) team to ensure that these students receive a free and appropriate education. Sections 300.5 and 300.6 of the IDEA defines assistive technology as "any item, piece of equipment, or product system . . . that is used to increase, maintain, or improve the functional capabilities of a child with a disability." This is a wide and subjective definition, and its intent is dependent not only on the diagnosis and needs of the child but also the IEP team's personal and professional opinions.

Defining what assistive technology is in an IEP is important because IDEA requires that schools, not families, are responsible for making assistive technology available when it is required as a part of students' special education services, related services, or supplementary aids and services (Section 300.105, Individuals with Disabilities Education Improvement Act of 2004). Limited provisions exist to enable a student to use devices at home, but the family does not own any device provided to a student.

Being able to afford technology after school into graduate school was a big hurdle.

—Twitter Chat Participant

Therefore, when a student transitions to a different school district, or to postsecondary settings, the student is not entitled to bring the device with him or her. Some families may not have the financial ability to purchase such devices. Among youth with disabilities between ages 15 and 24, more than 50 percent report that they do not have all the assistive devices that they need, and 25 percent do not have any device (Lindsay and Tsybina 2011). This can impede a student's future success in college, training programs, and careers, and ultimately their ability to live independent lives. As the various ways technology can be used to enable students with disabilities to access education continue to advance and change, how students and families receive funding for assistive devices is an area of policy and practice that will need to be adjusted and updated. For example, although Title V of the Elementary and Secondary Education Act (ESEA) of 1965 provides funding to school districts to pay for technology (U.S. Department of Education n.d.), low-income students, schools, and districts would benefit from greater opportunities to use ESEA Title I funds to enhance access to assistive devices during transitional periods.

Science, Technology, Engineering, and Mathematics (STEM) Education

Technology is important for improving the lives of people with disabilities on two important levels. First, technological products and advances enable students with disabilities to have equitable educational opportunities to students

without disabilities. As a result of labor market predictions and labor shortages in science, technology, engineering, and mathematics (STEM) fields, efforts have been under way to increase all students' mastery of and interest in STEM education. Just like their peers without disabilities, students with disabilities should have the 21st century education that provides them with the STEM expertise and skills to compete for these jobs. Second, the availability of accessible ICT and assistive technology that provides equitable opportunities for students with disabilities is itself dependent on innovation in the STEM fields.

Advancements in STEM fields are directly related to the development of many of the assistive technology tools that are available, yet people with disabilities are significantly underrepresented in STEM industries. Although 23 percent of undergraduate students with disabilities are enrolled in STEM majors, roughly on par with enrollment rates of students without disabilities, these students represent only 7 percent of people pursuing graduate-level STEM degrees and only 1 percent of those earning doctoral degrees in STEM fields (NSF 2009).

Laboratory experience and course work are critical to the science and engineering fields. Distance learning and virtual classrooms have enhanced opportunities for students to access STEM education, but they are rare. One example of a fully accessible science classroom environment is the Accessible Biomedical Immersion Laboratory at Purdue University. The Accessible Biomedical Immersion

The need for PWDs [people with disabilities] to be leading the experience, coding, and engineering of technology is huge.
—Twitter Chat Participant

Laboratory is a biology wet lab created specifically for making science careers more attainable for people with disabilities (Kline 2013). The lab features adjustable workstations and signage for people who have low vision or are blind. The lab was designed using Unity, software that has been used to create immersive environments and is frequently used in building computer games. A virtual tour of the Accessible Biomedical Immersion Laboratory is also available online and can serve as a model for other science labs that will include an accessible design. Despite this example, it is important to note that many laboratories are not accessible to people with disabilities.

Simply encouraging students with disabilities to study STEM fields is not enough to enhance educational access and opportunity. Just as students benefit from both using and learning to develop technology, they will benefit from both engaging in STEM fields in general and exploring STEM concepts from a perspective that focuses specifically on how STEM can be used to further improve the lives of people with disabilities. To accomplish this, STEM curriculum should cover topics that address inclusiveness and accessibility to encourage students to develop technology that is *born accessible*. The U.S. Department of Labor's (DOL) Office of Disability Employment Policy recognizes this as an important approach, as reflected in its support of the Benetech initiative, the DIAGRAM Center. This Center advances the digital imperative that any content that is "born digital" can and should be "born accessible"

(Diagram Center n.d.). STEM curriculum should also prepare students to develop assistive and rehabilitative technology. Including these topics in the curriculum brings about awareness among people without disabilities and empowers students with disabilities to apply what they are learning in a manner that improves accessibility for themselves and others. The Computer Science for All initiative aims to increase access to computer science courses and STEM education among all students, with special attention to those from underrepresented backgrounds. The initiative is supported by the National Science Foundation (NSF), U.S. Department of Education, and other private/public partnerships, and offers great promise to infuse access issues throughout STEM curricula. This initiative has the potential to ensure that students with disabilities can participate in computer science and other STEM curricula and to teach students enrolled in these classes about the importance of accessible design when developing new technology (U.S. Department of Education 2016).

Learning does not stop after secondary or even postsecondary school. With ever-increasing opportunities for learning across the lifespan, it is important that people with disabilities have access to technology that supports their particular learning needs both during transitional periods and as they enter the workforce. This includes retaining technology when transitioning to middle school or high school, which falls within the scope of IDEA, and accessing reasonable accommodations in higher education and beyond, which is outlined in Section 504 of the Rehabilitation Act and in the ADA. Students should also be able to retain technology as they transition from one school district to another,

from high school to postsecondary education, and then to employment to support ongoing professional learning.

Employment

Accessible ICT and assistive technology in the workplace can promote economic self-sufficiency through inclusion in employment. As early as 1993, people with disabilities reported the benefits of assistive technology in helping them earn more money, perform work better and more quickly, and find employment (Stumbo, Martin, and Hedrick 2009). The Federal Government funds the Partnership on Employment and Accessible Technology (PEAT) to support employers, IT companies, and others to understand the benefits and process of building and purchasing accessible technology.

Connecting to Employment Opportunities

Before a person can benefit from technology in the employment setting, it is important to consider issues of access and inclusion in the workforce long before the job begins. For employers, this inclusion starts with a commitment from the outset—during the application development and recruitment efforts. For job seekers, the need for accessible technology begins even before the application process, starting with the job search, résumé development, and other preparatory steps.

The advent of accessible online job search engines and apps has enhanced the ability of people with disabilities to search and apply for jobs. Applying for a job online and virtual interviewing enables people with observable

disabilities to choose when to disclose their disability. There are a number of resources, such as abilityJOBS (abilityJOBS n.d.), that focus specifically on connecting employers with job seekers with disabilities. Employers benefit by having access to a targeted population of potential new hires to meet their various business needs. Further, these resources afford federal contractors a pool of candidates, amongst other benefits, to consider as they respond to Section 503 regulations that aim to enhance hiring practices for people with disabilities. Job seekers benefit because these platforms are accessible and offer a safe space to highlight their contributions to a company without the fear of stigma. Virtual recruiting fairs, such as those offered through Bender Consulting Services (Bender Consulting Services n.d.), target people with disabilities and allow job seekers to enter their résumés into a database and participate in text-based or video chats with potential employers.

For those interviewing in person, technology can play a major role in facilitating the early steps in the employment process. Applying for a job can be stressful, particularly for a person with a disability who is anxious about facing stigma in an interview process. An in-person interview can also be challenging for people with communication disabilities. Certain types of software can help to alleviate that stress and encourage people to pursue employment. The Dan Marino Foundation has developed ViTA DMF, a virtual environment that allows people to practice interview and conversation skills critical to obtaining and maintaining employment (ViTA DMF n.d.).

The broader use of text messaging/chat at work means more access for Deaf/HOH workers
— Twitter Chat Participant

Workplace Information and Communication Technology (ICT)

Regardless of whether a person is teleworking or working from a traditional office space, the ability to communicate is essential for all forms of employment. The CVAA expands protections to provide accessible ICT delivered via broadband, digital, mobile, and other devices and apps (Federal Communications Commission [FCC] 2016). Access to such technologies can be essential for enabling, for example, people who are Deaf and HOH to participate in teleconferences.

The benefits of technology extend to people with disabilities who are entrepreneurs. As one person shared during crowdsourcing activities conducted for this report, social media and digital editing tools made work as a freelance photographer more feasible. This person was able to connect readily with customers through the Internet and could use digital tools to access and edit pictures instead of having to navigate photography development labs.

Accessible technology can be essential for people with disabilities who want to pursue entrepreneurship in this digital age. There has been an increase in automation of positions in industries such as service, manufacturing, and sales, reducing employment positions held by some people with disabilities. However, new opportunities have emerged with the "gig" economy. Gig employment involves work that is contracted out, usually for short-term engagements. For example, Uber, TaskRabbit, and Airbnb connect customers with a short-term service on an as-needed basis. By 2020,

40 percent of American workers are expected to be part of the "gig economy" (Weber 2014). This option provides greater flexibility for people with disabilities who must work part-time or in shorter shifts. Gig jobs can also provide income when more traditional jobs are hard to find. These jobs usually focus on whether a person can perform the specific task and may be easier to obtain for people with disabilities than traditional careers. Although gig jobs offer opportunities for people with disabilities to secure meaningful work, there are limitations to consider. Potential drawbacks include no health care benefits, inconsistent income, risk of losing Social Security benefits, and ambiguity in the application of laws that address employment such as the ADA.

Workplace Options

Accessible ICT and assistive technology enable people with disabilities to execute their job tasks and promotes equitable access to employment opportunities as required by the ADA. From a corporate standpoint, supporting accessible and assistive technology could become a hiring differentiator. *Fortune* magazine (Clancy 2014) highlighted a Utah-based company, TCN, which added features to its cloud-based service that enabled businesses to include employees who have visual impairments in customer support roles. This was made possible by connecting the company's Windows® operating system with the Job Access With Speech (JAWS®) screen reader, sold by Freedom Scientific. The rollout of this connection took only a matter of hours. Accessible technological tools used by

Telecommuting allows people to be part of the team when circumstances don't make that possible.

—Twitter Chat Participant

today's workforce could positively impact all workers—improving productivity and satisfaction among employers as well. Data from a 2015 Job Accommodation Network survey described one company that purchased a communication device that enabled a computer technician who was experiencing hearing loss to communicate better with coworkers (Job Accommodation Network 2015). The communication device included a microphone and tablet that transcribed utterances of coworkers to text and used a speech-generating device when needed. Despite the cost of the accommodation, the employer reported that the device enabled the employee to communicate more effectively—an essential part of relationship building and effectiveness on the job. People with disabilities, employers, and the public all benefit when people with disabilities are fully included in the workplace.

Full inclusion in the workplace does not always require a physical location. As cloud computing, videoconferencing, and other virtual collaboration tools have become ubiquitous in the workplace, instances of teleworking have also increased. Regular instances of teleworking among the population of those who are not self-employed have grown by 103 percent since 2005, and 80–90 percent of the U.S. workforce reports that they would like to telework at least part time (GlobalWorkplaceAnalytics.com n.d.). Teleworking is of particular benefit for people with disabilities who have inadequate access to transportation or limited ability to travel (Institute of Medicine 2007). Technology that enables people with disabilities to work from home, therefore, is not

always a matter of simple convenience as it is for people without disabilities. The crowdsourcing activity that informed this report generated comments about how technology for telework is critical to employment success among many people with disabilities.

Some participants commented that even having the option to telework a few days a week has saved hours and energy they otherwise would have had to spend on a commute, enabling them instead to channel that energy into their jobs. It is important to note that not all people with disabilities may want to telework. Some people with disabilities have reported feeling isolated during telework, and providing the option to telework only for people with disabilities can increase stigma if it is perceived as preferential treatment by other employees (Tompa et al. 2015). Telework should also not be used in place of providing appropriate workplace accommodations.

Although mainstream technologies such as cloud computing and mobile devices support enhanced job functioning, the one-size-fits-all technology available in mainstream markets is not always sufficient for enabling full integration of people with disabilities into the workforce. The use of these communication technologies is essential for many job functions, and without the adoption of standards for making ICTs accessible, people with disabilities will experience unequal access to the information and resources they need to compete in the workplace. In addition, interoperability challenges plague both people with and without disabilities. Identifying ways to ensure that assistive technology works with existing employer systems would provide more seamless workplace integration for people with disabilities.

People with disabilities may also face stigma in the workplace for using assistive and other forms of technology that support job functions. This stigma may center on concerns regarding device aesthetics, gender and age appropriateness, and social acceptability (Parette and Scherer 2004). Wider acceptance of the use of mobile devices such as tablets and smartphones in workplaces as well as assistive device integration would enhance the ability of people with disabilities to work effectively.

Reducing employment discrepancies among people with disabilities requires the removal of barriers at each stage of the employment process. Civil rights laws and technological advances have done much to level the playing field for people with disabilities. However, much work is left to be done as people with disabilities continue to face barriers to employment. People with disabilities attend college at rates similar to those of people without disabilities but graduate at lower rates, have far lower rates of employment, and are overrepresented in low-paying jobs (U.S. Department of Labor 2014). They are overrepresented in 17 of the 20 fastest declining occupations and underrepresented in 16 of the 20 fastest growing ones (U.S. Department of Labor 2014). Further, since the ADA was signed in 1990, the employment gap between people with and without disabilities has widened (Yin and Shaewitz 2015). As discussed earlier, technology can broaden access to the educational and learning opportunities that can prepare people with disabilities for a range of employment opportunities such as those in the STEM fields, while also enabling them to take on job roles that may have previously been inaccessible. This enables people with disabilities to share their talents and expertise with many

employers, organizations, and other people who need them.

Health and Well-Being

Health and wellness can look different from person to person, according to culture, interests, ability, race, and myriad other factors. To support these differences among people with and without disabilities, access to health care professionals and appropriate devices to diagnose and support health are critical. Communication technology and advances in engineering have been particularly important in helping people with disabilities access the services that support their health and wellness.

Health Information Technology and Electronic Health Records

The U.S. Department of Health and Human Services' (HHS) Office of the National Coordinator for Health Information Technology (ONC) defines health information technology (HIT) as the application of information processing involving both computer hardware and software that deals with the storage, retrieval, sharing, and use of health information for health care (HealthIT .gov 2013). HIT includes not only traditional technologies such as electronic and personal health records, but also mobile and telehealth technology, cloud-based services, medical devices, remote monitoring devices, and assistive technologies. HIT is important for people with chronic and complex conditions (such as people with disabilities) to support self-management, health monitoring, care coordination, self-directed learning, and patient-clinician communications. Evidence suggests that HIT-supported self-care can reduce costs, improve health outcomes, and increase patient satisfaction.

For HIT to deliver its potential for all Americans, including people with disabilities, older adults, and family caregivers, the technology must match the needs of users with a wide variety of limitations and impairments. Resources such as Early Innovator grants provided through ACA created funding to help states build HIT infrastructure for the health insurance marketplace. Other efforts to promote the adoption of HIT include the "meaningful use framework" developed by ONC. The meaningful use framework requires that a health care provider must show that they are "meaningfully using" their certified electronic health record (EHR) technology in order to receive EHR incentive payments from Medicare or Medicaid. Therefore, meaningful use criteria must include factors, such as accessibility, that are important to people with disabilities. Implementation of the meaningful use framework by eligible health care providers has occurred in three stages, with stage 1 implementation required between 2011 and 2014 (Centers for Medicare and Medicaid Services 2010), stage 2 implementation required between 2014 and 2016 (Centers for Medicare and Medicaid Services 2012), and stage 3 implementation required by 2017 and beyond (Centers for Medicare and Medicaid Services 2015).

As more people use the Internet and smartphones as their primary interfaces for HIT, ICT developers can use guidelines developed by the U.S. Access Board and the Web Accessibility Initiative as a model for making smartphone and other HIT technologies accessible. Finally, further support of reimbursement for HIT services will open business opportunities for providing HIT services for people with disabilities. Support of HIT development, accessibility, and usability

can potentially improve the lives of people with disabilities by providing the necessary platform for many of the technologies described below.

Telemedicine and Telerehabilitation

The American Telemedicine Association defines telemedicine as "the use of medical information exchanged from one site to another via electronic communications to improve patients' health" (American Telemedicine Association n.d.). In practice, this can encompass a teleconference with a health care provider, people using the Internet to find specialized health information or receive peer support, and using devices in patients' homes to monitor such health measures as blood glucose or vital signs remotely. During the crowdsourcing activity conducted for this report, participants shared ways that they were able to leverage social media and mobile apps to take control of their health. One participant stated that technology had improved her health by enabling her to connect with other women with her disability, which reduced her feelings of isolation and enabled her to know what to expect as she aged. Mobile apps have also enabled all people, including people with disabilities, to track their own medical issues, centralize their health information, and direct their health care better. For example, fitness apps have been widely used to enable people to keep track of their physical activities and calorie intake, and many health care providers offer mobile health portals where personal records and doctor information are located. Virtual doctor consultations are

Using applications to track my health from exercising to my "female" stuff. I have "proof" of issue and progress for my doctor visits.
—Twitter Chat Participant

particularly beneficial to people with disabilities who experience limited mobility or who for other reasons find it burdensome to travel to a medical facility. Physician-rated quality of care was also shown to be higher for patients who received consultations with telemedicine than for patients who received either telephone or no consultation. Telemedicine was also associated with more frequent changes in diagnostic and therapeutic interventions and higher satisfaction than were telephone consultations (Dharmar et al. 2013). Telemedicine, along with patient web portals and mobile medicine, was shown to be a promising practice in supporting diabetes-related health outcomes for socially disadvantaged populations (eHealth Initiative 2012).

The American Telemedicine Association Telerehabilitation Special Interest Group defines telerehabilitation as the "delivery of rehabilitation services via information and communication technologies" (Brennan et al. 2010, 31). This covers the range of rehabilitation and habilitation services including, but not limited to, assessment, monitoring, prevention, intervention, supervision, education, consultation, and counseling. The term *telerehabilitation* is broad, referring to many disciplines and settings. Telerehabilitation services can be provided in health care settings, clinics, homes, schools, and community-based workplaces. It can also refer to specific rehabilitation and habilitation disciplines such as speech pathology (telespeech) or occupational therapy (teleOT). Telerehabilitation has shown improved access to services, increased cost-effectiveness, efficient provision

of services, and access to specialist consultation as needed (Mashima and Doarn 2008). People with disabilities also report high satisfaction with telerehabilitation services (Lopresti, Jinks, and Simpson 2015).

