wirelessRERC
REHABILITATION ENGINEERING RESEARCH CENTER

ENVISIONING INCLUSIVE *FUTURES*

State of Technology Summit

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PROCEEDINGS

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NIDILRR
NATIONAL INSTITUTE ON DISABILITY, INDEPENDENT LIVING, AND REHABILITATION RESEARCH

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Envisioning Inclusive FUTURES

State of Technology Summit Proceedings

Contents

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These Summit proceedings are dedicated to the memory of Dr. James White, who served as the Futures chair and who pushed us from our comfort zones…"if this, then this"…into the possibilities of Futures thinking…"what if…"

The contents of these Summit proceedings were developed under a grant from NIDILRR (grant number 90RE5007-01-00). NIDILRR is a Center within the Administration for Community Living (ACL), Department of Health and Human Services (HHS). The contents of these Summit proceedings do not necessarily represent the policy of NIDILRR, ACL, HHS, and you should not assume endorsement by the Federal Government.

INTRODUCTION

In the United States, more than 56 million people have been identified as having a disability, constituting nearly 20% of the total US population. When the Rehabilitation Engineering Research Center for Wireless Technologies (Wireless RERC) launched in 2001, wireless technology was on the cusp of a revolution. WiFi was a novelty and the "cloud" was still largely a dream. Rudimentary internet access was available on a limited number of "(not-so)-smart" mobile phones. Social media were limited to chat rooms, dating websites and instant messaging. To fully understand how people with disabilities use and could benefit from wireless devices, a Consumer Advisory Network (CAN) and Survey of User Needs (SUN) was created. The first results of the SUN in 2004 revealed that 66% of people with disabilities owned a mobile/wireless device. By 2013 the percentage had risen to 91%. In the Deaf community wireless devices quickly became a fundamental communications platform. People who rely on Augmentative and Alternative Communications (AAC) increasingly were using tablets as an assistive technology. Voice controls, speech-to-text, hands-free features and switch access have been major facilitators for people with a variety of disabilities.

Funded since 2001 by the National Institute on Disability, Independent Living and Rehabilitation Research (NIDRR), the Wireless RERC is a recognized leader on issues and solutions related to the accessibility and usability of mobile wireless products and services by people with disabilities. Our mission is to research, evaluate and develop innovative wireless technologies and products that meet the needs, enhance independence and improve the quality of life and community participation of individuals with disabilities.

The Wireless RERC team members have worked directly with consumers, industry, wireless carriers and device manufacturers and design students to increase their knowledge of the user experience of people with disabilities. We have helped regulators understand the needs of people with disabilities by participating in more than 50 rulemakings, especially rules that ensure access to emergency alerts and been cited more than 150 times, impacting the outcome of rules affecting people with disabilities.

In short, the Wireless RERC research, engineering and policy work has had a significant impact on accessibility. Wireless RERC projects include:

- User Center Research: Consumer Advisory Network
  The purpose of this project is to enhance consumer participation in wireless research and development by expanding and refining the research "portal" into the needs of people with disabilities for wireless technologies. This portal is the Wireless RERC's Consumer Advisory Network (CAN), the nationwide network of approximately 1,500 individuals with all types of disabilities. Additionally, through our Survey of User Needs (SUN) we track changes in use, usability, and needs and wants of people with disabilities by periodically re-surveying a representative national sample of previous SUN respondent. Another goal is to examine how wireless technology and social media promotes inclusion of youth with disabilities.

- Policy Approaches to Promote Access to Wireless Technologies
  This project provides substantive input into policymaking to help reduce barriers and accelerate adoption of accessible wireless products, services (including emergency alerts), and software applications. This project conducted the preparatory research and policy analysis related to the needs of people with disabilities, accessibility, and migratory shifts from legacy, fixed technologies to higher-functionality next-generation wireless technologies that framed the theme and topics for the Summit. Additionally, our participation in the federal rulemaking process with evidence-based input, has helped to inform the development of wireless technology policy and regulations that are inclusive of the needs of people with disabilities. Relevant technology policy findings have been provided to key stakeholders via the timely dissemination of information. A key output of this project is the T*echnology and Disability Policy Highlights*.

- App Factory
  The overall purpose of this project is to advance universal design in the wireless community. The objectives of this project are development, deployment, and adoption of software applications ("apps") to enhance the utility and usability of wireless products and services for wireless customers with and without disabilities. App Factory output includes apps designed specifically to address barriers to wireless access and use by people with cognitive, physical, sensory, and/or speech disabilities. Wherever practical, these apps incorporate features useful to all customers, with or without disabilities. A complementary objective of this project is development of a practical model for consumer participation in the process of app development. In 2011, the Wireless RERC pioneered the App Factory to fund innovative ideas that enhance the utility, usability and accessibility of wireless products and services. Eleven mobile apps have been released and have accumulated over 500,000 downloads.

- Emergency Lifelines on Wireless Platforms
  This project's development work provides alternative and accessible emergency lifelines over wireless platforms that assist people with disabilities in managing the transition from (a) legacy alerting systems (e.g. broadcasts over TV and radio) to (b) next-generation versions of the Emergency Alert System (EAS), Wireless Emergency Alert (WEA) messages and next generation distribution systems for emergency alerts, such as social media platforms. Researchers explore and tests new capabilities that can be added to future versions of next-generation alerting systems; and demonstrates, testifies, and participates in working groups. Findings from development activities on accessible solutions to deliver emergency alerts and information are shared with government agencies, policymakers, wireless technology designers/developers, emergency management officials, and organizations serving people with disabilities.

- Promoting Awareness of Access and Usability Needs for Wireless Devices
  The purpose of this project is to advance awareness among industry and consumers on usability and accessibility issues, and available solutions, to improve use of wireless

products and services by people with disabilities. Training and technical assistance are provided to consumers in selecting and using wireless devices, services and applications; promoting knowledge translation and dissemination of App Factory deliverables; assisting industry in understanding and addressing the needs of their customers with disabilities; and serving as an industry liaison to coordinate procurement and allocation of resources received from industry across RERC projects (e.g., mobile devices, software development kits, technical expertise). A key output of this project is the Wireless Independence Now! (WIN!) Workshops… an AT&T and Wireless RERC roadshow on mobile device accessibility for people with disabilities.

- Building Research Capacity in Wireless Accessibility and Usability
  This project provides opportunities for advanced-level research training on accessibility and usability of mobile wireless technologies. It includes four activities: 1) graduate research traineeships, 2) universal design curriculum development in design-related courses at Georgia Tech, 3) annual student design competitions focused on access and usability of mobile wireless technologies, and 4) training in accessible applications development for programmers with disabilities. A key output of this project is the "Getting Wireless" student design completion. Since 2010, the Wireless RERC has been offering industrial design (ID) students an opportunity to participate in a brief project to explore application of the Principles of Universal Design to mobile wireless technologies. Faculty of the ID programs of Georgia Tech and Virginia Polytechnic Institute and State University (Virginia Tech) have embraced the challenge and incorporated this project in their spring curricula.

- SoT Summit - Envisioning Inclusive Futures: Migratory Trends in Technology
  The overall purpose of this project was to create a state of technology event which would disseminate research findings and develop strategies to ensure that people with disabilities have access to wireless technologies and services of tomorrow. The Summit addressed five broad areas related to trends in mobile wireless technologies and their real and potential impacts. The macro topics include: 1) technology; 2) society/culture; 3) economics; 4) law/policy, and 5) health.