During crowdsourcing activities, multiple stakeholders commented that technology had enabled them to communicate more effectively and directly with their health care providers, to direct their own health care better, and to receive better medical care. Multiple participants suggested that ICT could be leveraged to provide people with disabilities with better access to mental health professionals

> *I think the technology has allowed people to create a medical home and centralize their health information.*
>
> *—Twitter Chat Participant*

and care. Provider concerns about privacy with the use of HIT and telemedicine are discussed further in Chapter 3.

Telemedicine and the use of HIT have particular application to the growing percentage of the country that is aging and experiencing disabilities as they age. The Centers for Disease Control and Prevention reported that more than one-quarter of all Americans and two out of every three older Americans have multiple chronic conditions and that treatment for this population accounts for 66 percent of the country's health care budget (Centers for Disease Control and Prevention 2013).

Using the latest communications technology empowers health care providers with the knowledge and resources they need to treat these patients and helps engage patients more in their own care.

Using HIT effectively can also reduce long-term costs for health care providers. The U.S. Department of Veterans Affairs reported 20 percent reductions in use of urgent care or emergency room visits when care coordination and remote in-home telemonitoring were employed (Darkins et al. 2008). States that participated in HIT reforms to improve care coordination and access using ACA funding saw economic benefits and improved patient health outcomes (Connecticut General Assembly n.d.).

Increased federal investment in expanding access to broadband technology and initiatives to help low-income households afford broadband technology will be essential to the future success of HIT. Twenty-one percent of physicians reported that the lack of broadband capability was a barrier to their use of telemedicine. Approximately 55 percent of rural areas had broadband, compared with 94 percent of urban areas (Neville 2015). Only 47 percent of households with incomes below $25,000 had broadband services (File and Ryan 2014). The costs of a subscription for broadband service and computer equipment have been identified as barriers to broadband adoption for people with low income (U.S. Government Accountability Office 2015). Increased access to HIT must also be tempered with concerns about the privacy of patients. As health records become more digitized, it is imperative that privacy safeguards be reviewed and updated as necessary.

Would love to see more use of Skype-like communication with doctors and therapists.

—Twitter Chat Participant

Accessible Health Equipment and Medicare Reimbursement Program

Diagnostic medical equipment is a critical component of both preventive and ongoing care. However, diagnostic medical equipment was not initially constructed with people with disabilities in mind. In 2012, the U.S. Access Board released a proposed rule regarding the need to make medical diagnostic equipment—including examination tables, scales, and radiological equipment—accessible to people with disabilities. During NCD crowdsourcing activities, one participant specifically commented on how important accessible mammogram machines were to improving health for people with disabilities.

Exercise and cardiovascular health are also critical components of preventive health care. Accessible and adaptive public and home exercise equipment has the potential to improve health outcomes and could reduce health care costs.

The ability to be mobile and independent is critical to ongoing well-being. Engineering and technology advances have allowed for the building of mobility devices with customizable controls and supports, and these can greatly improve the experience of people with disabilities. Medicare is the gold standard by which most private insurance companies establish their own guidance for coverage and reimbursement. Medicare uses the term durable medical equipment (DME) to refer to the

equipment that it will cover. DME is equipment prescribed by a medical doctor that must be long lasting, used for a medical reason, expected to last at least three years, and is only to be used in the home. DME coverage can include blood sugar monitors, canes, manual or power wheelchairs, suction pumps, and walkers. Assistive technology, which focuses more on function than medical conditions, sometimes falls under Medicare's DME coverage. Still another challenge confronts providers and users of complex rehabilitation technology (CRT). CRT may be considered DME sometimes, but often requires broader services and specialized health care providers than is covered by DME. CRT includes products or services designed to meet the unique physical and functional needs of a person with a primary diagnosis resulting from a congenital disorder, progressive or degenerative neuromuscular disease, or certain types of injury or trauma. Although a person with a severe disability may need wheelchair accessories such as stand-up features, the Centers for Medicare and Medicaid Services (CMS) does not provide clear definitions to distinguish CRT from DME. Action is needed to enable all people with disabilities to have access to the necessary technology that will give them the ability to achieve equal access to opportunity, inclusion, and self-determination.

Independent Living

Many technological advances that are conveniences for people without disabilities are critical to the social integration and self-determination of people with disabilities. These advances are of particular relevance as people with disabilities transition from institutional settings into the community as a result of

Olmstead v. L.C., 527 U.S. 581 (1999). The Olmstead ruling required states to provide services to people with disabilities in the most integrated setting that meets their needs. To meet the requirements of the Olmstead ruling, some states have developed Olmstead plans, and other states provide services under Medicaid Home and Community-Based Services Waivers under Section 1915(c) of the Social Security Act. States may cover services such as case management, personal care, adult day health services, habilitation, and respite care under their Olmstead plans or their Home and Community-Based Services Waivers. Technological supports such as voice recognition software, screen readers and speech-for-text software, mobile apps, computers, and tablets are also essential communication tools for people with disabilities that can facilitate independent living. Together, these services and technologies support people with disabilities in their homes and/or communities instead of in institutional settings.

Smart Houses

When accessibility standards were introduced in the ADA, accessible homes were often conceptualized through wide hallways, ramps, grab bars, and the installation of features such as light switches and countertops at lower heights. These features can be invaluable to allow people with disabilities to move physically through a space, yet they are not sufficient to account for the wide range of functions performed as a part of daily living. For example, an extra wide front door and entryway do not make a home accessible to someone who uses a wheelchair but does not have the fine motor control required to unlock a door and operate a handle. A sitting room you can access through a wide hallway is

not comfortable if one is unable to adjust the temperature appropriately.

Advances in technology, however, have expanded how homes can be modified to allow people with disabilities to live independently. Homes can now be outfitted with remote controls and key fobs in place of metal keys. A number of apps allow people to connect the controls of their thermostats and security systems to mobile devices. There are now some houses on the market that are infused with technology that responds to the needs of people with disabilities. A smart home (or building) is one that is "equipped with special structured wiring to enable occupants to remotely control or program an array of automated home electronic devices by entering a single command" (TechTarget n.d.). The technology in these smart houses can be customized according to a person's functional needs. Door locks, garage door closers, and security systems can be programmed and controlled remotely. Some houses also include prompting systems to support independence. This type of system can check to see whether a variety of daily living activities have been performed and deliver customizable prompts, or reports, depending on the data. As a person's needs change across time, features and systems can also be changed.

Amazon Echo is an example of a device that has many of the features that are built into a smart home and can help people with vision, physical, and other disabilities perform tasks that may otherwise prove challenging. The device is a voice-enabled wireless speaker developed by Amazon that combines speech recognition, machine learning, and artificial intelligence to control several smart devices by using itself as a home automation hub. Amazon Echo is also capable of voice interaction; music playback; making to-do lists; setting alarms; streaming podcasts; playing audiobooks; and providing weather, traffic, and other real-time information (Business Wire 2015).

Mobile Apps

Apps designed specifically for people with disabilities are often available at no cost, and others are often available for only a few dollars. Although a travel app may serve as a basic convenience for most travelers, certain travel apps can be the determining factor in the ability of a person with a disability to travel independently. For example, apps like TripIt, TripCase, and WorldMate can collate travel information across thousands of websites to create one unified and accessible travel itinerary. This function could be critical to a traveler who is blind or visually impaired or to an autistic person or someone who has attention deficit disorder who may have limited managerial and organizational functions.

Apps can also be developed to meet very specific needs of people. For example, the U.S. Bureau of Engraving and Printing (BEP) developed EyeNote specifically as an aid for people who have a visual impairment to identify denominations of U.S. paper currency. The user positions a bill in front of a camera built into a phone or device. The app then scans the bill and

Social Media!! It [has] broken barriers and allowed access like never before! Connecting with others is easier than ever.
—Twitter Chat Participant

announces the bill's denomination in English or Spanish. EyeNote runs on the Apple iOS platform and is available at no charge (BEP n.d.). BEP collaborated with the U.S. Department of Education to develop a similar app for the Android platform called IDEAL Currency Identifier. IDEAL Currency Identifier is also available at no charge (Data.gov 2012). Although these apps can allow a person who is blind or has low vision to identify and organize paper currency without relying on support from others, it is important to note that only adjustments to tactile currency will provide people with disabilities equity in the handling of paper currency.

There are also a number of apps that support everyday communication. For example, video-relay services apps enable people who are Deaf and HOH to use a computer, tablet, or smartphone to place calls that are routed to an interpreting center. The caller is connected to an interpreter who is fluent in American Sign Language and English and appears on the device. The caller signs to the interpreter, who then calls the hearing user via a standard phone line and relays the conversation between the two parties.

Apps also can be used to support people with disabilities who have limited verbal functionality to communicate their thoughts and needs via augmentative and alternative communication apps. Augmentative and alternative communication itself is not a new technology; communication boards that consist of a grid or keyboard of images that a person can point to have been in use for many years. Using the app form makes communication mobile. Instead of

Traditional activism can be ableism. Tech has allowed me to make my voice heard when traditional activism is not possible.

—Twitter Chat Participant

carrying around a specific board or device, any device can become a communication tool. In addition, having digital information opens more options. Instead of one grid with a few dozen pictures, apps can allow the user to customize the images and vocabulary available for specific contexts.

Social Interactions

Recent advances in technology have enabled people with disabilities to become more socially engaged with their peers. Two of the biggest social media platforms, Twitter and Facebook, are becoming increasingly accessible, especially through the use of screen readers and keyboard navigation options (American Foundation for the Blind n.d.). In February 2016, with the guidance of its accessibility team, Facebook began using an automatic alternative text feature, which can automatically describe the content of photos to users who are blind or have low vision. Snapchat, Instagram, Vine, and Periscope are social media apps popular among youth and young adults. However, many youth with disabilities cannot access these apps because of accessibility barriers. Guidelines such as the Federal Social Media Accessibility Toolkit offer insight on how to make social media accessible (DigitalGov n.d.).

When social media is accessible, it goes beyond connecting people with disabilities to their immediate social circle; it connects them to a global community on the basis of interests and identities. This is of particular importance when circumstances associated with a

disability prohibit travel. The crowdsourcing activity that informed this report illustrated how important social media is in connecting people with other people with disabilities across the country and the world. In particular, a number of people commented that they have been able to use social media to organize and advocate on behalf of the disability community. Others shared that social media enabled them to get or give advice and establish friendships with others who had the same shared experiences as themselves.

As technology becomes more integrated into the fabric of everyday experiences and society, people with disabilities in particular stand to gain increased independence, interdependence, and quality of living.

Connecting via social media has greatly impacted my sociability— I now have friends all over the world.
—Twitter Chat Participant

Society has seen the achievements of people with disabilities time and again when people are given appropriate supports and accommodations to address functional limitations. Technological advances have provided opportunities for all people to differentiate their communication, increase their mobility, experience better health outcomes, and attain greater self-determination. For people with disabilities, access to these technologies is particularly important, yet affordable and accessible technologies are still too far beyond reach for many. Although people with disabilities can benefit incidentally from innovations, all people benefit when innovations are created with people with disabilities in mind.

Chapter 2: Barriers that Interfere with the Right to Accessible Technology

As reflected in Chapter 1, technology has the potential to be especially useful for people with disabilities. However, the experience of this population when using technology can differ from that of people without disabilities. This chapter explores barriers that can interfere with the ability of people with disabilities to engage with both ICT and ICT-related assistive technology.

Information and Communication Technology (ICT)

ICT is known as "technologies that facilitate the transfer of information and various types of electronically mediated communication" (Zuppo 2012, 19). Examples include computer and network hardware and software, websites, cellular phones, radio, television, satellite systems, and videoconferencing platforms. Accessible ICT is paramount to staying engaged with the world. It facilitates communication, allows individuals to remain informed about world events, and enables people to retrieve the information needed to function in society. However, barriers to accessible ICT can interfere with each of these activities and can be especially detrimental during emergencies (NCD 2014). This section examines barriers to ICT within the contexts of web-based content, computer hardware and software, and media.

Web-Based Content

The Internet has become central to how we work, learn, and socialize, and for many, it serves as a platform for paying bills, shopping, and engaging in recreational activities. Further, Web Accessibility In Mind (WebAIM) describes the Internet as "one of the best things that has ever happened to people with disabilities" (WebAIM 2016). For example, screen-reading software that is interoperable with a technology device has the potential to read web content to people who are blind, have low vision, or experience another print-based disability. Thus, screen-reading software can replace the need for audiotapes and braille printouts. This saves money, time, and physical space and decreases dependency on others. Accessible websites not only enable users with disabilities to retrieve information online but also can help enhance search engine optimization and usability and create a more inclusive workplace or educational setting for people with disabilities and aging users (Henry and Arch 2012).

Despite the potential that technology has for all people, people with disabilities do not benefit from the Internet to the same extent as do people without disabilities. For example, one study showed that only 54 percent of adults living with a disability use the Internet compared with 81 percent of adults without a disability (Fox and Boyles 2012). Another study that looked at broadband adoption and use in the United States found that 39 percent of nonadopters had some type of disability, while only 24 percent of adopters had a disability (Horrigan 2010). The same study found that people with disabilities are less likely to use Internet-based communications technologies, with 65 percent of Americans reporting having home broadband, but only 42 percent of Americans with disabilities reporting that they

have this service (Horrigan 2010). The expense associated with high-speed Internet can serve as a barrier for all people, especially those with disabilities, to access the Internet (the topic of disparities in income between people with disabilities and people without disabilities is explored later in this chapter). In addition, the study found that almost half of those who do not use the Internet cite monthly cost as a barrier (Horrigan 2010).

Inaccessible website design is an issue that falls outside of the control of people with disabilities. A significant barrier to using the Internet that many people face involves the ability to access content. Approximately 95 percent of Fortune 100 company websites are not accessible to people with disabilities (Loiacono and Djamasbi 2013) and as many as 90 percent of U.S. government

websites have been found to have "major access barriers" (Lazar and Jaeger 2011).

Applying appropriate access standards during the website development process is essential for creating an online experience that is accessible to people with disabilities. The World Wide Web Consortium (W3C) is the premier international standards organization for the World Wide Web. The W3C established the Web Accessibility Initiative (WAI) to develop voluntary Web Content Accessibility Guidelines (WCAG) 2.0 and other resources to guide developers to factor in accessibility when building and updating websites and web-based tools (W3C 2016). The W3C has established five requirements

that a site must meet to conform to WCAG 2.0 (W3C n.d.). However, trends in technology can interfere with the accessibility process, and WCAG 2.0 requirements continue to evolve in order to stay current with these trends. In addition to applying WCAG 2.0 standards, it is critical that web designers include people with disabilities during the user research process. This process is addressed in the next section.

The Federal Government also promulgates rules on website accessibility standards through the U.S. Access Board. This federal agency develops and maintains design criteria for the built environment, transit vehicles, telecommunication environment, medical

W3C Requirements for WCAG 2.0 Conformance Synopsis

1. Mandates that all information on a page either conforms to WCAG 2.0 requirements or has a conforming alternate version available from the page. This requirement also mandates that information on a page satisfies at least all of the Level A success criteria. WCAG 2.0 has three levels of conformance, each of which indicates a measure of accessibility: Level A, minimum; Level AA, intermediate; and Level AAA, maximum level of conformance.

2. Necessitates that a whole page conform, rather than just part of a page.

3. Prohibits a web page that is part of a larger process from being considered

conforming if the overall process is not. This might include the process of applying for a job that requires navigating through multiple pages before submitting an application.

4. Calls for web content that can be used by assistive technologies to present information to users.

5. Allows technologies that are not accessibility supported as long as (a) all other information is also available using technology that is accessibility supported and (b) as long as the materials that are not accessibility supported do not interfere with materials that are accessibility supported.

W3C n.d.

diagnostic equipment, and ICT. It also provides technical assistance and training on these requirements and on accessible design. The website access standards approved by the Access Board in July 2016 are informed by guidelines established through WAI and apply to Section 508 of the Rehabilitation Act (the Rehabilitation Act is discussed further in Chapter 4). Additional agencies such as the FCC, U.S. Department of Justice (DOJ), DOL, and U.S. Department of Education, Department of Homeland Security, and Social Security Administration also offer insight on website accessibility.

Computer Hardware and Software

Design features for the accessibility of any technology device or software should originate during the research and development (R&D) process. When access is not addressed early, technology becomes susceptible to access barriers that can be challenging and expensive to remedy later. People with disabilities may find themselves unable to benefit from technology because of these barriers. As illustrated in Chapter 1, this can impact opportunities related to education, employment, health and well-being, and independent living. The consequences for ICT companies can be significant. Inaccessible technology can compromise a company's ability to enter into contracts with the Federal Government because of violations of Section 508 regulations, risking significant revenue loss. In addition, as local and state government and industry become more aware of their obligations under the ADA to make web-based software accessible, technology developers will face a greater demand for products that can be used by people with disabilities. Thus, in order to create

technology that can be used by the broadest population, the R&D phase of technology creation must consider the usability needs of people with disabilities. This chapter explores the following aspects of technology R&D: assistive technology incompatibility, user research, and R&D budgets. In addition, factors such as technology procurement decisions and user knowledge can interfere with use of accessible technology. These issues are also explored in this section.

Barriers Related to Research and Development

Assistive Technology Incompatibility. For assistive tools to work smoothly with other technology products, they must be developed in a way that renders their technologies and interconnections compatible. Over time, standardized approaches have made this challenge both simpler and less costly to address. For example:

- Standardized protocols such as Hypertext Transfer Protocol (HTTP), JavaScript Object Notation (JSON), and Hypertext Markup Language (HTML) have made transferring and presenting data much easier and consistent.

- Platform-independent languages such as Java, JavaScript, and jQuery have enabled many applications to operate on different platforms (e.g., Windows, Mac) and devices (e.g., desktop, mobile).

- Application programming interfaces (APIs) have made using the functions of software applications and services simpler for developers.

- Universal data access methods such as Structured Query Language (SQL) have

made data storage, access, and sharing more fluid and seamless.

- Tiered architectures and interfaces allow developers to manage data independently of representation.