SHOWCASE & RECEPTION

Day one of the Summit featured 18 poster presentations and technology demonstrations that targeted solutions to address a wide range of visual, speech, hearing, mobile, emotional and cognitive disabilities. Following is a brief description of participants:

Wireless RERC Demos

- **App Factory**: recognizing the growing importance of "apps" to enhance the accessibility and usability of wireless products, the App Factory creates an "open (to any app developer) shop" to promote development of a variety of software applications that address the needs of people with disabilities. Two apps that were featured were:

- ZyroSky A simple but engaging single-switch accessible runner game reinforcing cause and effect App.
- BrailleTouch A smartphone app that allows people that are blind and visually impaired to type on a touchscreen.

❖ **Bluetooth enabled external alerting interface:** connects to mobile phones via Bluetooth and alerts the user with a sequenced light display and a siren only when a Wireless Emergency Alert (WEA) is received on an associated phone. It allows up to 3 accessible attachments to be connected to the device, such as a pillow shaker, bed shaker or strobe light.

❖ **Student Design Challenge: Universal Design for Travel:** Georgia Tech sophomore industrial design students implement techniques related to universal design, empathy, and marketing to incorporate/utilize wireless technologies. The project task was to design a suitcase for air travel to meet the needs of the general market as well as users with limited mobility (defined for this project as manual wheelchair users). Below are a list of the demonstrations presented at this showcase:

- AeroCase
- Ambi-Pera
- Any Trip
- Carry On
- COSM!
- Digi Duffle
- Evanesce
- Float
- Modulo Luggage
- Pac Trac
- Sherpa

❖ **Easy as Pi Youth Code Club (Youth Code) Demos**

Youth Code engaged local K-12 students in computer programming to stimulate an interest in pursuing computer science degrees and eventual careers. Grady High School students were given Raspberry Pi programmable computers to develop projects that would benefit people with disabilities. The club is an education and outreach activity piloted by BCS, the Chartered Institute for IT, USA Section, Southeast Regional Group (SERG) and the CACP.

- Cam PI-Spy An inexpensive alternative to security surveillance, which provides capabilities to benefit users that are elderly and/or have a disability. Through the use of motion sensors, Cam-PI Spy is able to capture the images that matter.
- Roam Therapy An aroma therapy prototype that uses Raspberry Pi and Arduino interfaces to create a remotely accessible essential oil diffuser. Designed to be beneficial to people with emotional disabilities and other needs.

Related Development Projects

Early Bird A mobile application that displays a unique hashtag (#) to provide additional information to users with disabilities during times of emergency. It can be linked to a variety of social media sources to provide important lifesaving information in greater detail than is currently possible. Funded by the Department of Homeland Security, Federal Emergency Management Agency.

EyeRemember is a Google Glass app that helps users with memory difficulties keep track of the people in their circle, such as friends and family. It works in conjunction with Bluetooth low-energy beacons (BLE)-small transmitters- that must be worn or carried by friends. The project is funded by a Glass Accessibility Award the team received from Google in 2014.

SUMMIT PARTICIPANTS

Speaker & Facilitator Biographies

Steve Bauer, Ph.D.
Project Officer, National Institute on Disability and Rehabilitation Research (NIDRR)

Dr. Steve Bauer is a Project Officer at the National Institute on Disability, Independent Living, and Rehabilitation Research (NIDILRR) with a focus on assistive and universally designed technologies. His research includes: 1) the Assistive Technology Device Classification (ATDC) and its application to technology (medical, assistive, universal) classification, technology (assistive, universal, ICT-based) design, and public policy; and 2) the Assistive Technology Service Method (ATSM) and its application to cross-disability, inter-disciplinary, trans-contextual service provision that is both ethical and evidence based. Steve's core interest also spans public policy, technology transfer, knowledge translation and transaction spaces, diffusion of innovation, the International Classification of Functioning, Disability, and Health (ICF), and other important standards (e.g. ISO9999, ISO26000).

Mike Jones, Ph.D.
Co-Director, Wireless RERC
Vice President for Research and Technology, Shepherd Center

Dr. Mike Jones is Vice President for Research and Technology and founding Director of the Virginia C. Crawford Research Institute at Shepherd Center. Prior to coming to Shepherd Center in 1996, Dr. Jones was executive director of the Center for Universal Design at NC State University, a NIDRR-funded RERC. While at the Center for Universal Design, Dr. Jones and Jim Mueller coordinated the team of investigators that created the Principles of Universal Design. Dr. Jones also served as associate director of the Research and Training Center on Independent Living, from 1982-1988.

Helena Mitchell, Ph.D.
Principal Investigator and Co-Director, Wireless RERC
Executive Director, Center for Advanced communications Policy

Dr. Helena Mitchell is a Regents' Researcher, which represents the highest academic status bestowed by the Board of Regents, which governs the University System of Georgia. In tandem she is the Executive Director of the Center for Advanced Communications Policy (CACP) at the Georgia Institute of Technology. She is also the Principal Investigator (PI) for the Wireless RERC and PI for several emergency communications projects funded by the U.S. Department of Homeland Security (DHS). As CACP's executive director she focuses on program building, development of multi-unit interdisciplinary teams and cutting-edge policy/research initiative. Her areas of specialty include broadband and wireless communications, educational technologies, regulatory and legislative policy,

emergency/public safety communications, and universal service to vulnerable, rural and inner city populations.

Salimah LaForce
Project Director, Wireless RERC
Research Analyst, Center for Advanced Communications Policy

Salimah LaForce is a Research Analyst for the Georgia Tech Center for Advanced Communications Policy (CACP). She conducts policy and industry research and analysis for CACP's emergency communications initiative. Additionally, Salimah is the project director for the Wireless RERC's research project, Policy Approaches to Promote Access to Wireless Technologies. A chief responsibility of Salimah's is information and data collection, analysis and dissemination of resultant findings and reports. She is instrumental in the tracking and drafting of comments filed on pertinent Federal Communications Commission rulemakings; editor of the monthly policy newsletter, *Technology and Disability Policy Highlights*, and has co-authored more than 50 conference papers, journal articles, and regulatory filings.

Wendy Shultz, Ph.D.
Director, Infinite Futures

Dr. Wendy Schultz is an academically trained futurist with over thirty years of global foresight practice. Her MA and PhD research in the Alternative Futures program at the University of Hawai'i at Manoa focused on leadership, vision, and creativity. She has designed and facilitated futures research projects for NGOs, government agencies, and businesses. Dr. Schultz's conference keynotes, workshops, and publications include topics as varied as emerging change and evolving patterns of risk in the rail industry; innovations and the future of art; future competitiveness for urban regions; the future of transport; the future of learning and higher education; and the role of women in designing our emerging technological futures, among others. Her award-winning articles on futures methods and applications have been published in *Futures*, *Foresight*, and the *Journal of Futures Studies*. She is a member of the Association of Professional Futurists; Professional Member of the World Future Society; a Senior Fellow at the Center for Post-normal Policy and Futures Studies; a Fellow of the World Futures Studies Federation and its VP of Operations; and a Fellow of the Royal Society for the Encouragement of Arts, Manufactures, and Commerce.