These and various dedicated accessibility standards such as Section 508 and WCAG 2.0 have made 21st century technologies much easier for motivated and informed developers to create software and web products that can be used by people with different kinds of disabilities. Nevertheless, the myriad technology and accessibility standards pose a new challenge for technology developers. Before embarking on development projects, they must do a significant amount of research and learning about these standards before integrating them into the products they create. This is a significant technology transfer issue that can cause usage barriers among people with disabilities if not addressed properly during the design phase.

Further, technology development and accessibility standards continue to evolve in a rapidly changing technology environment. More interactive, immersive, and media rich applications will raise new challenges for developers. Assuring that future innovations appropriately address the needs of people who represent a wide range of disabilities will require careful attention and continuing diligence. To assure that technology and accessibility standards appropriately consider these needs, people with disabilities should be included in the design and development stages.

People with disabilities should be involved in design of technology and website(s) at the beginning through the process, not after issues arise.
—Twitter Chat Participant

User Experience Research That Is Not Inclusive. Designing ICT that complies with Section 508, WCAG, and other standards is essential for developing accessible ICT. However, it is also important to include people with disabilities in user experience research activities for insight on how this population experiences and engages with accessible ICT. User research provides insight on user behavior, needs, and motivation. This can be accomplished through a number of feedback methodologies such as observation techniques and task analysis (Usability.gov n.d.). In addition, market behavior research can provide valuable insight on the range of consumers with disabilities.

Similar to consumers without disabilities, this population has different levels of awareness, confidence, and attitudes toward technology. People with disabilities also vary in their goals and styles. The combined approach of designing with accessibility standards and engaging people with disabilities in usability processes can enhance technical and functional usability for people with disabilities, leading to an accessible user experience (WAI 2016). In practice, usability research often does not sufficiently reflect the needs of this population (WAI 2016), making it difficult for the ICT industry to understand and improve the user experience. In addition, it is important to acknowledge and respond to the variation in experiences that may be associated with a visual, auditory, physical, cognitive, or other disability. Therefore, even when adhering to access standards, the ICT industry is at risk of developing technology that is not practical for the

broadest population possible when people with various disabilities are underrepresented in user experience research.

Limited R&D Budgets. A significant barrier to creating accessible technology is rooted in the limited allocation of federal funds toward R&D in the field of disability research. Overall, the amount of federal spending on disability R&D is "very small in relation to the personal and societal impact of disability" (Institute of Medicine 2007, 197). In particular, there is insufficient spending on R&D to improve the development of assistive technologies and accessible mainstream technologies (Institute of Medicine 2007). Despite the recommendation in the Institutes of Medicine's 1997 report, *Enabling America: Assessing the Role of Rehabilitation Science and Engineering,* that "rehabilitation science and engineering should be more widely recognized and accepted as an academic and scientific field of study," overall funding levels in this area have remained largely unchanged (Institute of Medicine 2007, 316).

An analysis of the five leading funders of rehabilitation research—the National Institute on Disability and Rehabilitation Research, which is now known as the National Institute on Disability, Independent Living, and Rehabilitation Research (NIDILRR); the U.S. Department of Veterans Affairs; the National Center for Medical Rehabilitation Research; the Centers for Disease Control and Prevention; and NSF—showed that each agency contributed a unique mission and key set of priorities to the field; however, a lack of visibility and interagency coordination has resulted in an inadequate overall

program of research in rehabilitation science and engineering. For example, the majority of rehabilitation research funded by NSF focuses on individual stages of disability rather than looking at the interaction between people and rehabilitation in the context of the environment (Brandt and Pope 1997). Furthermore, although multiple agencies fund R&D for assistive technologies, no database of the federally funded disability research exists. As a result, there are limitations in how agencies can identify gaps and coordinate in the development of accessible technology (Institute of Medicine 2007). More comprehensive and coordinated funding for research in rehabilitation science and engineering across all agencies will facilitate the R&D of accessible technology that benefits the overall quality of life for people with disabilities.

Although private sector innovation regarding assistive technology has had and will continue to have a far-reaching impact, pressures of the market may cause companies to overlook the development of technologies that are much needed yet might yield lower profits. For this reason, the government should incentivize private sector entities to pursue research needed to develop these technologies. This, in conjunction with increased federal spending on R&D for assistive technology and better oversight and coordination of research would eliminate some of the barriers facing the creation of technology that is accessible to people with disabilities.

Barriers Related to Technology Procurement Decisions

Using technology is a basic expectation in employment, education, government, and a host of other settings. Organizations invest large amounts of money in technology intended to increase access to information, help users perform tasks, and ultimately improve productivity for employees and satisfaction for customers. When accessibility is not factored into the procurement process, people with disabilities may face barriers when using technology that interfere with the ability to perform to the same extent as their peers without disabilities. The same principles apply to entities covered by the ADA that offer kiosks, apps for mobile devices, and other technology that facilitates self-service transactions. The ADA prohibits local and state governments, along with places of public accommodation, from discrimination based on disability.

The Federal Government plans to spend more than $86 billion in 2016 on information technology (Office of Management and Budget 2015). The Department of Justice issued a report indicating that only 40 percent of agency

---

Electronic and Information Technology Accessibility Standards

"The Section 508 EIT [Electronic and Information Technology] Accessibility Standards contain technical requirements for six specific technology areas: software applications and operating systems, web-based information or applications, telecommunication products, video and multimedia products, self-contained, closed products (e.g., information kiosks, calculators, and fax machines), and desktop and portable computers."

U.S. Department of Justice, American Disability Act Division 2012

components offer Section 508 training and one-half of agencies have general Section 508 policies. Nevertheless, a majority of agencies incorporate Section 508 requirements into their procurements for electronic and information technology in some way. However, in most instances, agency components must rely on materials provided by vendors, rather than actual product testing, to validate Section 508 compliance. Further, 21 percent of agency components reported that they do not document decisions regarding Section 508 applicability or exceptions on electronic and information technology procurement (U.S. Department of Justice, American Disability Act Division 2012).

Barriers Related to User Knowledge and Use

Many of the barriers that interfere with the ability of people with disabilities to use technology to improve their lives are rooted in external factors, but others may involve the end-users themselves. However, there is greater opportunity for existing access features embedded in common technology to be used. Large technology companies such as Apple and IBM report that they factor accessibility into every aspect of the R&D process (Apple Inc. n.d.; Keohane 2016). Despite these efforts, research suggests that access features are underused by people who could benefit from them the most. Microsoft commissioned a study to understand the use of accessible technology and identify areas for potential growth and predictions about future use among adults who range in age from 18 to 64. The study showed that nearly three-quarters of people who live with some type of difficulty or impairment used computers and that more than two-thirds of them used some form

of accessible technology (Microsoft Corporation 2004). However, those who reported using accessible technology were most often motivated to use it because it made their computers more comfortable and easier to use. The study concluded that one's computer experience and confidence drives the use of accessible technology more than does the presence or severity of difficulties or impairments. The study also revealed that many users of accessible technology discover accessible technology while seeking opportunities to improve their computing experience (Microsoft Corporation 2004). Findings from this study suggest that efforts should be made to raise awareness of accessibility features that can help improve functioning and productivity. Additional research is needed to gain insight into barriers to technology adoption among people with disabilities who do not use computers or other forms of ICT, as well as to understand technology adoption among people who are age 65 and older.

Media

People with sensory impairments face barriers to accessing mainstream media when appropriate accommodations are not available. For example, people who are Deaf and HOH benefit from captioning that accompanies audio. People with low or no vision may benefit from audio descriptions to explain action or written text that appears on the screen. The FCC's rules require closed captioning on 100 percent of new television programming and 75 percent of older programming (i.e., analog programming published or exhibited before January 1, 1998, and digital programming before July 1, 2002). The FCC's rules allow for certain exemptions from these

requirements, including limited exemptions for new networks, overnight programming, and advertisements. The CVAA expanded the captioning requirements to mandate that video programming that is closed captioned on television must be closed captioned when distributed via Internet protocol.

The CVAA also created new requirements for certain TV programming to contain audio descriptions for people who are blind or visually impaired, although these requirements are far more limiting than the FCC's requirements for closed captioning. The four largest television network channels (ABC, NBC, CBS, and Fox) and the five cable television stations with the largest viewership (which varies) are required to provide only four hours of audio description per week. Thus, when compared with people who do not rely on audio description, people with visual impairments have access to only a small fraction of TV entertainment. The FCC has proposed to increase the number hours of audio-described programs.

Many people with hearing loss continue to face barriers to enjoying media. For example, the National Association of the Deaf reports that only 1 percent of all movies shown in movie theaters today are shown with captions (National Association of the Deaf n.d.). DOJ has pending regulations that would require movie theaters to display films with captioning and audio description. However, no final rules have been issued as of July 2016. Although all movie theaters with fixed seating for more than 50 patrons are required to provide an assistive listening device system, assistive listening devices do not provide enough accessibility to follow dialogue for many people who are hard of hearing.

Examples in the section focus on media for entertainment. However, it is important to recognize that media is integrated into an array of settings, such as employment and education.

Information and Communication Technology-Related Assistive Technology

Assistive technology is known 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 [people] with disabilities" (Technology-Related Assistance for Individuals with Disabilities Act of 1988, S. 2561, P.L. 100-407. 100th Cong. [1988], 102 STAT. 1044). Such devices can include technology that is designed for the general population but used by a person with a disability to improve function, either with or without modification. Assistive technology can also be designed specifically for people with disabilities to enhance functional capabilities. The Assistive Technology Act of 1998 (S. 2432, P.L. 105-394, 105th Cong. [1998], 112 STAT. 3627) identifies several benefits of assistive technology, including increasing involvement in and reducing expenditures associated with, programs and activities that facilitate communication, ensuring independent functioning, enabling early childhood development, supporting educational achievement, providing and enhancing employment options, and enabling full participation in community living for people with disabilities. This section examines factors linked to cost, funding streams, and the need to demonstrate efficacy that can cause barriers to gaining access to assistive technology.

Cost

Many people with disabilities rely on assistive technology to improve their daily life function. Access features in mainstream technology are becoming standard. However, some people with disabilities require more specialized options that are costly, which can serve as a barrier to securing assistive technology. For example, Braille note-taking and personal digital assistant devices can cost more than $5,000, while a pair of hearing aids may cost from $3,500 to $7,000. Many assistive technology devices come with additional expenses associated with updates, maintenance, and repairs. These assistive devices are not luxuries; rather, people with disabilities use technologies like these to so that they have the same opportunities to participate in daily living activities as those without disabilities. Unfortunately, many people are faced with the expense of assistive technology, coupled with the reality that they lag behind financially when compared with their peers without disabilities. People with disabilities are more likely to live below the poverty line than their peers without disabilities (28.2 percent compared with 12.5 percent) (Yin, Shaewitz, and Megra 2014). On average, people with disabilities who are employed full time make less money than their peers without a disability ($38,300 for those who have a disability compared with $43,300 annually for people who do not have a disability) (Yin, Shaewitz, and Megra 2014). The pay disparity between people with and those without disabilities exists even for those who are comparably educated (Yin, Shaewitz, and Megra 2014). The discrepancy in income between the two populations, coupled with the significant expense associated with some assistive technology devices, can serve as a barrier to

using accessible technology. Issues surrounding third-party reimbursements are addressed in the following section.

Funding Streams

CMS establishes benefit coverage criteria for what is referred to as *durable medical equipment* or *DME*. CMS does not use the term *assistive technology*, which is associated with not only medical but also functional support to carry out activities of daily living. One of the functions of the U.S. Food and Drug Administration (FDA) is to regulate medical devices. The FDA defines a medical device as:

> an instrument, apparatus, implement, machine, contrivance, implant, in vitro reagent, or other similar or related article, including a component part, or accessory which is recognized in the official National Formulary, or the United States Pharmacopoeia, or any supplement to them, intended for use in the diagnosis of disease or other conditions, or in the cure, mitigation, treatment, or prevention of disease, in man or other animals, or intended to affect the structure or any function of the body of man or other animals, and which does not achieve any of its primary intended purposes through chemical action within or on the body of man or other animals and which is not dependent upon being metabolized for the achievement of any of its primary intended purposes (FDA 2015).

The FDA determines whether a device is a medical device on the basis of its use in the treatment, reduction, diagnosis, or prevention of a disease or health condition. Medical devices

that receive FDA clearance may become eligible for benefits from Medicare, Medicaid, and private insurance reimbursement. However, a number of devices that are necessary for everyday function do not fall within Medicare coverage criteria. These include hearing aids, eyeglasses, and some accessories for manual and powered wheelchairs.

Without a system in place for a third-party funding source, many people with disabilities cannot benefit from assistive technology because reimbursement may not be available. Thus, people with disabilities are in need of a federal funding stream to help pay for assistive technology that contributes to daily living activities and supports their employability and ability to be self-sufficient. This is especially important for the growing number of people who are aging into disability yet want to work or stay active in the community.

Efficacy

Regulators and insurers often require evidence from research studies showing that devices are safe and efficacious. Public R&D agencies with large research budgets, such as the National Institutes of Health (NIH), tend to regard randomized controlled trials (RCTs) as the research gold standard to demonstrate how devices and services contribute to functional improvements. However, RCTs may not always be practical for assistive technology. There is an array of obstacles that interfere with the implementation of RCTs as a realistic option. They include (1) the small size of the population of people with a given disability and their unique circumstances coupled with the need for a large sample to show scientific validity and reliability, (2) the need for a homogeneous sample and the variation that exists within each disability group, and (3) the high cost of RCTs and limited availability of R&D funds for assistive technology within the public sector (Smith 2016). In addition, recruiting typical consumers as research subjects who are not necessarily tech savvy can also be a challenge. Some researchers argue that more appropriate research methodologies are available and should be considered to inform funding decisions. For example, Smith (2016) proposes the use of single-study designs and the development of a national aggregate database registry to demonstrate assistive technology outcomes for people with disabilities.

Assistive Technology Research Needs

"Basic researchers want to understand foundational factors explaining why AT [assistive technology] works and the related causes and effects. People with disabilities and service providers want to know which AT devices work and under what real-life conditions. Manufacturers and developers want to demonstrate that their products work. Funders want to know what functional improvements are made with which devices and services and at what costs. . . . People with disabilities want products that work."

Smith 2016

Chapter 3: Moving Forward in the Right Direction with Emerging Technology

Access to affordable technology for people with disabilities will require coordinated efforts across the public and private sectors. The Federal Government plays a critical role by encouraging innovation in technology that is designed for and by people with disabilities. To this end, federal legislation and programs that promote innovation and support access to technology for people with disabilities have already been enacted, with bipartisan support. Private industry must be thoughtful, collaborative, and considerate of the needs for accessible technology and also is served well by doing so. This chapter explores the roles of the Federal Government and of private industry in ensuring that emerging technology is responsive to the needs of people with disabilities.

Federal Programs and Investments

The primary role of the Federal Government in encouraging innovation in technology that meets the needs of people with disabilities is to subsidize relevant R&D. As Ben Bernanke (2011, 37) noted, "The primary economic rationale for a government role in R&D is that, without such intervention, the private market would not adequately supply certain types of research . . . and no matter how good the policy environment, big new ideas are often ultimately rooted in well-executed R&D."

One of the most significant sources of funding to support technology innovation specifically for people with disabilities is the National Institute on Disability, Independent Living, and Rehabilitation Research (NIDILRR), part of HHS' Administration for Community Living (ACL). The following list describes programs that NIDILRR funds and supports:

- **Small Business Innovation Research** grants help support the development of new rehabilitation technology. This two-phase program takes a product from development to market readiness.

- **Disability and Rehabilitation Research and Related Projects** may develop methods, procedures, and rehabilitation technology to assist in achieving full inclusion and integration into society.

- **Rehabilitation Engineering Research Centers (RERCs)** conduct programs of advanced research of an engineering or technical nature that are designed to apply advanced technology, scientific achievement, and psychological and social knowledge to solving rehabilitation problems and removing environmental barriers.
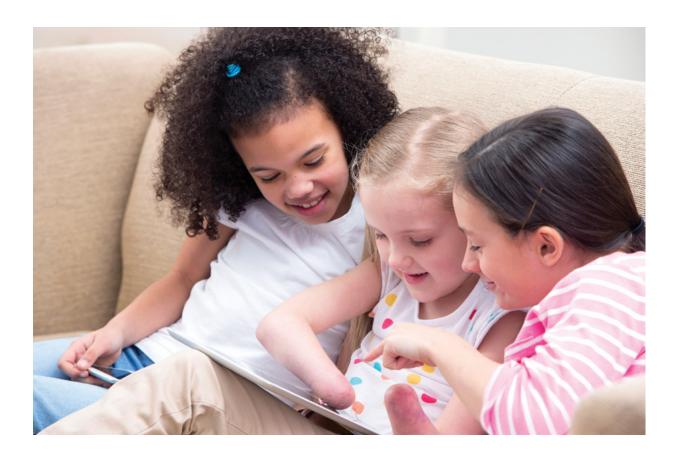
These programs, which specifically focus on technologies and devices that support the functioning and independence of people with disabilities, are indispensable, and Congress should continue to fund them. Investment in disability-specific R&D is particularly critical given the high cost and relatively low investment return on orphan technologies. Two NIDILRR-funded examples of how R&D is working to support the assistive technology needs of people with disabilities are the RERCs and AbleData. The RERCs are tasked with developing systems to support the exchange of technical and engineering information worldwide and improving the distribution of technological devices and equipment to people with disabilities. A number of RERCs have played major roles in developing voluntary standards that industries use when developing wheelchairs, seating systems, prosthetics and orthotics, universal design apps, and web accessibility. Examples of products developed and scaled-up by RERCs and adopted by mainstream industry include accessible kiosks, voting booths, automated teller machines, talking signs, and hand-held hearing screen devices.

AbleData is a website that provides comprehensive information on products, solutions, and resources to improve productivity and ease with life's tasks for people with disabilities. AbleData is funded by NIDILRR to provide information to assist domestic and international customers and their family members, vendors, distributors, organizations, professionals, and caregivers in understanding the assistive technology options and programs available. In addition to a comprehensive, searchable database of products, AbleData includes guidelines on ways to navigate and communicate with private and public sector assistive technology vendors.