Presenting Author Biographies

DeeDee M. Bennett, Ph.D.
Assistant Professor, University of Nebraska Omaha, School of Public Administration

DeeDee Bennett, Ph.D. is an Assistant Professor in the Emergency Services Program within the School of Public Administration at University of Nebraska Omaha. Her research focuses on the intersection of emergency management, advanced communications, and socially vulnerable populations. Dr. Bennett has authored in several places including emergency

management journals, textbooks, federal research reports, published white papers, practitioner briefs, and conference proceedings. Additionally, she has worked on six sponsored research projects in the field, with two as principle investigator. Dr. Bennett received her B.S. in Electrical Engineering and M.S. in Public Policy from the Georgia Institute of Technology and received her Ph.D. from Oklahoma State University's Political Science Department in Fire and Emergency Management Administration.

John Bricout, Ph.D.
Associate Dean, University of Texas at Arlington (UTA)

Dr. Bricout's research focuses on the influence of social technology on community participation outcomes for people with a disability. He also studies university-community research collaborations, and the development of online communities of practice. He was a 2012 Fulbright Scholar in the Republic of Georgia at the Ivane Javaakishvili Tbilisi State University (TSU) where he lectured to graduate and undergraduate students in Applied Social Psychology. Dr. Bricout is currently the UTA site Principle Investigator on a three-year National Science Foundation grant (2014-2017) on human user-assistive robot learning networks, with a focus on user engagement factors and ethics.

Joshua Cole
Engineer & Inventor

Engineer and Inventor Joshua Cole has worked in the consumer electronics and telecommunications industry for fifteen years, starting in technical support and network operations, and working his way to a position as a senior engineer in product development. Mr. Cole is a subject matter expert specializing in accessibility, hardware design, and emerging technologies. He is the author of one of the first comprehensive carrier driven accessibility specifications in wireless, and is an avid proponent of universal design and Kansei engineering. Joshua currently resides in Overland Park, Kansas.

Richard Einhorn
President, Einhorn Consulting, LLC

After losing much of his hearing to a virus in June 2010, award-winning composer, music producer, and recording engineer, Richard Einhorn, has become a nationally known advocate for better hearing assistance. Einhorn has consulted on the design of hearing apps for smartphones; written articles for audiology and medical magazines, and given numerous talks. Graduating summa cum laude from Columbia University, Einhorn's *Voices of Light* has been called a "great masterpiece of modern music." He won a Grammy for producing Yo-Yo Ma's Bach Suites recording. Recently, Einhorn was elected to the board of the Hearing Loss Association of America.

Maribeth Gandy Coleman, Ph.D.

Director, Wearable Computing Center, Georgia Institute of Technology

Dr. Maribeth Gandy is the Director of the Wearable Computing Center and of the Interactive Media Technology Center within the Institute for People and Technology at Georgia Tech. She received a B.S. in Computer Engineering as well as a M.S. and Ph.D. in Computer Science from Georgia Tech. In her fourteen years as a research faculty member her work has been focused on the intersection of technology for augmented reality, mobile/wearable computing, human computer interaction, assistive technology, and gaming.

Mark Hakkinen
Research Scientist, Educational Testing Service

Dr. Hakkinen is a Research Scientist in the Center for Validity Research at Educational Testing Service (ETS) in Princeton, New Jersey. His research focuses on accessibility and assistive technologies, with specific interest in innovative access to STEM content using multimodal interfaces on tablet devices incorporating haptics and audio. Dr. Hakkinen has a long involvement in accessibility standards and currently chairs the IMS Global Learning Consortium's APIP Accessibility Task Force, and co-chairs the W3C Research and Development Working Group.

Tracy Mitzner, Ph.D.
Associate Director, Human Factors & Aging Laboratory, Georgia Institute of Technology

Dr. Tracy Mitzner is a Senior Research Scientist at the Georgia Institute of Technology and the Associate Director of the Human Factors and Aging Laboratory (www.hfaging.org). She serves as a Co-Director of the Rehabilitation Engineering Research Center, Technologies to Support Successful Aging with Disability, funded by the NIDRR. She is also an investigator for the Center for Research and Education on Aging and Technology Enhancement (CREATE www.create-center.org), funded by the NIH (National Institute on Aging). Dr. Mitzner's current research is exploring how current technologies (e.g., computers, tablets, smartphones) and emerging technologies (e.g., robotics, wearables) can be used to provide support for the physical and social wellness of older adults.

Brenda Phillips, Ph.D.
Associate Dean, Ohio University Chillicothe

Brenda Phillips, Ph.D., is the Associate Dean and Professor of Sociology at Ohio University in Chillicothe. She is the author of multiple books in the field of emergency management including *Disaster Recovery*, *Introduction to Emergency Management*, *Qualitative Disaster Research* and most recently *Mennonite Disaster Service: Building a Therapeutic Community after the Gulf Coast Storms*. Dr. Phillips is the recipient of the Blanchard Award for excellence in emergency management education and the Myers Award for work on the effects of disasters on women. She was inducted into the International Women's Hall of Fame for Emergency Management and Homeland Security in 2013. She has been funded multiple times by the

National Science Foundation to study disasters, particularly as they affect vulnerable populations.

Helen Sullivan, Ph.D.
Research Psychologist, Rider University

Dr. Sullivan is a Cognitive Psychologist and Adjunct Professor in the Department of Psychology at Rider University. Her research interests revolve around human sensory and cognitive processes, and the use of mobile devices to support individuals during times of crisis, as both a cognitive support and sensory substitution aid. Dr. Sullivan has been active in international projects examining mobile technologies and crisis communications, most recently as senior researcher on a multi-year European Union funded project at the University of Jyvaskyla in Finland.

Respondent Biographies

David Dougall
Director, Accessibility & Sustainability, BlackBerry Limited

Dave Dougall has worked on accessibility programs for the past eight years at BlackBerry, a leading designer, manufacturer, and marketer of innovative wireless data solutions. As Director of Accessibility and Sustainability, Dave is responsible for promoting awareness and expertise of accessibility and sustainability requirements and opportunities among BlackBerry's designers, developers, and managers.

David Dzumba
Manager, Microsoft

David Dzumba joined Microsoft after 15 years with Nokia in Texas. While there, he established Nokia's Accessibility program, including early innovations of text-to-speech on devices for customers who were blind, and an inductive loop for t-coil-equipped hearing aid users. He has served as the co-chair of the FCC's Emergency Access Advisory Committee and as panelist for organizations including the European Year of Disabilities, NCLUDE/STAKES, Cost219bis, Tiresias, TAG, and U.S. Department Homeland Security. Dzumba has a Master of Science, summa cum laude, in Engineering Telecommunications from Southern Methodist University. He also serves on the Advisory Board of the Wireless RERC at Georgia Institute of Technology.

Kendra Green
Manager, Regulatory Compliance at Samsung Telecommunications America

Kendra Green is Regulatory Compliance Manager for Samsung Electronics America. She is responsible for driving accessibility and regulatory issues for a range of mobile devices. Since 2000, Kendra and her team have developed solutions that specifically address accessibility challenges. As Samsung's Designated Agent for Accessibility, she has personally helped

customers with disabilities learn more about Samsung mobile device features that directly support and help overcome accessibility challenges. She holds a Bachelor of Science in Electrical Engineering from Prairie View A&M University; Master's in Business Administration from Keller Graduate School of Management; and legal studies at Concord Law School.