For some people with disabilities, devices specifically designed and created for rehabilitation purposes are an important component of enhancing functional performance associated with disability. In addition, mainstream technological advances designed with people with disabilities in mind can play such a role. There are other opportunities to include the needs of people with disabilities within larger federal investments of R&D of technological innovations. However, federal investments in R&D to support people with disabilities are not—and should not be—limited to NIDILRR. The Veterans Administration has engineering research centers, and the National Center for Medical Rehabilitation Research commits a portion of its R&D budget on assistive technology. One example of how federal investments in innovation and technology can be leveraged to support people with disabilities is the America Creating Opportunities to Meaningfully Promote Excellence in Technology, Education, and Science Act of 2007 (America COMPETES Act of 2007, H.R. 2272, P.L. 110-69. 110th Cong. [2007], 121 STAT. 572).

The America COMPETES Act of 2007 is bipartisan legislation signed by President George W. Bush and reauthorized by President Obama in 2010 and 2015. The purpose of this act is "to invest in innovation through research and development, and to improve the competitiveness of the United States." Although the America COMPETES Act of 2007 is a primary focus of the U.S. Department of Energy (DOE) and its projects, it also encompasses STEM education, as well as workforce programs, research programs, and innovation programs at

agencies outside the DOE. America COMPETES Act of 2007 grants have been used by agencies in the past to support the development of technology and mobile apps specifically designed with people with disabilities in mind. Some uses have included a competition by the Census Bureau to fund an accessible app that easily enables people with disabilities to find places to live or travel in Minnesota, and DOL's competition for mobile or web-based tools that promote the employment of people with disabilities.

However, an informal review revealed that only a few of these competitions specifically address considerations for people with disabilities. The few competitions that do, specify whether the final product produced will be accessible for a person with a sensory

disability or encourage innovations specifically for people with disabilities. Federal investments in R&D of innovative technology should offer more incentives for developers to consider apps or devices that can help people with disabilities enhance functional performance to improve outcomes in education, employment, and independent living. For example, agencies or offices sponsoring America COMPETES Act opportunities could incorporate a focus on outcomes for, or partnerships with, people with disabilities into their judging criteria. Doing this would underscore the commitment to the rights of people with disabilities to accessible and affordable technology and will ultimately leverage federal funds better.

Designing and creating affordable and accessible technologies will be for naught,

however, if people with disabilities and their family members, service providers, and other community members are not informed about their existence. The Federal Government plays another role in the realm of knowledge transfer and technology use: promoting availability of accessible technology to people with disabilities. People with disabilities and their families, caregivers, and service providers must be made aware of these technologies, and the technologies must be affordable and accessible.

In 2012, DOL's Office of Disability Employment Policy launched ePolicyWorks, a web-based approach to policymaking that engages citizens and stakeholders in new and innovative ways. The initiative leverages the latest technology to address barriers to employment for people with disabilities and fosters real-time collaboration and communication about key issues.

Dialogues have focused on a number of specific topics, including the needs of our nation's wounded warriors, veterans, service members and their families, and others, by channeling the brainpower of our federal partners, nongovernmental organizations, and other stakeholders. NCD has cosponsored a number of ePolicyWorks online dialogues about technology and people with disabilities. For example, ePolicyWorks held two Advancing Accessibility and Inclusion in Social Media dialogues, one from a user perspective and the other from an industry perspective. These dialogues gathered ideas and input on ways to incorporate universal design concepts into the technology development process in order to improve the accessibility of social media tools. NCD also cosponsored a dialogue on encouraging people with disabilities to pursue careers in STEM.

It is imperative that federal funding continue to support innovative accessible technology R&D, as well as transfer programs. This will help ensure that people with disabilities are considered across the full product development and marketing life cycle of new technologies. Federal agencies also have a role in supporting communication and collaboration across the private and public sectors.

Private Industry and Promising Practices

Private industry could benefit from considering the needs of people with disabilities during the product design and development process to build products that are *born accessible*. This approach would help organizations increase their market share of the nation's largest minority group, people with disabilities. Approximately 19 percent of the U.S. population has a disability (Stoddard 2014) and 31 percent of U.S. families have at least one member with a disability (NAC and AARP 2009). Each day, millions of people with disabilities shop, travel, dine out, communicate, and work alongside their friends and families, and emerging technologies have helped to facilitate fuller participation in these activities. Although new technology stands to revolutionize the ways in which people with disabilities interact with the world around them, offering increasing levels of personal independence and social inclusion, people with disabilities also possess tremendous power to help shape and improve these technologies.

Corporations that build accessible features into their products stand to benefit from the wider audience of consumers who are able to use their services. People with disabilities and disability-related advocacy groups have played

an immense role in pushing for and facilitating such adjustments. For example, in a first-of-its-kind settlement, Robert Baran, the American Council for the Blind, and the Bay State Council of the Blind reached an agreement with Netflix to provide closed captioning on all of its originally produced programming. Netflix will also request audio description assets in all new contracts with streaming content providers and make reasonable efforts to obtain existing audio description assets for videos provided by third parties that are already in the Netflix streaming library. Further, Netflix will add audio description to video streaming and DVD rental subscriptions by adding audio description tracks offered by television and movie studios (Netflix Settlement Agreement and Release 2016). This positions people with disabilities as both an economic force and critical audience that technology providers should consider and consult.

As some organizations have realized, considering accessibility challenges and involving people with disabilities during developmental phases helps create products of wide appeal and usefulness. Technology giants such as Microsoft and Apple have turned accessibility features into immensely popular—and now essential—elements of such products as Windows 8, Internet Explorer 11, Office 2013, Apple OS X, and IOS (Microsoft Corporation n.d.; Apple Inc. n.d.). Even companies outside of the technology field have come to understand the importance of making technology accessible to the customers they serve. For example, JP Morgan Chase & Co. established an Electronic Communications Accessibility Team (eCAT) to lead efforts to integrate inclusive digital design across the bank (Hamidullah-Bahl 2015). This team identifies,

suggests, and implements solutions for accessibility barriers based on the W3C WCAG 2.0 standards and compliance with accessibility laws. They also work to deliver accessible apps and content on mobile platforms and documents. Mattel has incorporated brain wave-reading technology, initially intended to enable people with paraplegia to move items with their minds, into a game controlled by players' brain waves (Jana 2009; Warmflash 2015). Hands-free devices, voice-control technology, e-readers, and even technology designed to enable people to manipulate tools by reading the users' brain waves are examples of products developed for people with disabilities that have been embraced by the masses (Jana 2009).

Similarly, some companies deploy trainers to work with their designers on the job to teach them how to design accessible technologies. The Teach Access initiative takes a comprehensive and systematic approach to transforming the field of technology development so that it is responsive to the needs of users with disabilities. The Teach Access initiative, founded by Adobe, Facebook, Google, HP, LinkedIn, Microsoft, The Paciello Group, and Yahoo, along with Georgia Tech, Olin College, Rochester Institute of Technology, Stanford, Towson University, and the University of Colorado, aims to broaden expertise on accessibility across the industry so that accessibility becomes mainstream. Teach Access does this by (1) providing basic training for developers and designers and (2) promoting accessibility and universal design principles in higher education programs. Programs such as the Teach Access initiative have the potential to enhance the way people with disabilities are able to use technology to improve their lives (Teach Access n.d.).

The ePolicyWorks approach described earlier in this chapter is a model that can be, and has been, replicated by private industry to elicit feedback and crowdsource ideas throughout the product development process, either in coordination with the public sector or on its own. For example, Google has conducted hackathons as part of its Impact Challenge to improve access for people with disabilities (Pratt 2016). Google has also pledged $20 million in grants to support nonprofit organizations that use technology to address accessibility challenges as part of this initiative (Google n.d.). Google also sponsors the Google Summer of Code, a program that provides stipends to student developers to write code for open source software projects, and includes partnerships with organizations such as Benetech to engage young developers in accessibility (Benetech 2014). Similarly, AT&T partnered with New York University's ABILITY Lab to launch a three-month competition in which participants could win more than $100,000 worth of prizes for designing accessible software, wearable technology, and solutions aimed at enhancing the lives of people with disabilities at work, home, and play (New York University 2015).

In addition to supporting one-time events and contests, product developers and private industry leaders could also consider longer-term knowledge development and capacity-building activities. A number of resources and venues provide regularly facilitated discussions about issues of accessibility and emerging technologies. The annual International Technology and Persons with Disabilities Conference, sponsored by California State University, Northridge is one example. This conference provides an opportunity for researchers, practitioners, exhibitors, end-users, speakers, and other participants to share knowledge and best practices in the field of assistive technology.

The Global Public Inclusive Infrastructure (GPII) is one example of people from industry, academia, and nongovernmental organizations collaborating to develop accessible technologies for people with disabilities. The GPII project is led by Raising the Floor, an organization of diverse people from industry, academia, nongovernmental organizations, and other sectors. The goal of the project is to ensure that people who face barriers due to disability, literacy, digital literacy, and aging are able to understand, access, and use the digital world to the full extent. The project aims to create a low-cost, secure, open-source code that will provide individual users with their own personalized accessibility features to use throughout a browsing experience.

Emerging Technologies

As illustrated earlier, the public and private sectors can play a significant role in encouraging innovation, collaboration, and use of technology that can benefit people with disabilities. The proliferation of smart technologies such as wearables, visual sensors, and home automation systems—or smart homes, assistive robotics, and similar types of devices—offers support that can facilitate a greater sense of security and independence among people with disabilities. This pioneering technology, which is also known as the Fourth Generation Wave, is also important for the populations that have become technology dependent and have or will age into disability. Increasingly sophisticated artificial intelligence provides support for and can even automate a wide range of physical and cognitive

tasks, such as systems that provide navigational support for people with cognitive impairments (Pollack 2005). Ongoing improvements in smart technologies, powered by artificial intelligence, further enhance the power of assistive technologies by making them increasingly easy to operate, more responsive to the user and environment, and better connected to other systems and devices. The following offers a brief overview of some emerging technologies that hold great promise for improving the lives of people with disabilities.

Three-Dimensional Printing (Additive Manufacturing)

Additive manufacturing, or three-dimensional (3D) printing, refers to specialized printers that can layer thin sheets of a material, such as plastic, to create physical objects. These printers can be used to create standalone objects or components of complex devices. This manufacturing process makes creating specialized devices easier and more cost-effective. Instead of sending a design file to a manufacturing plant and waiting for the file to come back, users can immediately test and adjust designs or reconfigure a specific component of a complex device without having to recreate the entire device. Three-dimensional printing holds great potential for people with disabilities due to its ability to create products based on custom physical and functional specifications. For example, 3D printers are being used to create customized eating utensils for people with dexterity issues that are easier to grip than those that are currently available. The e-NABLE network connects amputees and their families, designers, engineers, physicians, and 3D print enthusiasts to develop and share 3D-printable prosthetics (National Institutes of

Health n.d.). Given the small size of the market for prosthetics, which can hinder innovation (Kuniholm 2009), such collaborative activities have the potential to offer customized and affordable prosthetics.

The cost of 3D printers is falling. Further, 3D printers are now available for use for a fee in some stores across the country and can also be used in some public libraries. With access to publicly available and affordable machines, there is great potential for people with disabilities to access low-tech aids for daily living. However, the issue of accessibility and requisite knowledge of how to use these machines must be considered for people with disabilities. For example, are they enabled with audio controls for people with blindness or visual impairments? Are the control panels designed in a way that enables access for people positioned in a wheelchair or who have limited fine motor skills?

In addition, creating specialized complex devices for people with disabilities is more likely to require engineering skills and knowledge. Because people with disabilities are best equipped to understand the challenges they face and are well positioned to identify the types of devices from which they would most benefit, encouraging and supporting more people with disabilities to become engineers would enhance the ability of the field to meet their needs. Also, it is critical to acknowledge the role of medical and rehabilitative professionals, who should be prepared to incorporate 3D printers into their professional practices. For example, occupational therapists or other service providers who understand the functional needs of people with disabilities could receive training in designing and creating 3D printed assistive devices. However, making this sustainable would require

policy changes to fund devices that are produced this way.

Autonomous Vehicles

Autonomous vehicles are rapidly moving from possibility to reality. Autonomous features, directed by artificial intelligence, such as lane assist, speed control, and the coordination of collision and brake systems have already been incorporated as luxury or safety features into some models on the market. These vehicles offer tremendous opportunities for independence and self-sufficiency for people with disabilities—including sensory, intellectual, and mobility disabilities, along with driving limitations that occur with aging. However, incorporating luxury automated features into how vehicles are currently designed and engineered will not be sufficient in realizing the potential for this population, because many vehicles and their operating controls are not accessible for people with disabilities. Designs for autonomous vehicles will need to consider specifically how people who have mobility disabilities and may use assistive mobility devices can easily enter, exit, ride in, and control such vehicles in the event of an emergency. In addition, deliberate attention would be required to ensure that navigation and safety systems are accessible both for people who are Deaf and HOH and those who are blind or have visual impairments.

Fully autonomous vehicles are self-driving vehicles that do not require a human operator. Before being approved for large-scale production, the automobile industry still has many legal, safety, and practical considerations to overcome. For example, it is unclear how to incorporate both autonomous and manually operated vehicles safely in the same spaces. Policymakers must also determine what types of licensures or certifications would be required to own or operate a vehicle, with particular attention paid to the needs of people with disabilities. As the technical and practical questions are addressed by private and public industry, people with disabilities should be a significant part of the stakeholder group that influences the design of the vehicles to ensure their accessibility, as well as the infrastructures put in place to support them to ensure equal access. NCD addresses these and other issues of importance in a 2015 report dedicated to autonomous vehicles (NCD 2015).

Telemedicine

Telemedicine can help deliver on the promise of improving access to health services for people with disabilities. As described in Chapter 1, telemedicine can encompass a range of services, such as teleconferences with a health care provider, people using the Internet to find specialized health information or receive peer support, and using devices in patients' homes to monitor health measures such as blood glucose levels or vital signs remotely. This technology has been shown to support diabetes-related health outcomes for socially disadvantaged populations and is effective for diagnosing and assessing mental health services, without affecting the quality of care patients receive (Garg and Brewer 2011).

As the use of telemedicine has increased, addressing the security and privacy risks of telemedicine remains essential to the continued development of this promising practice. Telemedicine security focuses on both physical safety and patient information security. Effective physical safety for telemedicine relies on patients

having access to a private and confidential environment in which to interact with their providers. A physically safe environment also relies on the provider being able to conduct accurate patient examinations remotely. Effective patient information security relies on standardized authorization, authentication, and accounting in telemedicine apps. Providing secure telemedicine apps can improve the quality of care that patients receive and create more confidence in the services for both providers and patients.

Groups such as the American Telemedicine Association have developed core standards for telemedicine apps focusing on the clinical and technical guidelines. For example, the American Telemedicine Association developed practice guidelines for video-based online mental health that discusses the key issues and potential solutions for telemental health models of care. These guidelines discuss addressing informed consent, establishing and documenting an appropriate physical environment, and managing emergency or crisis situations. On the technical side, the guidelines focus on device characteristics such as mobility, connectivity, and the maintenance of privacy and security. Standardization of these kinds of guidelines can improve the dissemination of telemedicine services and the quality of care provided.

Robotics

Robotic arms with grasping and lifting power have been developed for use by people with advanced muscular or severe upper extremity disabilities (Abilities.com n.d.). Many of the designs of these robots mirror the functionality and purpose of manufacturing and industrial robots: reaching and grasping. The robotic limbs

can be used to support essential functions such as eating and hygiene care and enable independence in completing regular chores or tasks. For example, the reaching and grasping functions can help people shop independently.

Just as important as advances in the functionality of robotics themselves are advances in how robotics are controlled. Advances in computing have already been achieved to develop eye-tracking software to control communication devices and other simple robotics. Another emergent area is using brain waves to control simple machines. These robotics and cutting-edge software hold great promise for independent living for people with disabilities, particularly for people with spinal cord injuries.

Another emergent area in robotics is caregiving robots. Recently, a Japanese company created RoboBear, a caregiving robot that can lift and transfer people (Doan 2015). Here in the United States, NIH, in collaboration with a number of other agencies, supports the National Robotics Initiative, which is working to accelerate the development and use of robots that work beside or cooperatively with people. The National Robotics Initiative is also encouraging the development of assistive robotic technology that allows robots to support functions such as home care, behavioral therapy, mobility, communication, and vision (National Institutes of Health 2015).

Internet of Things

The *Internet of Things* (IoT) is a term used to describe how the Internet and technologies such as radio-frequency identification can transform everyday items into smart devices that can sense, interpret, and react to other elements and devices in an environment

(Domingo 2012). Currently, large companies such as Amazon, Samsung, and Microsoft, as well as a vast number of start-ups, are looking for ways to connect their own systems to the IoT and developing commercial and industrial services and devices that use the IoT (Brown 2016). Such devices could involve a wearable technology that tracks one's exercise and sleep patterns and that can recognize when one wakes up in the morning and automatically communicate with a coffee machine and let it know when to start brewing. Smart houses, discussed in Chapter 1, that allow for security features and household appliances to be controlled via a mobile device are also examples of IoT technology. Amazon's Alexa-enabled speaker, Echo, is one such device which enables users to control music and connected household items such as light switches and thermostats, and to interact with Internet applications such as calendars, navigation, weather forecasts, and even food delivery platforms using voice control alone. There are myriad possibilities for how IoT connectivity can improve accessibility and quality of life, both in individual homes and out in the community. For example, an integrated system of sensors in public parking spaces and personal smartphones could provide better information and management of parking spaces allocated for use by people with disabilities. People with disabilities could reserve a slot and authenticate themselves when parking, assisting the authorities with usage monitoring for law enforcement and capacity-planning purposes (Lambrinos and Dosis 2013).

IoT technology can also incorporate haptic or kinesthetic feedback to support independence and mobility for people with disabilities. Haptic technology recreates the sense of touch by applying forces, vibrations, or motions to the user; many cellular phone keyboards provide haptic feedback. Two innovators developed shoes that use haptic feedback to help visually impaired people navigate better on their own. The shoes connect with GPS systems; sensors in each shoe vibrate to indicate when and which way the wearer should turn. The sensors can be built into a specific shoe or insoles that can be inserted into different pairs of shoes. In addition, sensors can be used to track fitness and alert the wearer if he or she has left his or her phone somewhere (Coxworth 2014). Although these were developed specifically for users who are blind, the shoes could help other people with cognitive disabilities who may benefit from navigational cues. Moreover, these shoes provide unique features that can be used by, and marketed for, the general public. This illustrates the benefits of considering the needs of people with disabilities in emerging technologies.