Jamie Hastings
Vice President, External and State Affairs, CTIA - The Wireless Association

Jamie Hastings joined CTIA in 2011 and is responsible for advocating on policy issues for the U.S. wireless industry before all levels of state government, including public service commissions, state legislatures, governors and state attorney generals. She also engages numerous third-party organizations on a variety of topics and analyzes state legislation and regulatory proposals to ensure market-driven policies continue to reflect the ever-changing and innovative wireless industry.

Lee Mabie
Director, Emerging Consumer Markets, AT&T Mobility

Lee Mabie is AT&T's Director of Emerging Consumer Markets. In his role Lee advocates for the disability, aging and informal caregiver consumer segments; a population of 131 million Americans via the award-winning AT&T Advisory Panel on Access and Aging (AAPAA). Lee lives in the metro-Atlanta area, has been married to Liz Mabie for 14 years. He is a father of four children, volunteers at Watermarke Church, has coached youth basketball and is a former Cub Scout Den Leader with The Boy Scouts of America. Lee enjoys competitive running in 5K and 10K events and studies martial arts through the American Taekwondo Association.

Vincent Martin
Ph.D. Student in Human Centered Computing, Georgia Institute of Technology, College of Computing

Vincent Martin is the first totally blind graduate student in the history of Georgia Tech. His initial education consists of three undergraduate degrees: Textile Engineering Technology, Industrial Engineering Technology, and Psychology with an emphasis In Engineering Psychology. He holds a Master's of Science in Human Computer Interaction and is currently in the PhD program in Human Centered Computing. Based in Dr. Bruce Walker's sonification lab in the School of Psychology, his research interests include haptic and auditory access to computer software and hardware, mobile interfaces, and wayfinding devices for the blind.

Jim Mueller
Universal Design Specialist

Jim Mueller is an Industrial Designer with more than 20 years of experience in assistive technology, disability management, and universal design. He is recognized as one of the most experienced practitioners and advocates of universal design (i.e. design for people of all ages and abilities) and is one of the authors of the 7 Principles of Universal Design. His clients have included federal and state agencies, private employers, disability insurers, and product manufacturers.

Richard Ray
ADA Technology Access Coordinator, City of Los Angeles, Department on Disability

Richard Ray is an ADA Technology Access Coordinator for the City of Los Angeles Department on Disability. Mr. Ray oversees compliance with the Americans with Disabilities Act regarding communication access to City and County of Los Angeles as well as state and local governments. Mr. Ray is a co-Chair of the National Emergency Number Association Accessibility Committee. Mr. Ray was appointed to serve on the Federal Communications Commission Optimal PSAP Architect Task Force and Disability Advisory Committee. Mr. Ray is involved in several projects including Emergency Notification Systems, Text Messaging to 9-1-1 and Next Generation 9-1-1.

Leanne West
Chief Engineer for Pediatric Technologies, Georgia Institute of Technology
Director of the Landmarc Research Center

Leanne West is the Chief Engineer for Pediatric Technologies for Georgia Tech and the Director of the Landmarc Research Center. As Chief Engineer, she coordinates all research activities across campus that are related to pediatrics. She helps manage the formal relationship with Children's Healthcare of Atlanta. As the Director of Landmarc, she coordinates a team of researchers who focus on mobile and wireless system development, database development, and system integration. She serves on the executive management teams of the Parker H. Petit Institute for Bioengineering & Bioscience, as well as the Institute for People and Technology, with the goal of creating large-scale collaborations across campus in the area of healthcare.

Also Around the Table

Paul Baker, PhD, Senior Director, Center for Advanced Communications Policy
Bill Belt, Senior Director, Technology and Standards, Consumer Electronics Association (CEA)
Carrie Bruce, Research Scientist, Center for Assistive Technology and Environmental Access
Peter Casanova, Project Director, Wireless RERC
Christina Choi, Project Director, Wireless RERC
Joan Durocher, Director of Policy & General Counsel, National Council on Disability (NCD)
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FUTURES OF DISABILITIES

The Wireless RERC has been at the forefront of the migratory shift to wireless technology and how it can positively impact people with disabilities. Reflection on the history of wireless accessibility and prospecting its future promise led us to convene the 2015 State of Technology Summit: ENVISIONING INCLUSIVE ***FUTURES***. As a result of a futures-oriented process, including a Delphi survey, this high level meeting prioritized disability access issues on a range of social, technology and policy factors. This invitation-only event provided the unique opportunity to bring 45 subject matter experts together to advance pathways to a future which is more inclusive of all citizens.

THE DELPHI SURVEY

Background

The gap between the potential and the reality of technology as a resource for people with disabilities is growing. For example, CTIA-The Wireless Association reports wireless penetration in the US exceeding 104% and 90% of households using wireless products and services (2015). Wireless phone service expenses surpassed landline service expenses in 2007 with youth (under 25) spending the most on cellular service (United States Department of Labor, Bureau of Labor Statistics), indicating that youth are driving the move away from landline use. Such migratory trends and transitions in technology have the potential to create a large-scale, positive impact on educational attainment, employment and social inclusion.

At present the reality differs. While many companies and colleges only allow on-line applications, many such applications are not accessible to people with vision disabilities. Telework as an accommodation could improve the unemployment rate of people with disabilities as the availability of wirelessly connectivity and mobile devices has led to an increasing number of support applications. The availability of support technologies available to people with disabilities can also promote independence in the workplace. Further, virtual technologies can be used to simulate job environments as a means of coaching people with disabilities on effective approaches to daily activities and work tasks. Yet with all of these technology advancements, non-institutionalized, people with disabilities, ages 21-64 still only make up 35% percent of the labor force, compared to 77% of their non-disabled counterparts (Erickson, et al. 2015).

In terms of educational attainment, only 14% of non-institutionalized, people with disabilities age 21-64 have earned a Bachelor's Degree or higher (Erickson, et al. 2015) in spite of the potential for tablet computers, eReaders and distance learning to positively impact inclusive educational environments. The implementation and application of new technologies within the contexts of education, employment and social inclusion is currently not effectively meeting the needs, enhancing the independence or improving quality of life and community participation of people with disabilities. The availability of the technology alone, is not a solution for the socioeconomic and cultural change required to significantly impact the population of people with disabilities.

In some cases, new technological advances may result in some parts of the population being left behind. For instance, TTY (teletype) use among people with hearing loss is in rapid decline. Yet, there is only limited alternate access for a person who is Deaf or speech impaired to contact 9-1-1 from their mobile device. Despite the body of disability access law, problems persist for people with disabilities gaining and maintaining access to information communications technologies and the benefits that ensue. Maintaining access is central to the discussion because technological developments far outpace the rules and regulations that govern their use. A prime example is the to-and-fro of rules and regulations governing broadband.