Maximizing Opportunities of Emerging Technology for People with Disabilities

As this section describes, new advancements in technology hold great promise to improve the lives of people with disabilities. Affordability, equity, and access must remain at the forefront of conversations regarding these innovations. It will take a combination of strong, effective policy; the purposeful inclusion of people with disabilities in the design and development of products; and public and private sectors dedicated to advancing *born accessible* andassistive technologies to enable people with disabilities to take advantage of the vast benefits that these new and emerging technologies provide.

Chapter 4: Policies, Technology, and People with Disabilities

This section provides an overview of select legislation and treaties and the ways they apply to technology and the rights of people with disabilities. This section also identifies areas of concern regarding the way these policies are put into practice in today's society. The chapter closes with a discussion of the need to develop a Technology Bill of Rights for People with Disabilities.

The Rehabilitation Act of 1973, as Amended

The Rehabilitation Act of 1973 (P.L. 93-112 [1973]) prohibits discrimination on the basis of disability in programs conducted by federal agencies, in programs receiving federal financial assistance, in federal employment, and in the employment practices of federal contractors. Although technology is not specifically mentioned in every section of the Rehabilitation Act, inaccessible technology can be a form of de facto discrimination against people with disabilities. For example, Section 503 prohibits employment discrimination by Federal Government contractors and subcontractors with contracts of more than $10,000. Refusing to hire a candidate because he or she cannot use inaccessible technology to perform required tasks may be regarded as a form of discrimination. The same

principle applies to hiring within the Federal Government under Section 504. Section 504 also prohibits discrimination against people with disabilities in federally funded programs such as students in most educational settings, including postsecondary education, and all are required to consider accessible technology.

Section 508 of the Rehabilitation Act requires federal electronic and information technology to be accessible to people with disabilities, including employees and members of the public. This applies to any electronic and information technology developed, maintained, procured, or used by the Federal Government. As discussed in Chapter 2, the Federal Government continues its efforts to procure and maintain accessible technology.

The Office of Management and Budget (OMB) published the Strategic Plan for Improving Management of Section 508 of the Rehabilitation Act to guide federal agencies in their efforts to implement Section 508. In response to this plan, the CIO Council Accessibility Committee developed a standard government-wide template for agencies to use in reporting baseline compliance of key measures. The template also supports agencies in their efforts to conduct a baseline assessment of the maturity and effectiveness of their Section 508 programs

(CIO Council Accessibility Committee n.d.). The template, formally called "Section 508 OMB Dashboard/Reporting Template," offers a legend of mandatory metrics. However, the descriptions associated with each mandatory metric are limited, allowing room for interpretation among respondents for these self-reported data.

In addition, the Strategic Plan required each agency's chief information officers along with the chief acquisition officers to develop a plan for completing an agency baseline assessment of the Section 508 program. Each agency had flexibility to include either a full baseline or sampling method that represents high-risk or key areas. Further, it was up to each agency to determine whether the baseline would be performed for either an entire agency or department, or for each component (CIO Council Accessibility Committee n.d.). Agencies assess progress toward Section 508 and file a report with OMB every six months. The requirement

for agencies to assess their Section 508 program is expected to help individual agencies measure growth. However, the lack of standardization in each agency's approach makes it difficult to understand how the government, as a single entity, will make progress toward Section 508 requirements.

The Access Board establishes accessibility requirements for technology covered by Section 508. However, the rapid pace at which technology evolves makes it difficult for the Federal Government to update and approve new standards in a timely fashion. Therefore, although Section 508 standards have led to accessible technology when first drafted or revised, they may not lead to fully accessible technology in the future. The technology standards that guide Section 508 are in the process of being updated. A proposed rule was issued in February 2015 and a final rule is expected in fall 2016. The proposed updated standards align with WCAG 2.0. When the Access Board approves the final updated standards, it will be OMB's decision to clear the proposed standards in order for the rule to take effect.

Assistive Technology Act of 1998, as Amended

The Assistive Technology (AT) Act of 1998 was designed to help people with disabilities access and acquire assistive technology that facilitates participation in education, employment, and daily activities alongside members of their communities who do not have a disability. To accomplish this, the AT Act supports various assistive-technology related programs designed to improve awareness of, access to, and acquisition of assistive technology devices and services for people with disabilities. The AT

Act authorizes a continuum of four state-level activities, including (1) state financing activities, (2) device reutilization, (3) device loan/borrowing, and (4) device demonstration services, as well as state leadership activities that include information and assistance, training and technical assistance, and coordination and collaboration. Independent low-interest cash loan financing programs were also developed and supported through this legislation. However, the legislation does not offer payment reimbursement to people with disabilities for assistive technology.

The AT Act is the only U.S. federal legislation that provides funding for assistive technology programs and addresses the assistive technology needs of people with disabilities from birth to adulthood. However, limited funding has led to issues such as waiting lists for high-demand device loans, unmet requests for refurbished equipment, and outdated equipment in demonstration inventories (ATAP 2016; ATAP 2012). In addition, the AT Act falls short of equipping Information and Referral Programs to meet the information needs of consumers, and of providing substantial ongoing financial support of Alternative Financing Programs. Consumers who rely on these programs need education and training on interpreting information related to the explosion of assistive technology that has entered the market. This is of particular concern as consumers try to identify devices that meet one's specific needs, but do not have access to the accurate information on technology options that can support the decision-making process. Given the current level of demand for AT Act Programs, increased funding for the AT Act is critical to provide comprehensive activities and guidance to help people with disabilities maximize functioning with assistive technology.

Americans with Disabilities Act (ADA)

The ADA prohibits discrimination on the basis of disability in employment, in state and local government programs, in services and activities, and in public accommodations and commercial facilities. It also addresses certain kinds of public and private transportation as well as telecommunications. The ADA was enacted in 1990, before the Internet and other forms of ICT became a significant part of everyday life. It was amended in 2008; however, the amendments did not include language regarding the ADA's applicability to technology. This ambiguity has led to a significant debate about the ways in which the ADA applies to technology. Does Title I of the ADA require employers to make the employment application process, technology-based training, and other technology in the workplace accessible? Does Title II require state and local governments to make technology that is used by the public accessible? Does Title III require businesses and other places of public accommodations to offer accessible technology to the public? NCD asserts that the ADA does, in fact, apply in each of these instances. The CVAA, which is discussed later in this chapter, offers clarification on many of the topics addressed in Title IV of the ADA.

ADA Title I: Employment

Access to employment is one of the most important issues among people with disabilities. When the ADA was first implemented, many employment cases focused on discrimination during hiring decisions. However, as explained in Chapter 1, people with disabilities already face discrimination long before hiring decisions

are made due to inaccessible web-based employment applications. Title I of the ADA prohibits discrimination against people with disabilities in employment both before and after they are hired. A Technology Bill of Rights for People with Disabilities would clarify the legal responsibilities of employers as well as offer guidance on addressing discriminatory practices with the U.S. Equal Employment Opportunity Commission.

ADA Title II: Public Services

On April 29, 2016, DOJ withdrew its Notice of Proposed Rulemaking (NPRM) titled, "Nondiscrimination on the Basis of Disability; Accessibility of Web Information and Services of State and Local Government Entities" (28 CFR Part 35, RIN 1190-AA65 [2015]). This NPRM was initially submitted to OMB for review pursuant to Executive Order 12866 on July 9, 2014. The NPRM would have established specific requirements for state and local governments to make programs, services, and activities offered on their websites accessible for people with disabilities, which would, in turn, offer greater access to these programs, services, and activities.

DOJ withdrew the NPRM in part because the Internet, accessibility tools, and assistive technologies have evolved since 2010, when DOJ issued its Advance Notice of Proposed Rulemaking (ANPRM) (6 CFR 29, RIN 1601-AA77 [2010]). Consequently, DOJ is seeking more current public comments. DOJ is also seeking more detailed, specific, and focused information about the potential application of technical accessibility requirements to the websites of public entities. For example, DOJ anticipates obtaining more information regarding the specific benefits of web accessibility and how to measure those benefits, data on the costs of web accessibility, and information about the current level of accessibility on public websites.

DOJ rulemaking about accessibility has been ongoing since 2010. Although DOJ has consistently taken the position that the ADA requires website accessibility even in the absence of a specific technical standard since 1999, people with disabilities are often denied equal access to the services, programs, and activities of state and local governments because many websites remain inaccessible.

Despite DOJ's withdrawal of the NPRM, some local and state government entities are taking measures to increase access to technology to make sure their services, programs, and activities are equally available to people with disabilities. For example, due in part to DOJ's enforcement efforts, the city of Milwaukee has agreed to ensure that the city's website conforms to the WCAG 2.0 Level AA standards. This agreement stemmed from DOJ's Project Civic Access, an initiative that helps ensure public entities comply with Title II of the ADA (ADA.gov n.d.).

New York City has taken proactive measures to comply with Title II. On March 14, 2016, the mayor of New York City signed into law Intro. 683-A, which requires New York City to adopt a protocol that is based on federal regulations, the WCAG, or any successor standards in order to ensure people with disabilities are able to access New York City websites. The law includes a provision for instances in which New York City finds the need to deviate from these standards, which involves consulting with experts in web design and reasonable accommodations and

holding a public hearing (N.Y.C., N.Y., Local Law No. 26 [2016]).

ADA Title III: Public Accommodations

Title III of the ADA requires places of public accommodation and commercial facilities to meet accessibility standards promulgated by the Attorney General. Courts have taken different positions on whether "places" of public accommodation applies only to physical places or whether online businesses qualify as places of public accommodation as well. In 2010, DOJ issued an ANPRM announcing its considerations on revising ADA regulations to establish requirements for making the goods, services, facilities, privileges, accommodations, or advantages offered by a place of public accommodations via the Internet, specifically, accessible to people with disabilities. The 2010 ANPRM also reiterated that the ADA mandate for "full and equal employment" requires nondiscrimination by a place of public accommodation in the offering of all its goods and services, including those offered via websites. DOJ's NPRM regarding web access for private entities was expected in July 2016. However, the timeline has been delayed. In fall 2015, DOJ announced its firm belief that the Title II website accessibility rule will facilitate the creation of an important infrastructure for website accessibility that will play a significant role in the Title III website accessibility NPRM. Consequently, DOJ delayed the development of the proposed Title II website accessibility rule and included it among its long-term rulemaking priorities. DOJ currently has not provided a date for the Title III website rule. Until the Title III website rule is in place and in effect, many people with

disabilities will continue to face accessibility barriers as they attempt to engage with businesses and other entities that incorporate web-based technology into consumer experiences.

There is no consensus within the federal courts on the application of Title III to websites. Courts in the First, Second, Fifth, and Seventh Circuits have held or suggested that a place of public accommodation does not have to be a physical structure (*Doe v. Mutual of Omaha, Ins. Co.*, 179 F.3d 557, 559 [7th Cir. 1999]; *Nat'l Fed'n of the Blind et al. v. Scribd, Inc.*, 97 F. Supp. 3d 565, 576 [D. Vt. 2015]). In contrast, courts in the Third, Fourth, Sixth, Ninth, and Eleventh Circuits have held or suggested that Title III is limited to physical structures, or in some jurisdictions,

online businesses with a nexus to a physical structure (*Earll v. eBay, Inc.*, 599 Fed. App'x. 695 [9th Cir. 2015]; *Nat'l Fed'n of the Blind v. Target Corp.*, 452 F. Supp. 2d 946, 953-54 [N.D. Cal. 2006]; *Access Now, Inc. v. Southwest Airlines, Co.*, 227 F. Supp. 2d 1312 [S.D. Fla. 2002]). Despite these courts' interpretations, a host of entities with inaccessible websites and other inaccessible ICT have agreed to structured negotiations to remedy accessibility barriers. This collaborative dispute resolution method, pioneered by disability rights attorneys Lainey Feingold and Linda Dardarian, focuses on identifying solutions without a lawsuit.

21st Century Communications and Video Accessibility Act (CVAA)

The CVAA was enacted in 2010. The legislation addresses accessibility of broadcast and cable TV, broadband, digital, and mobile innovations for people with disabilities, which includes the 36 million Americans with hearing loss and 25 million Americans with a significant vision loss (FCC n.d.). The CVAA is unique in that it was designed specifically to respond to the rapid pace of evolving technology. It also ensures that 20th century accessibility laws are brought up to date with 21st century technologies. As a result of its passage, people with disabilities now have greater access to web browsers on mobile devices, more Internet websites with captions, more television programs with audio description, more accessible controls to access and select programming on their televisions and other devices (e.g., computers, tablets, cellular phones) that show video programming, and audio access to emergency information during television programming that once only appeared as written text on a screen.

In April 2016, the FCC issued an NPRM proposing to expand video access for people with disabilities. The proposed rule calls for:

- An increase in the amount of described programming on each included network carried by a covered broadcast station or multichannel video programming distributor (MVPD), from 50 hours per calendar quarter to 87.5 hours;

- An increase in the number of included networks carried by covered distributors, from four broadcast and five nonbroadcast networks to five broadcast and ten nonbroadcast networks;

- Adoption of a "no-backsliding" rule, which would ensure that once a network is designated an "included network" required to provide description, it would remain an "included network" even if it falls out of the top five or top ten ranking;

- Removal of the threshold requirement that nonbroadcast networks reach 50 percent of pay-TV (or MVPD) households in order to be subject to inclusion;

- A requirement that covered distributors provide dedicated customer service contacts who can answer questions about video description; and

- A requirement that petitions for exemptions from the video description requirements, together with comments on or objections to such petitions, be filed with the FCC electronically (FCC 2016).

The CVAA has brought the accessibility needs of people with disabilities to the attention of

the television industry as well as Internet-based communications and media outlets. The existing and proposed provisions described in the CVAA should be considered not only as federal mandates, but also as opportunities to enhance experiences receiving information and enjoying entertainment among all media consumers, regardless of current disability status.

Patient Protection and Affordable Care Act (ACA)

ACA, signed into law in 2010, requires hospitals and primary care physicians to shift focus to better health outcomes and lower costs and enhance the distribution and accessibility of their professional practices. Among the provisions in ACA is the creation of essential health benefits required as part of private insurance coverage. One of ten health benefit categories that are essential for people with disabilities is rehabilitative and habilitative services and devices. However, ACA does not specify the scope, coverage, or amount of services allowed under this category; instead, each state selects a benchmark plan that all private insurance plans must follow (NCD 2016a). As a result, private insurance plans have the ability to curb benefits by placing caps on coverage for devices or limiting the number of therapy visits covered. Habilitation services are especially vulnerable to the gaps in the regulation because they may not be covered under plans that serve as the benchmark plan for a state. As a result, states and insurers must surpass benchmark plans in order to ensure that these services are covered (NCD 2016a).

Section 1557 of ACA prohibits discrimination on the basis of race, color, national origin, sex, or disability in certain health programs and activities. Under Section 1557, all electronic and information technology-based programs and activities must be made accessible to people with disabilities. This includes making reasonable changes to policies, practices, and procedures to provide equal access for people with disabilities (U.S. Department of Health and Human Services n.d.). Section 1557 also mandates that covered entities take steps to ensure effective communication for people with disabilities by requiring that appropriate auxiliary aides and services are provided to people with disabilities and giving "primary consideration" to a person's aid or service of choice (U.S. Department of Health and Human Services n.d.).

Section 1557 applies to entities with a health program or activity that receives federal financial assistance from agencies within HHS. Covered entities are exempt from the regulation on accessible information technology if "doing so would create an undue financial or administrative burden, or would result in a fundamental alternation in the nature of the covered entity's health program or activity" (NCD 2016b). The nondiscrimination regulations do not apply to Medicare Part B (i.e., medical coverage) or self-insured group plans because they are not considered as receiving federal financial assistance (DREDF 2016; Gordon 2016). The nondiscrimination regulations regarding electronic and information technology also do not apply to health employees with disabilities (DREDF 2016).

Although Section 1557 stipulates that health programs and activities offered through the use of medical diagnostic equipment must be accessible to people with disabilities, it does not provide specific guidance on what this entails. HHS defers to the U.S. Access Board for accessibility standards related to medical diagnostic equipment (Cornachione, Musumeci, and Artiga 2015). ACA added Section 510 of the Rehabilitation Act, which directs the Access Board to develop rules on accessible medical diagnostic equipment. In July 2015, the Access Board approved the text of the final rule. As of July 2016, a subsequent vote has yet to take place to approve the entire rulemaking package, including the preamble to the final rule and final regulatory assessment.

Compliance with the standards that the Access Board issues becomes mandatory only when an enforcing authority adopts the standards as mandatory requirements for entities subject to its jurisdiction. DOJ may adopt the standards as mandatory requirements for health care providers pursuant to its authority under Titles II and III of the ADA. Other federal agencies may adopt the standards as mandatory requirements for health care providers pursuant to their authority under Section 504 of the Rehabilitation Act.

The lack of clarity surrounding coverage of medical equipment and accessibility requirements means that people with disabilities have few protections to ensure that medical equipment meets the most up-to-date accessibility standards. There is a need for HHS Office of Civil Rights and other federal units such as DOJ to issue regulations or policies that require covered entities to meet the

Access Board standards for medical diagnostic equipment when they are finalized.

International Treaties

An estimated 15 percent of the world's population, representing more than 1 billion people, live with some form of disability (U.S. Agency for International Development [USAID] 2016). Although the United States is recognized as a global leader for its domestic disability rights laws, it has signed, but not ratified, two international treaties that pertain—in part— to technology access among people with disabilities. These treaties are the United Nations Convention on the Rights of Persons with Disabilities (CRPD) and the Marrakesh Treaty to Facilitate Access to Published Works for Persons Who Are Blind, Visually Impaired or Otherwise Print Disabled (MVT).

The CRPD is an international treaty that encourages nations to promote, protect, and ensure the rights of people with disabilities in order to realize a fully inclusive global society. The CRPD promotes accessibility to the status of a principle that should be embedded throughout our global society. The treaty specifically speaks to this issue as it relates to ICT, including the Internet. The CRPD advises State Parties to "promote the design, development, production, and distribution of accessible information and communications technologies and systems at an early stage, so that these technologies and systems become accessible at minimum cost" (UN General Assembly 2007).

Support for the CRPD sets an expectation of accessible ICT. Countries that adhere to CRPD principles send a message to the world that they support a society that is responsive and receptive to people with disabilities. This approach to inclusion has the potential benefit to Americans with disabilities who rely on ICT as they travel abroad by fostering opportunities to use technology to engage with their world. These benefits also apply to those who live abroad due to the nature of their work or that of a family member.