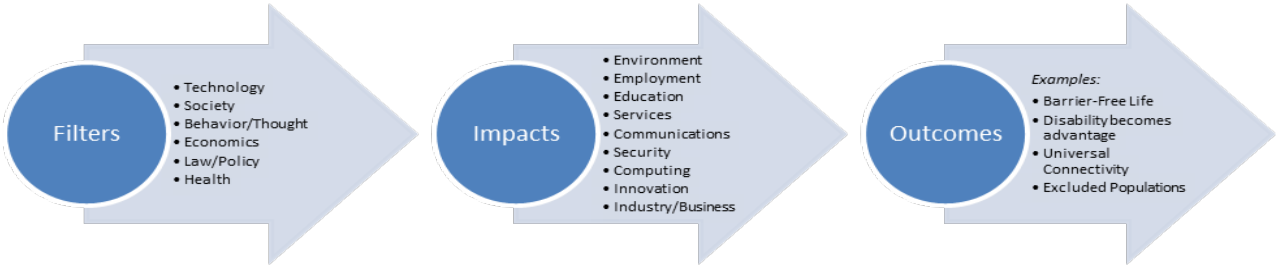
Why are people with disabilities still not fully participating in the technological revolution, and what future possibilities exist to change the situation? What are the possible consequences of the migration to mobile, digital technologies for people with disabilities? The focus of the Wireless RERC's Delphi research was to seek answers to these and other questions such as why technology is not living up to its promise for people with disabilities. Is it policy, poor implementation, cost, disinterest, lack of awareness, prejudice? What are the systemic barriers that keep people with disabilities excluded from full participation in the technological revolution? The outcomes of the research and the Summit proposed answers to these questions and suggested positive alternate futures.

Methodologies

Through the analysis of the results of a futures exercise utilizing a modified, policy-oriented Delphi method researchers explored answers to the questions posed by these challenges. Delphi is a set of procedures for eliciting and refining the opinions of a group - usually but not always a panel of experts (Dalkey 1967, Brown 1968). It is a group communication process, aimed at "allowing a group of individuals, as a whole, to deal with a complex problem" (Linstone and Turoff , 1975:3). The aim of a policy Delphi is not to achieve consensus but to generate a wide range of views: in short to act as a forum for ideas and to explore a range of positions on different topics related to the issue (Bjil 1992). In this case the primary issue focus of the Delphi was on the migration from legacy technologies to advanced communications services and wireless technologies. An ancillary focus was on the split between migrators and non-migrators, e.g. what is the nature of those who are falling behind, is the gap closeable and what is the potential of those who are already caught up? Migratory trends are interpreted broadly, to include macro trends (e.g. analog to digital, fixed to mobile, and content migration including social media, cloud, and smart/connected everything) and micro trends (e.g. print to electronic text, TTY to mobile, etc).

In preparation for the Summit, a literature review and environmental scan were conducted which identified search filters and possible impacts which could be affected by migratory trends (see figure below).

Figure 1: Literature Review Framework and Progression



In developing this schema, categories of opportunities and barriers were cross-referenced to arrive at sixteen areas of focus. The areas were: defining disability; cloud computing; near field communications; wearable devices; 3-D printing; ageing; shifts in familial patterns; environmental changes; employment; economic fundamentals; policy time lag with technology; implications of a more transparent policy process; privacy; secondary health conditions; health/environmental impacts; and veterans.

Round one of the Delphi polling presented a description of these areas and resulted in 44 open and close-ended questions to prioritize the issues. In round two, a preliminary analysis of the first round of the Delphi process resulted in a refined set of 23 questions for the experts to indicate levels of probability that the issues would be addressed and/or realized. Round three, was the Summit. The Summit participants, based on presentations and pursuant discussions, suggested possible futures that could counterbalance the otherwise grim picture that faced people with disabilities.

Delphi Results

Across two rounds of Delphi polling, more than 50 independent experts participated. In round one, respondents from academia made up 40% of the total respondents, with industry (19%) and government (19%) respondents together serving as the counterweight. Disability organizations (8.3%) rounded out the remaining independent experts. However, in round two, the respondent profile was more balance across all groups. Academia represented 33%, disability organizations (24%), business/industry (20%) and government at 22%.

	Round One	Round Two
Academia	40%	33%
Disability Org	8.3%	24%
Business/Industry	19%	20%
Government	19%	22%

Top Issues Rated Very Important and Important – Round One

The closed questions broadly addressed the 16 focus areas identified above, asking respondents to rate the issues as very important, important, slightly important or not important. The questions were designed to assess the experts' priorities. By combining the

totals for those that selected important and very important, researchers arrived at the top seven issues identified by respondents:

- The potential of **apps**, specifically in communications (98%)
- **Accessible solutions**' impact on technology adoption (94%)
- **Increased life expectancy** of people w/disabilities (94%)
- Time lag between **innovation and policy/regulations** (92%)
- **Affordability**'s influence on technology adoption (90%)
- Expanding role of the **family caregiver** (i.e. medical) (88%)
- Greater stigma associated with **mental health** issues (88%)

With regards to people with disabilities, the expert respondents overwhelmingly deemed apps, and since apps operate on wireless devices, by extension smartphones, tablets and wearables, as the most important migratory trend. The issue of increased life expectancy of people with disabilities also rated as very important. This demographic trend could result in growing the population of people with disabilities, thus creating more demand for accessible technologies that support independent living.

Top Issues Rated Probable and Highly Probable – Round Two

Respondents were challenged to focus more narrowly on the migration from legacy, analog technologies to mobile, digital technologies. Some of the provisional conclusions (as suggested by the answers judged most probable, and with most confidence) reinforced the trends indicated in the first round. In general, respondents were confident of the increased importance of digital technology in the lives of people with disabilities. In particular migration of technology from analog to all things digital was judged likely to have a positive impact on the social inclusion of people with disabilities, the accessibility of wireless technologies positively impacting communications, and access to an inclusive education.

- **Digital technology** will become more important (100%)
- Wireless technology will increase **social inclusion** opportunities (95%)
- Increased accessibility of wireless tech will **increase communications** (94%)
- Tech migration could positively impact **inclusive education** (91%)
- Tech convergence will **increase independence** (89%)
- Migration could positively impact **accessible public services** (89%)
- **Smart environments** for health, emergency response, etc. (88%)

Issues Rated Least Import and Least Probable

From a Futures perspective, it's important to note the outliers, as they can be missed opportunities if ignored. Their potential impacts may also go unnoticed and unchecked until they become a massive issue. If the impact is positive, it's a welcome surprise; but if the impact is negative, society has to scramble to fully understand and address the issue to mitigate any further damaging effects. By example, there was seeming skepticism about "smart environments" ever becoming a reality, and about the notion that the migration of

technology from analog to all things digital could have a positive impact on accessible public services. If the accessibility of smart environments is not considered now, if they ever become a reality, retrofitting and reengineering might be required. Further, if the smart environment features and interfaces are not relevant or usable by people with disabilities from the beginning, a new divide may be created where people with disabilities could be excluded from certain features and benefits of smart homes, buildings and cities. The top items in this category included:

Least Important

- **ADA Generation**'s impact on migration to wireless technology (25%)
- Perception of tech as fashionable impacting **perception of disability** (28%)
- **Youth w/disabilities** more likely to share emergency information on social media (32%)
- People w/disabilities **representation in the media** (33%)

Least Probable

- Tech migration will have little impact on **older adults** (25%)
- For redundancy and maintenance of capabilities **traditional phone networks** should be retained (31%)
- Realization of the **universal design** principle (36%)

The final review of the Delphi took place at the State of Technology Summit. Within the context of technology migration, topic areas addressed by participants included accessible design, human augmentation, emergency response, personalization, wearables, robotics, aging, artificial intelligence, independent living and more. The Summit brought together subject matter stakeholders to explore the implications of the current state and emerging trends in wireless technologies that are most likely to impact people with disabilities. The goal of the Summit was to identify ways and means to promote adoption of research findings, technology development, and policy recommendations for managing the technological migration from legacy technologies to advanced communications and computing services. The results and conclusions from the Summit are presented in these proceedings.