The United Nations General Assembly adopted the CRPD in 2006. As of June 2016, 160 nations have ratified the CRPD. Although the United States signed the CRPD on December 4, 2012, the Senate declined to give the President advice and consent in a vote to ratify the treaty. Since then, the CRPD has remained under consideration by the Senate, but the Senate has not voted on it again.

The MVT promotes access to print-based materials among people who are blind, visually impaired, and otherwise print disabled. It does this by setting forth requirements that state parties introduce a standard set of limitations and exceptions to copyright rules to permit reproduction, distribution, and making published works available in formats designed to be accessible to people who are blind, visually impaired, and otherwise print disabled. The treaty also permits the exchange of these works across borders by authorized organizations that serve those beneficiaries. As of June 2016, 17 countries have ratified or acceded to the MVT. The United States has expressed support for the treaty by signing it but has neither ratified nor acceded to it. On February 16, 2016, the President issued a statement urging the Senate to give early and favorable consideration to the MVT, along with its advice and consent to its ratification.

Technology Bill of Rights for People with Disabilities

The rights that people with disabilities have to accessible technology are reflected throughout various policies, including the ADA and the CRPD. In the CRPD, the concept of accessibility is elevated to the level of a principle. This principle is partially manifested through the availability of technology to people with disabilities. Nonetheless, this population continues to face barriers to using technology in everyday settings. This is partly because of the absence of clear language that specifies covered entities' responsibility to provide accessible technology. Our country is in need of a Technology Bill of Rights for People with Disabilities to clarify these rights and demonstrate how existing legislation applies to ICT and assistive technology.

A Technology Bill of Rights for People with Disabilities is highlighted as the guiding recommendation to promote accessible technology in Chapter 5.

Equal access to tech is a RIGHT— the digital divide is real, & disabled people cannot be left behind
—Twitter Chat Participant

Chapter 5: Recommendations to Promote Inclusive Technology

NCD recognizes that technology is instrumental in the full realization of citizenship, as illustrated in the Constitution, for people with disabilities. NCD makes the following recommendations to ensure that people with disabilities are able to experience full education, employment, health care, and community integration.

Recommendations for the President, Congress, and Federal Agencies

The Federal Government should promote the development and use of technology that can be used by all citizens, including people with disabilities. To this end, NCD offers the following recommendations:

1. Congress should establish a Technology Bill of Rights for People with Disabilities that identifies principles to be used for any future technology legislation and clarifies that the current landscape of laws, regulations, and Executive Orders establishes a right to accessible and inclusive technology and ensures equal and fair access to existing and emerging technology and related services. This process will involve NCD creating a Federal Advisory Committee

(FAC) to draft a Bill of Rights with a budget specifically authorized by Congress for that purpose. The FAC will be charged with the following mission: (a) identifying evidence-based public-sector innovation for increasing both the supply and demand for more fully accessible ICT "ecosystems;" (b) expanding the capacity of accessibility technology policy expertise; (c) coordinating across jurisdictional and public-private-advocacy boundaries; (d) reviewing existing regulations and assessing where harmonization can be achieved; (e) fostering collaboration among federal units and private sector entities; and (f) creating language that expressly states that the principles developed through this Bill of Rights applies to emerging and future technologies. The work of the FAC will result in a Bill of Rights that specifically outlines the panoply of technology rights available to Americans with disabilities including, amongst other items, the ADA's application to the Internet, Section 508 updates, and regulation and enforcement actions as identified by DOJ. The Bill of Rights will urge the United States to ratify the Marrakesh Treaty, the CRPD, and future international treaties that aim to

afford access to technology to people with disabilities. The Bill of Rights will be drafted by NCD in collaboration with the FAC.

2. DOJ should issue an NPRM that reinforces in plain language that the ADA relates to the Internet. The NPRM should incorporate WCAG 2.0 Level AA standards.

3. Federal agencies such as DOJ, the U.S. Access Board, and OMB should immediately finalize, clear, and issue—as appropriate— any outstanding regulations regarding accessibility to all ICT (e.g., web content, apps, hardware, software). To ensure that cross-agency regulations complement each other during this process, one federal agency should be tasked with overseeing cross-agency regulations and creating a roadmap that would foster harmonization.

4. Federal agencies should take aggressive steps to achieve and maintain Section 508 compliance. To ensure that this happens,

   a. The Administration should increase oversight and enforcement of Section 508 to ensure compliance.

   b. OMB should update each maturity measure for the compliance of Section 508 to offer additional detail. In addition, OMB should create Section 508 data dashboards that report progress toward Section 508 by agency and make these data dashboards publically available.

5. Congress should reauthorize IDEA to provide greater access to assistive technology in and across all educational settings. This could involve including

specific language that requires students' transition plans to consider training and use of accessible and assistive technology devices in all educational settings. The reauthorization should include a funding stream that offers partial or full reimbursement for students with disabilities to retain assistive technology when transitioning out of their local education agency. Congress should identify and authorize federal units to develop and implement a funding stream to provide partial or full reimbursement for people with disabilities who rely on technology, including CRT, DME, assistive technology, and accessible ICT (for example, a tablet and an app that can perform the same function more efficiently and costs less than a dedicated AT product is not likely to be paid for by public funds) to enhance functional performance in education, employment, health, community living, and other settings. The various funding streams should be analyzed and restructured to promote harmonization.

6. Congress should reauthorize the America COMPETES Act to include language that incentivizes agencies to incorporate a focus on outcomes for, or partnerships with, people with disabilities into their judging criteria.

7. Congress should make greater R&D investments that promote accessible ICT, assistive technology, and future innovations. This should involve:

   a. Greater investments for R&D of accessible apps and devices to

incentivize developers to create innovative technology, including orphan technology, which can help people with disabilities enhance functional performance to improve outcomes in areas such as education, employment, and independent living.

b. Increasing the R&D budget for NIDILRR, the Medical Research and Development Program, and the national disability data surveys in order to improve disability measures of function and participation and field periodic supplements.

c. Provide funding to a federal unit such as the Administration for Community Living (ACL) to design and fund technical assistance on R&D for the technology industry to support accessible design of emerging technology. This "early warning" will remediate the widespread problem of discovering accessibility barriers after a product reaches the market.

d. Provide funding to ACL to establish and expand peer support programs on accessible ICT and assistive technology. These programs could be provided through independent living centers and grassroots experts and should involve a community of practice platform for exchanging information and managing requests for peer consultation.

e. Provide funding to a federal unit such as NIDILRR to administer the development and field implementation of data collection protocols and instruments.

This may include surveys, observation templates, interview questions, and focus group questions to conduct action research on how people with disabilities use accessible and assistive technologies to enhance independence and functional performance. Data collection should include who uses these technologies and how, who does not use them and why, and other topics that treat people with disabilities as customers by examining their market behavior with a view to improving adoption and use of these technologies. The federal unit should also devise and implement a methodology for aggregating data into a national database for report generation and scientific inquiry.

8. Relevant federal agencies should issue regulations that support engaging people with disabilities in leisure and daily living activities through ICT. This should include but not be limited to requiring movie theaters to display films with captioning and audio description and requiring accessible kiosk transitions for entertainment, transportation, and other leisure and daily living activities.

9. The Senate should provide its advice and consent to the President in support of ratifying the CRPD and MVT.

Recommendations for the Technology Industry

The technology industry plays a significant role in determining how people with disabilities can access technology. NCD offers the following

recommendations to help guide the technology industry throughout professional practices:

1. Apply WCAG 2.0 Level AA standards when designing websites and web-based software.

2. Engage people with disabilities to participate in user experience research when developing new technology.

3. Provide technology developers with ongoing professional development on accessible design.

4. Expand training opportunities and information resources to educate consumers on how to use access features to enhance the user experience with technology devices.

5. Make greater investments in R&D of accessible technology.

Recommendations for the Private Sector and Local and State Public Sectors

The private sector and local and state public sectors are responsible for serving all, including people with disabilities. NCD offers the following recommendations to these entities to help maximize offerings to all constituencies:

1. All sectors should establish and implement procurement criteria and procedures that ensure the acquisition of accessible technology.

2. All sectors should ensure that technology used by job candidates and employees is accessible to people with disabilities.

3. All sectors should access federally funded resources such as the Partnership on Employment and Accessible Technology (PEAT) and the Job Accommodations Network (JAN) for guidance on assistive and accessible technology in the workplace.

4. Local education agencies and institutions of higher education should:

   a. Assess all aspects of STEM curricula to identify accessibility barriers that would preclude participation among students with disabilities and correct any accessibility barriers identified.

   b. Include learning standards related to accessible design in all STEM curricula.

5. State health and human services agencies should provide support to the health care industry so that it can implement the final rules of the nondiscrimination requirements in health programs and activities reflected in Section 1557 of ACA and the Access Board standards for accessible medical diagnostic equipment, including examination tables and chairs, weight scales, radiological equipment, and mammography equipment.

6. State health and human services agencies should incentivize insurers to increase coverage for additional habilitative and rehabilitative services and devices beyond those covered by the essential health benefits and the benchmark plan. This would involve an increase in coverage for durable medical equipment and CRT.

Conclusion

Technology that enables access to the full opportunities of citizenship under the Constitution is a right. The 2016 *Progress Report* demonstrates how accessible ICT and assistive technology play an essential role for many people with disabilities as they pursue this right in employment, education, health, independent living, and other aspects of life. Yet many people with disabilities face barriers to using accessible ICT and ICT-related assistive technology. These barriers are grounded in a host of issues including inaccessible design, ICT procurement decisions that do not consider the needs of a diverse user base, the high cost of technology, and limited understanding of access features among the users they are designed to benefit.

An abundance of domestic and international policies exist that promote access to technology among people with disabilities. The general principles of these policies are explicit, yet language in these policies lags behind the rapid pace of technology and new issues that emerge as technology evolves. This ambiguity can lead to discrepancies in the way that people interpret policies and incorporate them into their professional practices, creating a need for a Technology Bill of Rights for People with Disabilities.

A Technology Bill of Rights for People with Disabilities would help clarify the way civil rights apply to people with disabilities and their ability to use technology, regardless of the current or future state of technology. A Technology Bill of Rights for People with Disabilities would also explicitly express the obligations of the public sector, technology developers, private industry, and people with disabilities to evolve in their practices as technology evolves. Because each of these groups has a role in enforcing the rights of people with disabilities as they use technology, it is critical that representation from each group be instrumental in the development of such a document.

As readers reflect on the 2016 *Progress Report*, NCD encourages them to consider their role in transforming our society into one in which people with disabilities can experience the full opportunities of citizenship afforded under the Constitution with the support of accessible technology. It is essential that technology be born accessible from the onset for this to happen. The actions of policymakers, leaders in the technology industry, and decision makers in public-serving entities each play a role in leading the way toward ICT that is born accessible. Policymakers can include provisions for accessible ICT in legislation and policies that they advance and support. Leaders in the technology industry have the power to foster a workforce inclusive of developers that understand and implement WGAC 2.0

and other access standards into products, and engage people with disabilities when testing user experience with products. Decision makers in public-serving entities can require accessible technology acquisitions, which will extend their reach to a broader customer base.

Undoubtedly, it will take a commitment to accessible technology by those with influence over technology offerings in order for everyone to have access to the full opportunities of citizenship guaranteed under the Constitution. The decisions that these influencers make regarding technology has an immediate impact on people who live with disabilities today, and also impacts the millions of technology-dependent people who will age into disability in the future.

References

Abilities.com. n.d. "Product Spotlight: JACO Robotic Arm." *The Buzz*. Accessed August 16, 2016. http://www
.abilities.com/community/buzz/64b-jaco.html.

abilityJOBS. n.d. abilityJOBS. Accessed July 27, 2016. http://abilityjobs.com/.

Access Now, Inc. v. Southwest Airlines, *Co.,* 227 F. Supp. 2d 1312 (S.D. Fla. 2002).

ADA.gov. n.d. "Project Civic Access." Accessed August 16, 2016. https://www.ada.gov/civicac.htm.

America COMPETES Act of 2007. H.R. 2272, P.L. 110-69. 110th Cong. (2007), 121 STAT 572.

American Foundation for the Blind. n.d. "Using Social Media with a Visual Impairment or Blindness: Facebook, Twitter, and LinkedIn." Accessed July 26, 2016. http://www.afb.org/info/living-with-vision-loss/using-technology/using-social-media-with-a-visual-impairment-or-blindness-facebook-twitter-and-linkedin/123.

American Telemedicine Association. n.d. "What is Telemedicine?" Accessed August 12, 2016. http://www.americantelemed.org/about-telemedicine/what-is-telemedicine#.V63r5PkrK9J.

Apple Inc. n.d. "Accessibility." Accessed August 16, 2016. http://www.apple.com/accessibility/.

Assistive Technology Act of 1998, S. 2432, P.L. 105–394, 105th Cong. (1998), 112 STAT. 3627.

Association of Assistive Technology Act Programs (ATAP). 2012. "State AT Program Priorities—August 2012." Accessed August 18, 2016. http://www.ataporg.org/ATProgramPriorities.

Association of Assistive Technology Act Programs (ATAP). 2016. "AT Act Reauthorization Position." Position Paper, Association of Assistive Technology Act Programs.

Bender Consulting Services. n.d. "Our Services." Accessed July 26, 2016. http://www.benderconsult.com/our-services.

Benetech. 2014. "Advancing Math Accessibility with Google Summer of Code 2014." *Benetech Blog,* August 27. http://www.benetech.org/2014/08/27/advancing-math-accessibility-with-google-summer-of-code-2014.

Bernanke, Ben S. 2011. "Promoting Research and Development: The Government's Role." *Issues in Science and Technology* 27 (Summer). http://issues.org/27-4/bernanke/.

Brandt Jr., Edward N., and Andrew M. Pope, eds. 1997. *Enabling America: Assessing the Role of Rehabilitation Science and Engineering*. Washington, DC: National Academies Press.

Brennan, David, Lyn Tindall, Deborah Theodoros, Janet Brown, Michael Campbell, Diana Christiana, David Smith, Jana Cason, and Alan Lee. 2010. "A Blueprint for Telerehabilitation Guidelines." *International Journal of Telerehabilitation* 2 (2): 31. doi: 10.5195/ijt.2010.6063.

Brown, Bob. 2016. "10 Internet of Things Companies to Watch." *Network World*, April 12. http://www
.networkworld.com/article/3053552/internet-of-things/10-internet-of-things-companies-to-watch.html.

Bureau of Engraving and Printing (BEP). n.d. "Meaningful Access Program—Currency Identification Mobile Apps." Washington, DC: U.S. Department of the Treasury. Accessed July 25, 2016. http://www.bep.gov/currencyidmobileapps.html.

Business Wire. 2015. "Amazon Echo Now Available to All Customers." *Business Wire*, June 23. http://www .businesswire.com/news/home/20150623005861/en/.

Center for Implementing Technology in Education. n.d. "Multimedia Instruction of Social Skills." Accessed July 26, 2016. http://www.cited.org/index.aspx?page_id=154.

Centers for Disease Control and Prevention. 2013. *The State of Aging and Health in America 2013.* Atlanta, GA: Centers for Disease Control and Prevention, U.S. Department of Health and Human Services. http://www.cdc.gov/ features/agingandhealth/state_of_aging_and_health_in_america_2013.pdf.

Centers for Medicare and Medicaid Services. (2010). "Electronic Health Record Incentive Program, 42 CFR Parts 412, 413, 422, and 495, RIN 0938-AP78." Medicare and Medicaid Programs, U.S. Department of Health and Human Services. https://www.gpo.gov/fdsys/pkg/FR-2010-07-28/pdf/2010-17207.pdf.

Centers for Medicare and Medicaid Services. (2012). "Electronic Health Record Incentive Program—Stage 2, 45 CFR Part 170, RIN 0991-AB82." Medicare and Medicaid Programs, U.S. Department of Health and Human Services. https://www.gpo.gov/fdsys/pkg/FR-2012-09-04/pdf/2012-20982.pdf.

Centers for Medicare and Medicaid Services. (2015). "Electronic Health Record Incentive Program—Stage 3 and Modifications to Meaningful Use in 2015 Through 2017, 42 CFR Parts 412 and 495, RINs 0938–AS26 and 0938– AS58." Medicare and Medicaid Programs, U.S. Department of Health and Human Services. https://www.gpo.gov/ fdsys/pkg/FR-2015-10-16/pdf/2015-25595.pdf.

CIO Council Accessibility Committee. n.d. "Section 508 OMB Dashboard/Reporting Template." Accessed July 12, 2016. https://section508.gov/sites/default/files/CIOC_Accessibility_Committee_508_Reporting_Template.pdf.

Clancy, Heather. 2014. "Why Stephen Hawking Is Talking Up Intel's Assistive Technology Innovation." *Data Sheet,* December 5. http://fortune.com/2014/12/05/why-stephen-hawking-is-talking-up-intels-assistive-technology- innovation/.

Connecticut General Assembly. n.d. "Survey of States Covering In-Home Telemonitoring." Hartford, CT: Connecticut General Assembly. Accessed August 16, 2016. https://www.cga.ct.gov/hs/tfs/20151008_ Medicaid%20Rates%20for%20Home%20Health%20Care%20Working%20Group/20151109/Survey%20 of%20States%20Providing%20Coverage%20for%20Telemonitoring.pdf.

Cornachione, Elizabeth, MaryBeth Musumeci, and Samantha Artiga. 2015. *Summary of HHS's Proposed Rule on Nondiscrimination in Health Programs and Activities*. Menlo Park, CA: Kaiser Family Foundation. http://kff. org/disparities-policy/issue-brief/summary-of-hhss-proposed-rule-on-nondiscrimination-in-health-programs-and- activities/.

Coxworth, Ben. 2014. "Lechal Haptic Footwear Guides You by Buzzing Your Feet." *Gizmag,* February 21. http://newatlas.com/ lechal-haptic-feedback-navigation-shoes/30939/.

Darkins, Adam, Patricia Ryan, Rita Kobb, Linda Foster, Ellen Edmonson, Bonnie Wakefield, and Anne E. Lancaster. 2008. "Care Coordination/Home Telehealth: The Systematic Implementation of Health Informatics, Home Telehealth, and Disease Management to Support the Care of Veteran Patients with Chronic Conditions." *Telemedicine and e-Health* 14 (10): 1118–26.

Data.gov. 2012. "IDEAL Currency Identifier®." October 31, 2012. https://www.data.gov/education/applications/ ideal-currency-identifier-%C2%AE.

Dharmar, Madan, Patrick S. Romano, Nathan Kuppermann, Thomas S. Nesbitt, Stacey L. Cole, Emily R. Andrada, Cheryl Vance, Danielle J. Harvey, and James P. Marcin. 2013. "Impact of Critical Care Telemedicine Consultations on Children in Rural Emergency Departments." *Critical Care Medicine* 41 (10) (October): 2388–95. doi:10.1097/ CCM.0b013e31828e9824.

Diagram Center. n.d. "Born Accessible Publishing." Accessed July 26, 2016. http://diagramcenter.org/ born-accessible-publishing.html.

Diament, Michelle. 2015. "Graduation Rates Rise for Students with Disabilities." *Disability Scoop*, October 20. https://www.disabilityscoop.com/2015/10/20/graduation-rates-rise/20889/?_sm_au_=iVVDfs7rSRvSqM76.

DigitalGov. n.d. "Federal Social Media Accessibility Toolkit Hackpad." Accessed August 16, 2016. https://www.digitalgov.gov/resources/federal-social-media-accessibility-toolkit-hackpad/.

Disability Rights Education and Defense Fund (DREDF). 2016. "How the Affordable Care Act, Section 1557 Will Affect People in Cross-Disability Communities." *DREDF Newsletters,* May 2016. http://us2.campaign-archive1.com/?u=d8372142072c8ce7f2e90e349&id=0b9f33b211.

Doan, Kenny. 2015. "Japan Engineers Robo-Bear to Replace Human Caregivers." *VR-Zone*. February 25. http://vr-zone.com/articles/japan-engineers-robo-bear-to-replace-human-caregivers/87618.html.

Doe v. Mutual of Omaha, Ins. Co., 179 F.3d 557, 559 (7th Cir. 1999).

Domingo, Mari C. 2012. "An Overview of the Internet of Things for People with Disabilities." *Journal of Network and Computer Applications* 35 (2): 584–96. doi: 10.1016/j.jnca.2011.10.015.

Earll v. eBay, Inc., 599 Fed. App'x. 695 (9th Cir. 2015).

Econometrica, Inc. 2015, February 12. "Preliminary Regulatory Impact Analysis – Proposed Update of Section 508 Standards and Section 255 Guidelines." (Contract No.: GS-10F-0269K. Order No.: DTOS59-09-F-10094. Project No.: 1030-001). https://www.regulations.gov/document?D=ATBCB-2015-0002-0002.

eHealth Initiative. 2012. *An Issue Brief on ehealth Tools and Diabetes Care for Socially Disadvantaged Populations*. Washington, DC: eHealth Initiative. https://ehi-rails-app.s3.amazonaws.com/uploads/article/file/91/2012-09-14_eHI_An-Issue-Brief-on-eHealth-Tools-and-Diabetes-Care-for-Socially-Disadvantaged-Populations.pdf.

Elksnin, Linda K., and Nick Elksnin. 2003. "Fostering Social-Emotional Learning in the Classroom." *Education* 124 (1) (Fall): 63. https://www.questia.com/library/p5118/education/i2654782/vol-124-no-1-fall.

Federal Communications Commission (FCC). 2016. "FCC Proposes to Expand Video Description Rules." News release, March 31, 2016. Accessed July 11, 2016. https://apps.fcc.gov/edocs_public/attachmatch/DOC-338677A1.pdf.

Federal Communications Commission (FCC). n.d. "Twenty-First Century Communications and Video Accessibility Act." Accessed August 16, 2016. https://www.fcc.gov/general/twenty-first-century-communications-and-video-accessibility-act-0.

File, Thom, and Camille Ryan. 2014. "Computer and Internet Use in the United States: 2013." American Community Survey Reports, ACS-28. Washington, DC: U.S. Census Bureau. https://www.census.gov/history/pdf/2013computeruse.pdf.

Food and Drug Administration (FDA). 2015. "What Is a Medical Device?" Last modified December 12, 2015. http://www.fda.gov/AboutFDA/Transparency/Basics/ucm211822.htm.

Fox, Susannah, and Jan Lauren Boyles. 2012. *Disability in the Digital Age*. Washington, DC: Pew Research Center. http://www.pewinternet.org/2012/08/06/disability-in-the-digital-age/?_sm_au_=iVVt5W1FRDFQ4Wq8.

Garg, Vaibhav, and Jeffrey Brewer. 2011. "Telemedicine Security: A Systematic Review." *Journal of Diabetes Science and Technology* 5 (3): 768–77.

GlobalWorkplaceAnalytics.com. n.d. "Latest Telecommuting Statistics." Accessed August 16, 2016. http://globalworkplaceanalytics.com/telecommuting-statistics.

Google. Impact Challenge: Disabilities. Accessed July 24, 2016. https://www.google.org/impactchallenge/disabilities/.

Gordon, Fay. 2016. "New Regulation Prohibits Discrimination in Health Care: Key Highlights for Aging Advocates." *Justice in Aging* (blog). May 31, 2016. http://www.justiceinaging.org/1557-prohibits-discrimination-in-health-care/.

Hamidullah-Bahl, Taskeen. 2015. "How Creating Accessibility for Everyone Benefits Us All." *Forbes BrandVoice*, December 3. http://www.forbes.com/sites/jpmorganchase/2015/12/03/how-creating-accessibility-for-everyone-benefits-us-all/#5e6ddd286756.

HealthIT.gov. 2013. "Basics of Health IT." Last modified January 15, 2013. https://www.healthit.gov/patients-families/basics-health-it.

Henry, Shawn Lawton, and Andrew Arch, eds. 2012. *Developing a Web Accessibility Business Case for Your Organization*. Cambridge, MA: Web Accessibility Initiative (W3C). https://www.w3.org/WAI/bcase/.

Horrigan, J. B. 2010. "Broadband Adoption and Use in America." Omnibus Broadband Initiative (OBI) Working Paper Series No. 1. Washington DC: Federal Communications Commission. https://apps.fcc.gov/edocs_public/attachmatch/DOC-296442A1.pdf.

Individuals with Disabilities Education Improvement Act of 2004, P.L. 108-4556, 108th Cong. (2004), 118 STAT. 2647.

Institute of Medicine. 2007. *The Future of Disability in America*. Washington, DC: National Academies Press.

Jana, Reena. 2009. "How Tech for the Disabled Is Going Mainstream." *Bloomberg Businessweek,* September 24. http://www.bloomberg.com/news/articles/2009-09-23/how-tech-for-the-disabled-is-going-mainstream?_sm_au_=iVVtS4sTsJZHnRSM.

Job Accommodation Network. 2015. "Workplace Accommodation: Low Cost, High Impact." Accommodation and Compliance Series. Last updated September 1. http://askjan.org/media/downloads/LowCostHighImpact.pdf.

Kena, Grace, William Hussar, Joel McFarland, Cristobal de Brey, Lauren Musu-Gillette, Xiaolei Wang, Jijun Zhang, Amy Rathbun, Sidney Wilkinson-Flicker, Melissa Diliberti, Amy Barmer, Farrah Bullock Mann, and Erin Dunlop Velez. 2016. "Children and Youth with Disabilities." *The Condition of Education 2016* (NCES 2016-144). U.S. Department of Education, National Center for Education Statistics. Washington, DC. http://nces.ed.gov/pubsearch.

Keohane, Susann. 2016. "Aging and the Internet of Caring Things." *Age and Ability* (blog), March 11. http://ageandability.com.

Kline, Greg. 2013. "Virtual Environment Makes Purdue's Real-Life Accessible Biology Wet Lab Available Worldwide." *ITaP Newsroom.* Last modified February 22. https://www.itap.purdue.edu/newsroom/news/virtual_environment.html.

Kuniholm, Jonathan. 2009. "Open Arms: What Prosthetic-Arm Engineering is Learning from Open Source, Crowdsourcing, and the Video-Game Industry." *Institute of Electrical and Electronics Engineers* (*IEEE*) *Spectrum*. http://spectrum.ieee.org/biomedical/bionics/open-arms.

Lambrinos, Lambros and Aristotelis Dosis. 2013. "Applying Mobile and Internet of Things Technologies in Managing Parking Spaces for People with Disabilities." In *Proceedings of the 2013 ACM Conference on Pervasive and Ubiquitous Computing Adjunct Publication*, pp. 219–22.

Lazar, Jonathan, and Paul Jaeger. 2011. "Reducing Barriers to Online Access for People with Disabilities." *Issues in Science and Technology* 27 (2): 69.

Lightner, Kirsten L., Deborah Kipps-Vaughan, Timothy Schulte, and Ashton D. Trice. 2012. "Reasons University Students with a Learning Disability Wait to Seek Disability Services." *Journal of Postsecondary Education and Disability* 25 (2): 145–59.

Lindsay, Sally, and Irina Tsybina. 2011. "Predictors of Unmet Needs for Communication and Mobility Assistive Devices among Youth with a Disability: The Role of Socio-Cultural Factors." *Disability and Rehabilitation: Assistive Technology* 6 (1): 10–21. doi:10.3109/17483107.2010.514972.

Loiacono, Eleanor T., and Soussan Djamasbi. 2013. "Corporate Website Accessibility: Does Legislation Matter?" *Universal Access in the Information Society* 12 (1): 115–24.

LoPresti, Edmund F., Andrew Jinks, and Richard C. Simpson. 2015. "Consumer Satisfaction with Telerehabilitation Service Provision of Alternative Computer Access and Augmentative and Alternative Communication." *International Journal of Telerehabilitation* 7 (2): 3.

Mashima, Pauline A., and Charles R. Doarn. 2008. "Overview of Telehealth Activities in Speech-Language Pathology." *Telemedicine and e-Health* 14 (10): 1101–17.

Microsoft Corporation. 2004. "Accessible Technology in Computing—Examining Awareness, Use, and Future Potential." *A Research Report Commissioned by Microsoft Corporation and Conducted by Forrester Research, Inc., in 2004.* http:// download.microsoft.com/download/0/1/f/01f506eb-2d1e-42a6-bc7b-1f33d25fd40f/ResearchReport-Phase2.doc.

Microsoft Corporation. n.d. "Microsoft Accessibility." Accessed August 11, 2016. https://www.microsoft.com/ enable/guides/vision.aspx.

N.Y.C., N.Y., Local Law No. 26 (2016).

Nat'l Fed'n of the Blind et al. v. Scribd, Inc., 97 F. Supp. 3d 565 (D. Vt. 2015).

Nat'l Fed'n of the Blind v. Target Corp., 452 F. Supp. 2d 946 (N.D. Cal. 2006).

National Alliance for Caregiving (NAC) and AARP. 2009. *Caregiving in the U.S. 2009.* http://www.caregiving.org/ data/Caregiving_in_the_US_2009_full_report.pdf.

National Association of the Deaf. n.d. "Movie Captioning." Accessed June 2, 2016. https://nad.org/issues/ technology/movie-captioning.

National Council on Disability (NCD). 2014. *Effective Communications for People with Disabilities: Before, During, and After Emergencies.* Washington, DC: National Council on Disability. http://www.ncd.gov/ publications/2014/05272014.

National Council on Disability. 2015. *Self-Diving Cars: Mapping Access to a Technology Revolution.* Washington, DC: National Council on Disability. www.ncd.gov/sites/default/files/NCD_AutomatedVehiclesReport_508-PDF.pdf.

National Council on Disability. 2016a. *Implementing the Affordable Care Act: A Roadmap for People with Disabilities.* Washington, DC: National Council on Disability. http://www.ncd.gov/sites/default/files/Documents/ NCD_ACA_Report01_508-1.pdf.

National Council on Disability. 2016b. *The Impact of the Affordable Care Act on People with Disabilities: A 2015 Status Report.* Washington, DC: National Council on Disability. http://ncd.gov/sites/default/files/NCD_ACA_ Report02_508.pdf.

National Institutes of Health (NIH). 2015. Notice of Updates to the National Robotics Initiative (NRI). Notice Number NOT-EB-15-008. https://grants.nih.gov/grants/guide/notice-files/NOT-EB-15-008.html.

National Institutes of Health (NIH). n.d. "3D-Printable Prosthetic Devices." Accessed August 7, 2016. http://3dprint. nih.gov/collections/prosthetics.

National Science Foundation, Committee on Equal Opportunities in Science and Engineering (CEOSE). 2009. *Broadening Participation in America's STEM Workforce: 2007–2008 Biennial Report to Congress.* Arlington, VA: Committee on Equal Opportunities in Science and Engineering. http://www.nsf.gov/od/oia/activities/ceose/ reports/2008CEOSE_BiennialReport.pdf.

Netflix Settlement Agreement and Release. 2016. "Settlement Agreement and Release Between American Council of the Blind, the Bay State Council of the Blind, and Robert Baran, as an individual, and Netflix Inc." http://www .adatitleiii.com/wp-content/uploads/sites/121/2016/04/Settlement_Agreement_FOR_WEBSITEv2.pdf.

Neville, Anne. 2015. "National Broadband Map has Helped Chart Broadband Evolution." *National Broadband Map Blog*, March 23. http://www.broadbandmap.gov/blog/.

New York University. 2015. "NYU and AT&T Launch Tech Challenge to Empower People Living with Disabilities." *NYU Steinhardt.* http://steinhardt.nyu.edu/site/ataglance/2015/04/nyu-and-att-launch-tech-challenge-to-empower- people-living-with-disabilities.html.

Office of Management and Budget. 2015. *Analytical Perspectives—Budget of the U.S. Government, FY 2016.* Washington, DC: U.S. Government Publishing Office. https://www.whitehouse.gov/sites/default/files/omb/budget/ fy2016/assets/spec.pdf.

Olmstead v. L.C. 527 U.S. 581 (1999).

Parette, Phil, and Marcia Scherer. 2004. Assistive Technology Use and Stigma. *Education and Training in Developmental Disabilities* 39 (3): 217–26.

Partnership on Employment and Accessible Technology (PEAT). n.d. "PEAT." Accessed August 16, 2016. http://www.peatworks.org/.

Pollack, Mark A. 2005. "Theorizing the European Union: International Organization, Domestic Policy, or Experiment in New Governance?" *Annual Review of Political Science* 8: 357–98.

Pratt, Carl. 2016. "Hackathons a Fundamental Driver of Innovation." *LinkedIn* (January 6, 2016). https://www.linkedin.com/pulse/hackathons-fundamental-driver-innovation-carl-pratt.

Rehabilitation Act of 1973, H.R. 8070, P.L. 93-112, 93rd Cong. (1973). 87 STAT. 335.

Seelman, Katherine D. 2005. "Universal Design and Orphan Technology: Do We Need Both?" *Disability Studies Quarterly* 25 (3). http://dsq-sds.org/article/view/584.

Smith, Roger O. 2016. "The Emergence and Emergency of Assistive Technology Outcomes: Research Methodology." *Assistive Technology Outcomes and Benefits.*

Stoddard, Susan. 2014. "2014 Disability Statistics Annual Report." Durham, NH: University of New Hampshire. http://disabilitycompendium.org/docs/default-source/2014-compendium/annual-report.pdf.

Stumbo, Norma J., Jay K. Martin, and Brad N. Hedrick. 2009. "Assistive Technology: Impact on Education, Employment, and Independence of Individuals with Physical Disabilities." *Journal of Vocational Rehabilitation* 30 (January): 99–110. doi:10.3233/JVR-2009-0456.

Teach Access. n.d. Teach Access. Accessed August 16, 2016. http://teachaccess.org/.

Technology-Related Assistance for Individuals with Disabilities Act of 1988, S. 2561, P.L. 100-407, 100th Cong. (1988), 102 STAT. 1044.

TechTarget. n.d. "Smart Home or Building." Accessed July 21, 2016. http://internetofthingsagenda.techtarget.com/definition/smart-home-or-building.

Tompa, Emile, Alexis Buettgen, Quenby Mahood, Kathy Padkapayeva, Andrew Posen, and Amin Yazdani. 2015. *Evidence Synthesis of Workplace Accommodation Policies and Practices for Persons with Visible Disabilities: Final Report.* Ottawa, ON: Office for Disability Issues, Employment and Social Development Canada. https://crwdp.ca/sites/default/files/documentuploader/full_report_-_evidence_synthesis_visible_disabilties_tompa_et_al._2015.pdf.

UN General Assembly. 2007. Resolution 61/106. "Convention on the Rights of Persons with Disabilities." http://www.refworld.org/docid/45f973632.html.

U.S. Agency for International Development (USAID). 2016. Advancing Disability-Inclusive Development. Last modified January 15. https://www.usaid.gov/what-we-do/democracy-human-rights-and-governance/protecting-human-rights/disability.

U.S. Department of Education. 2016. *Dear Colleague Letter.* Washington, DC: U.S. Department of Education. http://www2.ed.gov/programs/promiseneighborhoods/stemdearcolleagueacces.pdf.

U.S. Department of Education. n.d. "Office of School Support and Technology Programs." Accessed August 9, 2016. http://www2.ed.gov/programs/innovative/index.html.

U.S. Department of Health and Human Services. n.d. Section 1557: Ensuring Effective Communication with and Accessibility for Individuals with Disabilities. Accessed August 9, 2016. http://www.hhs.gov/sites/default/files/1557-fs-disability-discrimination-508.pdf.

U.S. Department of Justice, American Disability Act Division. 2012. *Section 508 Report to the President and Congress: Accessibility of Federal Electronic and Information Technology.* http://www.ada.gov/508/508_Report.htm.

U.S. Department of Labor, Office of Disability Employment Policy. 2014. "Economic Picture of the Disability Community Project: Key Points on Disability and Occupational Projections Tables." https://www.dol.gov/odep/pdf/20141022-KeyPoints.pdf.

U.S. Government Accountability Office. 2015. *Broadband: Intended Outcomes and Effectiveness of Efforts to Address Adoption Barriers Are Unclear*. Washington, DC: U.S. Government Accountability Office. http://www.gao.gov/assets/680/670588.pdf.

Usability.gov. n.d. "User Research Basics." Accessed August 1, 2016. https://www.usability.gov/what-and-why/user-research.html.