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SUMMIT OVERVIEW

The Wireless RERC convened its State of Technology (SoT) Summit on May 14-15, 2015 in Atlanta, Georgia. The Summit included 45 subject matter experts in disability advocacy, wireless technology, communications policy, emergency management, hearing access, aging and disability, wearable computing and more.

The Summit focused on 1) key social, economic, political and technological forces at play in the migration from legacy, analog technologies to mobile, digital technologies, and 2) explored the consequential futures for people with disabilities. Two rounds of Delphi polling collected and aggregated expert opinions on complex or ambiguous forecasting problems. The Summit was a dialogic meeting, and served as the final phase of the assessment and forecasting process.

The "dialogic meeting" approach was utilized as a dynamic process open to conversations, comments and clarifications. The philosophical basis of the futures studies approach was to acknowledge that many ideas about potential futures exist. The futures process allowed participants to explore, analyze, compare, and critique competing concepts of "the future." Specifically, they engaged in dialog on the alternative possible inclusive future(s) of people with disabilities, in the context of technological migration, and explored innovative paths to a transformative future for people with disabilities.

The Process for Participants

Over the course of the two Delphi Rounds trends began to appear that either confirmed the status quo or challenged the status quo for inclusive Futures. Respondents to both rounds were then sent an invitation to submit a paper for discussion at the Summit. From the initial response of over a dozen, 9 authors were selected by the Summit steering committee to submit full papers that spanned the identified themes and to present those papers at the Summit. Additionally, each paper was assigned a respondent who was asked to remark on the content in the context of an "inclusive future." This process opened the third and final round of the Delphi and stimulated the Summit discussion.

Day One – Beyond the First Horizon: Emerging Changes

The nine papers framed the Summit's three thematic clusters: technological, social, and change process factors. Highlights of each paper were presented, responded to and then discussed by the participants.

First, authors gave a nine minute summation of the key points of their paper. Each author had a poster of an icon or image that was illustrative of the main concept of his or her paper. Participants were given a pad of Post-it notes. During the author's presentation, they jotted down ideas, questions, "ah-hahs" on the notes, and a runner stuck them to the presenting author's image.

Then, the nine respondents shared their reaction to the papers. The floor was then opened to discussion by all invitees. Attendees continued to jot down ideas, questions, and "ah-hahs." At the close of the session, the authors stood by their icons/images and the attendees were able to ask questions and discuss their comments with the authors.

Some common themes derived from day one's presentations and discussions included:

- Distinctions between the able and differently abled will decrease due to embedded technology.
- The paradox of privacy in a connected world.
- Performance enhancement/hyper abilities.
- Interoperable technology and interoperable User Experience.
- "Another AI," second consciousness, Assistive Intelligence.
- Autonomy - understanding of user preferences, not just needs – human agency.
- Transparency – transparent, usable, affordable.
- Policy Divide – tech solutions, will policymakers fund it, approve it, regulate it?
- Pro-sumption and co-design.
- Wearable devices as sensors.

Following are Day One paper abstracts and open discussion notes:

DAY ONE: BEYOND THE FIRST HORIZON - PAPER ABSTRACTS & DIALOGIC ROUNDTABLE

Technological Factors

The Future of Mobile Consumer Technology for People with Hearing Loss

Authored and presented by Richard Einhorn, Einhorn Consulting, LLC

Figure 1: Author One - Icon/Poster Image

Extended Abstract: People with hearing loss, some 48 million Americans, have a severely reduced ability to extract desired sound information such as speech or music from background noise. The consequences are severe, ranging from extreme social isolation to a significantly higher risk of dementia and other physical diseases.

While hearing loss is undoubtedly a medical problem with no biological cure likely within the next 15 years, hearing assistance is essentially an acoustic problem. Present-day hearing aids consist of very small microphones, digital signal processors, and loudspeakers worn on (and in) the ear. Although they are convenient and unobtrusive wearable technology, hearing aids often do not significantly improve speech comprehension in many real world sound environments due to several design constraints, including less than optimal microphone placement. Thus, even modern hearing aids are used by a small segment of the population that could benefit from them.

Wireless headsets and smartphones typically include larger microphones, bigger batteries, and more sophisticated audio processing capability than hearing aids. By linking such devices together and adapting them for hearing assistance, it is possible for mobile consumer technologies to minimize background noise and improve speech comprehension in many live situations. Future wireless technologies will permit the networking of microphones in multiple mobile devices, improving hearing comprehension even when it is extremely noisy. As a result,

many people with hearing loss may be able to hear as well as, if not better, than their normal-hearing companions.

This new hearing model is close to a classic "paradigm shift," disrupting and challenging conventional orthodoxy on hearing assistance. Currently, a trained audiologist meets patients in person, tests their hearing, and then programs their hearing aids, an expensive and time consuming process. In the future, most patients will simply run a smartphone app that automatically tests their hearing for them and configures affordable earpieces that wirelessly pair with their smartphones. Typically, fine-tuning will occur over the Internet rather than in person during time-consuming office visits.

Such dramatic changes to the current hearing assistance model will create numerous challenges. Manufacturers' high margins are likely to drop. Audiologists will need to redefine their role as hearing specialists or risk being side-lined by automated, cloud-based diagnostic and fitting algorithms. App designers may create difficult-to-use interfaces. The way people are trained to use hearing devices will need to change. Separate companies in the hearing industry may choose to retain their proprietary wireless protocols for connecting devices together rather than seek a common standard. This could easily lead to compatibility problems between different brands, customer confusion, and continued underuse of hearing technologies. In addition, regulations may limit innovation and consumer choice.

Despite the challenges, companies in the future will find ways to leverage consumer level mobile technology to create affordable, more reliable, more effective, and less stigmatizing hearing assistance, enabling millions to hear and communicate with friends, co-workers and the people they love.

Participant Notes

For this paper, participant's considered how the technologies discussed would be regulated and how the current system would be transformed by allowing for the user to configure their hearing technology, as opposed to an audiologist. Below are some notes to the author:

- Mastoidal conduction.
- OEMs already working on this solution.
- Great idea to break the wire.
- Would regulatory agency regulate the software app? What if app developer is very small?
- Stakeholder resistance to change >>> audiologists.
- Also consider individuals who do not want to "correct" their hearing – eg, deaf community want to use sign language.
- Wearable directional microphones.
- Disruption of traditional systems of care.
- New fields – oral rehabilitation regulatory change.
- Advanced directional microphones pose privacy threats – private conversations will be a thing of the past.
- Not just for hearing loss? Also hearing enhancement in a noisy environment.

- "Medical conditions may be missed" > probably not, with concurrent rise of health sensors and health apps.
- Increasing ability for users to tailor entire sensory suite – all incoming senses, filtered.
- Wearable and *fashionable.*
- Requirement for common technical standard for wireless interface – not tied to one manufacturer.
- De-stigmatize.
- Collapse of traditional hearing aid industry (parallels collapse of the Polaroid camera market).
- Audiologists play greater role in the training of solutions.