ViTA DMF. n.d. "ViTA DMF." Accessed on May 28, 2016. http://vitadmf.org/.

Wahl, Ellen. 2016. "A Study of Research and Internship Programs in Science, Math, Engineering, and Technology (STEM) for Students with Disabilities." AAAS Project on Science, Technology and Disability.

Warmflash, David. 2015. "Using the Human Mind to Control How Genes Work." *Genetic Literacy Project*, May 7. https://www.geneticliteracyproject.org/2015/05/07/using-the-human-mind-to-control-how-genes-work/.

Web Accessibility in Mind (WebAIM). 2016. "Introduction to Web Accessibility." Last modified March 15. http://webaim.org/intro/.

Web Accessibility Initiative (WAI). 2016. "Accessibility, Usability, and Inclusion: Related Aspects of a Web for All." *World Wide Web Consortium.* Last modified May 6. https://www.w3.org/WAI/intro/usable.

Weber, Lauren. 2014. "One in Three U.S. Workers is a Freelancer." At Work (blog), Wall Street Journal, September 4. http://blogs.wsj.com/atwork/2014/09/04/one-in-three-u-s-workers-is-a-freelancer/. World Wide Web Consortium (W3C). 2016. "Understanding WCAG 2.0: A Guide to Understanding and Implementing Web Content Accessibility Guidelines 2.0." https://www.w3.org/TR/UNDERSTANDING-WCAG20/Overview.html.

World Wide Web Consortium (W3C). n.d. "Understanding Conformance." Accessed July 28, 2016. https://www.w3.org/TR/UNDERSTANDING-WCAG20/conformance.html#uc-conformance-requirements-head.

Yin, Michelle, and Dahlia Shaewitz. 2015. *One Size Does Not Fit All: A New Look at the Labor Force Participation of People with Disabilities.* Washington, DC: American Institutes for Research. http://www.air.org/sites/default/files/downloads/report/Labor-Force-Participation-People-with-Disabilities-Yin-Sept-2015.pdf.

Yin, Michelle, Dahlia Shaewitz, and Mahlet Megra. 2014. *An Uneven Playing Field: The Lack of Equal Pay for People with Disabilities*. Washington, DC: American Institutes for Research. http://www.air.org/resource/uneven-playing-field-lack-equal-pay-people-disabilities.

Zuppo, Colrain M. 2012. "Defining ICT in a Boundaryless World: The Development of a Working Hierarchy." *International Journal of Managing Information Technology* 4 (3): 13.

Appendix A: Twitter Chat Summary

On April 13, 2016, NCD led a one-hour long Twitter chat to gather input from youth and young adults with disabilities about priority areas for accessible technology. Topics of discussion align with Chapter 1 of the 2016 *Progress Report* and include education, employment, health and well-being, and independent and daily living. The activity also prompted discussion about the need for a Technology Bill of Rights for People with Disabilities. This summary offers highlights of the Twitter chat and reveals lessons learned from the crowdsourcing activity.

Twitter Chat Highlights

Education

Technology is a critical medium that enables people with disabilities to have access to educational opportunities. Respondents underlined the importance of consistent and accessible technology to cover all people, including those in the disability community and students in individualized education programs. Examples of reported benefits of assistive technology include taking notes, participating in online education, and accessing curricular materials and audiobooks through screen readers. Despite these opportunities, challenges involving technology use exist. For instance, one respondent reported experiencing a sense of isolation by enrolling in online education that led to fewer in-person social interactions. Another felt stigma and lack of understanding of assistive technology by teachers and professors. One respondent identified the need for handwriting to fulfill requirements for the honor code, an issue that could not be mediated with technology. In addition, costs and the lack of training on technology prohibited some respondents from accessing and using technology in postsecondary education.

Employment

The discussions on employment mainly reflected concerns surrounding access to job opportunities, recruitment, and the workplace through technology, as well as accommodations in the workplace. Respondents explained that online applications and virtual interviewing technology have helped people with disabilities in searching, applying, and interviewing for jobs. They have been able to access interview preparation software that is applicable for people with all types of disabilities, work remotely from home, and telecommute with colleagues. Technology has enabled people with a vision-based disability to have access to printed materials in the workplace. One respondent noted that technology expands networks and increases opportunities for advocates to connect.

Respondents also identified employment challenges. Some reported misperceptions that people who physically go to the workplace perform better than those who work remotely. Several respondents reported a shortage of virtual job opportunities. Accessible technology in the workplace proved to be another employment-related challenge. Some respondents indicated that employers still are under the impression that accommodations, particularly for those who work on a computer all day, are considered costly. Furthermore, efforts to persuade employers to secure accessible technology were regarded as difficult. Several respondents expressed a need for increased online paperwork and more usage of text messaging and chat at work. Some respondents identified a lack of assistive technology in the workplace that affected those who use screen readers and other assistive devices, causing them to struggle in performing work duties. One respondent reported a lack of technological accommodation guidelines in work settings. Another noted the need for more people with disabilities to be technology developers and coders.

Health and Well-Being

Respondents suggested that technology has been essential to people with disabilities in terms of critical health functions, such as breathing devices, and independence, such as leg braces and motorized wheelchairs. One person with an orthopedic impairment reported connecting with others online concerning challenges and solutions for family planning. Another respondent wrote that advancements in 3D printing have allowed doctors to create specialized braces at an affordable price. The chat also revealed that technology enables people with disabilities to track their health information, exercise, and medical appointments through apps. Online textbooks have enabled respondents to pursue studies with no risk to physical health.

Although many health-related benefits surfaced during the chat, challenges related to health and technology also emerged. Respondents noted their needs for increased online and Skype communication with doctors and therapists, particularly mental health professionals, because traveling to hospitals is difficult. Another challenge involves the feeling of personal stigma and embarrassment toward health technology equipment use in public.

Independent Living

The most important positive impact of technology that respondents discussed is its ability to connect them with other people with disabilities and to foster participation in national disability advocacy communities. Respondents wrote that technology exposed them to opportunities to learn and exchange information about different topics, such as employment and accommodations. Technology also connected them with others from around the world, people who they would not have had the opportunity to engage with otherwise. A number of respondents presented benefits of technology in recreational activities such as online shopping, social networking, online apps, and racing wheelchairs. Despite these benefits, some participants underlined the need for transportation technology improvements, such as online subway apps, for greater independence and recreation

for people with disabilities. Some respondents mentioned that they faced barriers in accessing conferences and dating websites.

Technology Bill of Rights for People with Disabilities

Participants who commented on the need for a Technology Bill of Rights for People with Disabilities unanimously agreed that accessible technology is a civil right. Many respondents emphasized that a Technology Bill of Rights for People with Disabilities should align with the A11Y Project that enables people with disabilities to access websites more easily. In addition, a respondent noted the need for affordable ICT and assistive technological equipment. Several respondents highlighted that there should be people with disabilities involved in all steps of the technology development process to help ensure accessibility. Some also expressed the need for people with disabilities to provide input to the technology industry to help them better understand the needs of people with disabilities and to develop products that are responsive to those needs. Some participants stated that special considerations should be given to people who experience multiple marginalities, such as living in a rural community and being from a diverse background.

Lessons Learned

NCD Twitter chat produced an array of insights for NCD to consider related to technology policies and practices that impact youth and young adults with disabilities. For example, in the context of education, there is a need for teachers, professors, and others who serve students with disabilities to understand how technology can improve functional abilities as well as the social challenges that can accompany technology use among people with disabilities. In addition, the chat highlighted the need for more targeted training opportunities for students with disabilities so that they can maximize their education performance. Findings from the Twitter chat also suggest a need for employers to better understand how technology can be used as a reasonable accommodation to include youth and young adults with disabilities in the workforce. In addition, there is a need for explicit guidelines that speak to requesting and implementing assistive technology. The discussion also highlights the need for more virtual job fair opportunities so that youth and young adults can seek employment opportunities. In addition, there is an opportunity for more people with disabilities to be trained as coders and to be in positions in which they advise the technology industry on designing for inclusion. NCD learned that youth and young adults have an interest in using online communication with health care professionals to reduce time traveling to health care facilities. In addition, NCD learned that respondents need more accessible and inclusive transportation apps in order to maximize recreation and independent living opportunities. Furthermore, youth and young adults with disabilities would have more opportunities to engage with others if social media platforms had an accessible online presence.

Perhaps the most important lesson learned from the Twitter chat is that youth and young adults with disabilities are in need of a Technology Bill of Rights for People with Disabilities that is developed in collaboration with people with disabilities, reflects this population's needs, and is enforceable.

Appendix B: Glossary of Terms

This glossary serves as a reference for readers to clarify how the 2016 *Progress Report* uses terms that may be unfamiliar to some readers.

Advanced Notice of Proposed Rulemaking (ANPR). An Advanced Notice of Proposed Rulemaking (ANPRM) is a document that an agency may choose to issue before it is ready to issue a Notice of Proposed Rulemaking (NPRM). The ANPRM is used by a federal agency to obtain public input in the formulation of a regulatory change prior to arriving at any decisions on a particular regulatory change (The Regulatory Group, Inc. n.d.b.).

Artificial Intelligence. Artificial intelligence (AI) is the ability of a digital computer or computer-controlled robot to perform tasks commonly associated with intelligent beings. The term is frequently applied to the project of developing systems endowed with the intellectual processes characteristic of humans, such as the ability to reason, discover meaning, generalize, or learn from past experience (Semakuwa and Rashid 2014).

Assistive Technology Device. An assistive technology device is 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 the functional capabilities of a person with a disability. However, the term does not include a medical device that is surgically implanted or the replacement of such a device (ECTA Center 2016).

Assistive Technology Service. Assistive technology service is defined by the Individuals with Disabilities Education Act (IDEA) 2004 as any service that directly assists a child with a disability in the selection, acquisition, or use of an assistive technology device (ECTA Center 2016).

Audio Description. Audio description is a narration and commentary on images. It describes visual details about actions, characters, scene changes, on-screen text, and other visual content that are essential for comprehension for people who are blind or have low vision. It also provides access to a variety of media and arts such as film, performing arts, and museums that comprise any culture (Great Lakes ADA Center 2016).

Auxiliary Aids and Services. Auxiliary aids and services can take many forms, depending on individual needs. Examples of auxiliary aids and services that colleges and universities might be required to provide for students with disabilities include: qualified interpreters or other effective methods of making

aurally delivered materials available to people with hearing impairments; note takers; qualified readers, tape-recorded or digitally recorded texts, or other effective methods of making visually delivered materials available to people with visual impairments or learning disabilities; class materials that are provided in alternative formats (e.g., texts in Braille, on audiotape, or as digital files); or acquisition or modification of equipment or devices (DRC 2013).

Born Accessible. The digital revolution and continuing advances in technology have made it possible for more people to acquire a variety of content in several formats. With these changes, it is imperative for publishers to create content that is "born accessible." This term is used to refer to documents and information that are created in accessible formats that meet the needs of users right from the start (CTD and AIR n.d.).

Closed Captioning. Closed captioning displays the live audio portion of a program as text, which is transcribed by a real-time captioner, on a television screen. It can provide a critical link to news, entertainment, and information for people who are Deaf or HOH. Video programming distributers (VPDs) including cable operators, broadcasters, satellite distributors, and other multichannel video programming distributers are required by Congress to close caption their TV programs (FCC n.d.).

Crowdsourcing. Crowdsourcing is a way of engaging a "crowd" or group for a common goal that typically relates to innovation, problem-solving, or efficiency. Crowdsourcing makes it easier for individuals to contribute ideas, expertise, time, or funds for a project or cause and can take place on different platforms across various industries (Crowdsourcing Week n.d.).

E-Gov. The Office of E-Government and Information Technology (E-Gov) is headed by the Federal Government's Chief Information Officer (CIO). It develops and provides direction on how to use Internet-based technologies to make it easier for the public and businesses to interact with the Federal Government (Office of Management and Budget n.d.).

Information and Communication Technology. Information and communication technologies that facilitate the transfer of information and various types of electronically mediated communication (Zuppo 2012).

Haptic Technology. Haptic technology uses the sense of touch to amplify communication between humans and computers. For example, people with poor vision can use a mouse built with haptic technology that thumps slightly when the cursor has moved over a clickable button. The use of such technology permits businesses to better integrate people with poor vision into the workplace and allows people with poor vision to perform jobs that they would otherwise not be able to perform (RERC 2003).

Internet of Things (IoT). Internet of Things (IoT) is the concept of everyday objects—from industrial machines to wearable devices—using built-in sensors to gather data and take action on that data across a network. An example would be a building that uses sensors to automatically adjust heating and lighting or production equipment alerting maintenance personnel to an impending failure. IoT can transform everyday items into smart devices that can sense, interpret, and react to other elements and devices in an environment (SAS n.d.; Domingo 2012).

Notice of Proposed Rulemaking (NPRM). A notice of proposed rulemaking (NPRM) is a published statement by the *Federal Register* that serves to inform the public of a federal agency's intents for regulatory change. The NPRM describes the proposed new rule or changes in existing rules and informs the public how they may participate in the rulemaking process. In most cases, the public participate by submitting written comments to the agency during the comment period (The Regulatory Group, Inc. n.d.a.).

Orphan Technology. The phrase and notion of orphan technology was borrowed from the Orphan Drug Act of 1983 (P.L. 97-414), in which a rare disease or condition was defined as affecting fewer than 200,000 people in the United States. The drugs that would treat the disease or condition were considered orphan drugs because the market alone could not sustain them; their availability would depend on government subsidies or other external support. In the context of technology, orphan technology refers to an assistive technology device that serves a critical function for a small number of people, and whose market availability is similarly jeopardized (Seelman 2005).

Randomized Controlled Trials (RCT). Randomized controlled trials (RCTs), also known as true experiments or intervention studies, are considered to be the gold standard research design for demonstrating a cause-and-effect relationship between an intervention and an outcome. In RCT studies, people are randomly assigned to either a control group or an intervention group. Outcomes from both groups are compared, and any significant changes between the two groups can be attributed to the intervention (Salmond 2008).

Twitter Chat. A Twitter Chat or Tweet Chat uses Twitter to talk about a common interest with others during a preset time. It's like an online chatroom where you can participate and contribute in various discussions by tweeting (Twubs, Inc. n.d.).

Video Description. Video description is audio-narrated descriptions of a television program's key visual elements that are inserted into the natural pauses in the program's dialogue. Video description makes television programs, films, and other forms of media more accessible to people who are blind or visually impaired (FCC 2016).

References for Glossary of Terms

Center on Technology and Disability (CTD) and American Institutes for Research (AIR). n.d. "Born Accessible Learning Resources." Accessed August 2, 2016. http://ctdinstitute.org/sites/default/files/file_attachments/Born_Accessible_QuickGuide_508.pdf.

Crowdsourcing Week. n.d. "What is Crowdsourcing?" Accessed July 25, 2016. http://crowdsourcingweek.com/what-is-crowdsourcing/?_sm_au_=iVVMNWW7pJQR110j.

Disability Rights California (DRC). 2013. "Rights of Students with Disability in Higher Education: A Guide for College and University Students" (Pub. #5309.01) Accessed July 25, 2016. http://www.disabilityrightsca.org/pubs/530901.pdf.

Domingo, Mari C. 2012. "An Overview of the Internet of Things for People with Disabilities." *Journal of Network and Computer Applications* 35 (2): 584–96. doi:10.1016/j.jnca.2011.10.015.

Early Childhood Technical Assistance (ECTA) Center. 2016. "Federal Definitions of Assistive Technology." Last reviewed February 9, 2016. Accessed July 25, 2016. http://ectacenter.org/topics/atech/definitions.asp?_sm_au_=iVVMNWW7pJQR110j.

Federal Communications Commission (FCC). 2016. "Video Description." Last modified May 31, 2016. Accessed July 25, 2016. https://www.fcc.gov/general/video-description.

Federal Communications Commission (FCC). n.d. "Closed Captioning on Television." Last modified November 3, 2015. Accessed July 25, 2016. https://www.fcc.gov/consumers/guides/closed-captioning-television.

Great Lakes ADA Center. 2016. "Audio Description: The Visual Made Verbal." *Webinars and Audio Conferences*. Accessed July 25, 2016. https://www.accessibilityonline.org/ADA-Audio/session/?id=110484.

Office of Management and Budget. n.d. "Office of E-Government and Information Technology." Accessed July 25, 2016. https://www.whitehouse.gov/omb/e-gov.

Rehabilitation Engineering Research Center (RERC). 2003. "Workplace Accommodations Policy Highlights 1.5." *Workplace Accommodations* (July). http://www.workrerc.gatech.edu/News/Highlights0803.php?_sm_au_=iVVMNWW7pJQR110j.

Salmond, Susan S. 2008. "Randomized Controlled Trials: Methodological Concepts and Critique." *Orthopaedic Nursing* 27 (2): 116–22. http://xa.yimg.com/kq/groups/19792973/1038201281/name/random+controlled+trials+methods+concepts+and+critique.pdf.

Seelman, Katherine D. 2005. "Universal Design and Orphan Technology: Do We Need Both?" *Disability Studies Quarterly* 25 (3). http://www.dsq-sds.org/article/view/584/761.

Semakuwa, Senzota K, and Florence U. Rashid. 2014. "Artificial Intelligence in My Eyes on the Applications to Game Design." *International Journal of Engineering and Advanced Technology* 3 (6). http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.686.3470&rep=rep1&type=pdf.

Statistical Analysis System (SAS). n.d. "Internet of Things (IoT)—What It Is and Why It Matters." Accessed July 25, 2016. http://www.sas.com/en_us/insights/big-data/internet-of-things.html.

The Regulatory Group, Inc. n.d.a. "Regulatory Glossary." Accessed July 25, 2016. http://www.regulationwriters.com/regulatory_glossary?id=35.

The Regulatory Group, Inc. n.d.b. "Regulatory Glossary." Accessed July 25, 2016. http://www.regulationwriters.com/regulatory_glossary?id=5.

Twubs, Inc. n.d. "Twitter Chats." Accessed July 25, 2016. http://twubs.com/twitter-chats/about?_sm_au_=iVVMNWW7pJQR110j.

Zuppo, Colrain M. 2012. "Defining ICT in a Boundaryless World: The Development of a Working Hierarchy." *International Journal of Managing Information Technology* 4 (3): 13–22. doi:10.5121/ijmit.2012.4302.