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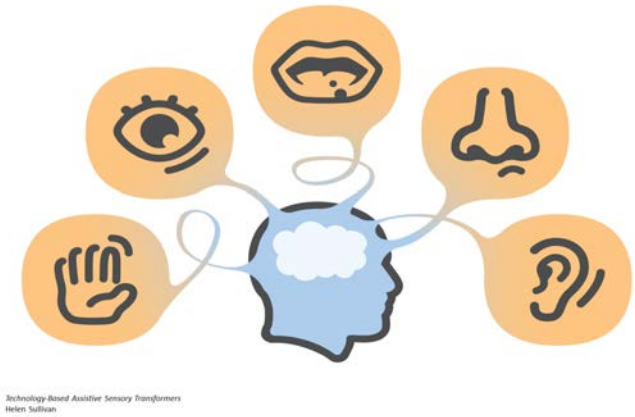
Technology-Based Assistive Sensory Transformers

Authored and presented by Helen Sullivan, PhD, Rider University

Figure 2: Author Two – Icon/Poster Image



Extended Abstract: One thing we can count on is that technology is in constant change; in the past the iterations appeared less rapid than today's regular stream of new technological innovations. We can gauge potential changes in the future by recognizing key transitions from one technology to another.

We will focus on what technologically influenced changes can be expected for people with disabilities, such as for people who are deaf and hard of hearing. One challenge faced by people who are deaf is an inability to recognize events in their environment cued by sounds. The hearing aid is technology that enables reception of these cues for those with some hearing, but the relatively recent ubiquity of smart phones, tablets and apps enables intelligent signal processing and alerting. Thus a key enabling change is the addition of apps that augment human senses, via a technological platform such as mobile phones or tablets.

In the future, whether the devices utilize apps, or more likely become a platform of personal services and functions that is seamless, they will have the capability to serve as sensory

transformers or substitution mechanisms. Individuals with impaired or no hearing may use the devices to communicate with others using sign language, via a camera and gesture recognizer; obtain updates for their digital cochlear implants, upgrade or improve the software to allow for enhanced hearing; or transform the spoken word into text narratives. With wearable technology, such as Google Glass, spoken dialog can be transformed into text captions visible only to the wearer. Students in the classroom who are deaf or hearing impaired would have barriers removed or significantly lowered by utilizing wearable speech processors that provide captions.

Today's simple vibratory feedback will evolve into sophisticated haptic interfaces to serve as a substitute for hearing, transforming environmental sounds into tactile cues. While the deaf may currently use a vibratory alarm in their pillows for fire or urgent notification, the potential exists to use vibrotactile cues to transform sound qualities, directionality and rhythm. Currently digital pedometers, used to monitor daily exercise also track hours asleep, heart rate, calorie intake, water intake and more. These devices provide vibrations on a wrist band to serve as notification of reaching a goal and allows for repurposing the wrist-borne vibrator to generate "silent" alarms to awaken the wearer. Such wearables are only the tip of the iceberg. Whether information is generated by the user, reporting health data gathered by wearable devices, or received from outside sources, and then passed from person to person, for conversation, interaction with medical staff, or between students and teachers, we anticipate continued miniaturization and blending of technology that will place the focus not on the technological tool, but on the task that the user wishes to accomplish. This trend will integrate ever more sophisticated technologies into devices we use and wear, linking more technological platforms, and evolving an elegant simplicity of use. Current day, effortful techniques will transform, blurring the lines of what is biologically synchronous technology and what is actually part of our human body.

Participant Notes

For this paper, participant's considered how the technologies discussed could impact the stigma associated with different disabilities. Below are some notes to the author:

- New stigma for a "new sense."
- How might this new technology affect the disability culture – especially "the Deaf"?
- Hyper-hearing.
- If we go smaller with everything, it's hard to use for older adults and those with fine motor problems.
- Environment and wearable / mobile understands the context of need.
- Great technology! What happens in the future? Where do we go?
- Couldn't these technologies be useful for those without disabilities too?
- Shift from qualitative / sensory understandings to quantitative / data-based.
- What happens if assistive 'ware is hacked?
- Possible to destigmatize disabilities because no-one can see what you're using your iPhone/iWatch/Fitbit *for*….
- New haptic language?
- Bodily sensations to augment other senses.

- Steep learning curve for alternative sensory input (e.g., cochlear implant) – especially for people with cognitive impairment.
- Leverage existing technologies already in smartphones – here now.
- Bionic effects – "cellphone cyborgs."
- Information transformation – simpler text. Add > symbols (non-text).
- Interactive innovations – gesture / speech control.
- Technology adapting media – privacy and security concerns.
- Immersive supportive environments throughout homes and businesses – Amazon Alexa (Amazon Echo) – summon assistance through voice or gesture commands (see *"Iron Man"* movies – Jarvis).
- Impaired population very diverse – some have much greater challenges which may not easily be aided with technology.
- It's not about device size – it's about the accessibility of the I/O.
- How might smart systems in homes transform caregiving?
- VEST – "Versatile extrasensory transducer" – uses sense of body to map cochlear patterns on body.
- Language and thought assists – possible futures for managing verbal or cognitive input or output for those with dyslexia, dementia, other cognitive impairment.
- Implantable Augmented Reality.
- Improving communications with groups and individuals.

♦♦♦

Robot-Human Collaborative Learning Communities: The Future of Innovative Accessibility

Presented by John Bricout, PhD, University of Texas - Arlington
Authors: John C. Bricout, PhD; Bonita B. Sharma; Paul M.A. Baker, PhD; Aman Behal

Extended Abstract: The information age in general, and the digital age in specific, offers new opportunities for learning that builds on the possibilities of non-physical connectivity while bypassing barriers posed by the physical. For people with disabilities, the tension between the two has been a concern often downplayed, almost as if by unwritten agreement, with strong implications for access to social goods such as education, employment, recreation and political participation. Perhaps more than any other facilitative technology, "socially assistive robotics (SAR), a new field of robotics that focuses on assisting users

through social rather than physical interaction[1],” represents a ground breaking development at the intersection of physical and non-physical learning. Hence, SAR offers a unique approach for significantly increasing the capabilities, and hence the social participation of people with disabilities. Emergent trends in augmentative technologies point to at least three inclusive future scenarios with accessibility cross-cutting digital and physical spheres of knowledge and action.

Digital communities populated by SARs and human users can spur accessibility by collaboratively creating a joint space for learning and exchange, unbound by physical constraints. SARs can dialogue with users in communities of interest, networked within broader wireless connections in the digital sphere, transforming both access to social goods and the market value of users as participants in information economies. This collaboration shifts the context from barrier-free, place-bound connections to informational, relational and experiential ties that expand with the networked capabilities of the SAR-user community. In broad terms, the accessibility flowing from this collaboration transforms normative processes to generative ones in the frame of technological advances, offers new interaction patterns, changing policy discourse, labor market participation, and commercialization.

How inclusive the SAR-user community proves to be in the future will depend upon the larger ecology of social technologies in which it is nested. A continuum can be drawn from a relatively ‘open ecology’ characterized by highly interdependent and coordinated social technologies, seamlessly integrated with facilitative technologies, to a comparatively ‘closed ecology’ of specialized and independent social technologies. Determining factors for which end of the continuum SAR-user communities will occupy include market-driven developments in systems interoperability, policy-driven resource alignments and technology-driven advances in the integration of intelligent agents. Three scenarios with differing facets of inclusivity reflecting ‘open,’ ‘closed’, and ‘middle-range’ ecologies possible in the future are: the ‘nexus scenario’ at high openness, at the ‘closed’ end, the ‘niche scenario,’ with the ‘community of communities’ scenario occupying a mid-point and possessing attributes of both closed and open ecologies. The implications of the continuum for inclusiveness and accessibility are non-linear and nuanced; more openness is not necessarily associated with greater accessibility or inclusiveness. Choice and self-determination are key threads in the accessibility and inclusiveness mosaic and operate at several levels concurrently, including conceptualization, design, functioning and relationship. The structure and culture of SAR-user communities and their relationship with the broader ecology will be critical to achieving higher-order accessibility outcomes such as enhanced user capabilities, learning, exchange and market value.

Policy and technical actions to foster generative AR-user communities will be discussed, together with a preliminary model of accessibility—positive AR-user communities in each of the three future scenarios.

[1] http://robotshelpingkids.yale.edu/overview

Participant Notes

For this paper, the discussion moved to more facilitative technologies such as robotics that focus on assisting users. Below are some notes to the authors:

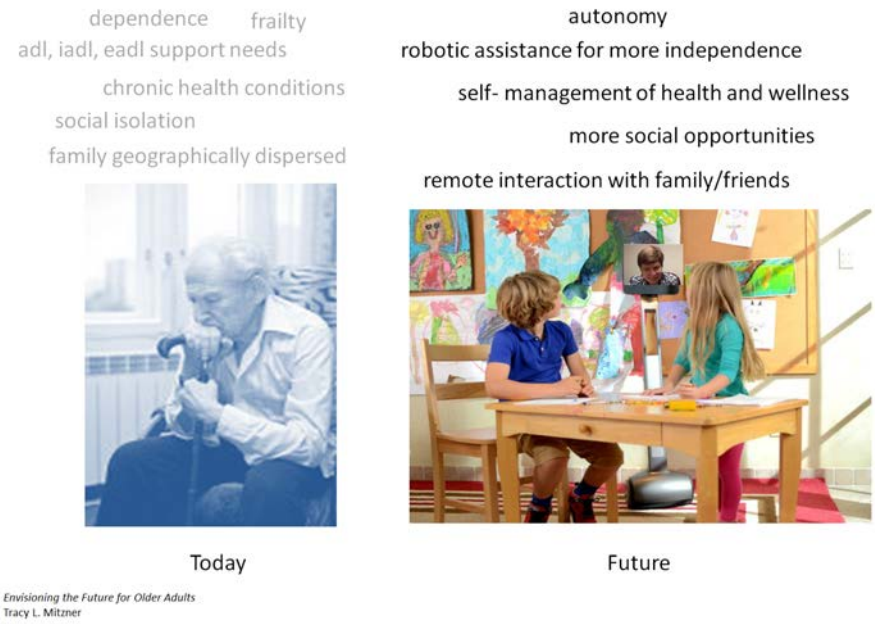
- What are some foreseeable responses to this technology by the disability community and their individual and collective cultures? Will this / these responses lead or follow those of the non-disabled community?
- Early adopters with disabilities need to share with manufacturers how and why and what their specific benefits are from their use case scenarios – build awareness.
- "I'll have my SAR contact your SAR."
- Love the idea of robots and humans living together – but do the robots take over?
- Issues of sentience? Do Socially Assistive Robots *want* to help?
- Think about how a social robot could identify early signs of depression or health decline – early intervention.
- Impact on emergency situations – could assist people with disabilities.
- Potential impacts on PAS (personal assistive services).
- Internet of Things is here now and will continue to morph.
- Configuration options provide choice.
- Village concept enhanced with robotics.
- The personas / scenarios seem "stretched" towards high tech solutions without making alternative low/no-tech solutions clearly impractical. Could this vision of technology be revised to support and facilitate – and encourage – self-help and self-management as a first choice over substituting tech for personal control?
- Natural social interactions – human > robot; who initiates?
- Communities of humans and socially assistive robots: what new conflicts would arise?
- Ambiguity of Asimov's Laws of Robotics – "A robot must never harm a human" – danger of "nanny" robots who restrict human freedom for our own good.
- Family dynamic changes.

Social Factors

Envisioning the Future for Older Adults: The Potential of Technology

Presented by Tracy Mitzner, PhD, Georgia Tech, Human Factors & Aging Laboratory
Authors: Wendy A. Rogers & Tracy L. Mitzner

Figure 4: Author Four - Icon/Poster Image



Extended Abstract: Who is the older adult of 2050? On many dimensions, future older adults will be similar to today. They will want to remain independent as long as possible. Many (currently 30%) will live alone in their own home and most will be managing multiple chronic health conditions with up to 40% having serious disabling conditions (Mitzner et al., 2014). They will need assistance with Activities of Daily Living (ADLs such as bathing, toileting), Instrumental Activities of Daily Living (IADLs such as preparing meals, managing medications), and Enhanced Activities of Daily Living (EADLs such as social communication, new learning). They will experience age-related changes in motor, perceptual, and cognitive capabilities. Although they will have experience with many technologies, there will be new developments that they will have to learn and incorporate into their daily routines.

Some differences in 2050 – the number of individuals over the age of 65 will almost double. They will have an active aging mindset; their approach to healthcare will be participatory; they will want autonomy, and will have a longevity focus. Given continued migratory patterns, family members will likely live long-distance and options for professional support may be limited due to financial constraints and workforce shortages. Thus, risk for social isolation may increase, which evidence suggests may impact their health negatively.

Consider this sample scenario:

Ronnie lives alone and needs assistance mostly with IADLs (meal preparation, medication reminders) and EADLs. She just had foot surgery so also has some temporary mobility challenges. Her family lives 500 miles away and her current ability to leave the house is reduced. She is less able to participate in her usual exercise class or meet friends. However, technological advances enable her to: actively engage with family and friends; meet her healthcare and nutritional needs; and ambulate easily around the house to tend to her personal needs. These supports are seamlessly integrated into her home, easy to use, and not intrusive:

- *Her personal robot, GOBI, can order food online, based on Ronnie's preferences and dietary restrictions. GOBI can then prepare meals on demand depending on Ronnie's schedule for a particular day. GOBI ensures safety of food preparation, proper storage of leftovers, and cleans up after the meal. While Ronnie eats, she is connected via a telepresence system to her daughter's home where her family is also having dinner therefore providing a community dining experience.*
- *GOBI reminds Ronnie to take her medications and brings her the required food and/or water. GOBI records when the medications were taken, side effects experienced, and effects on how she feels and on her vital signs. This information is incorporated into Ronnie's health record which is updated and accessible to her healthcare team as well as to Ronnie to identify patterns of medication effects.*
- *Her exercise trainer/physical therapist supervises and monitors her exercise routine using a telepresence system attached to a device that accurately and precisely captures Ronnie's movements.*
- *Her healthcare provider makes house calls via a telepresence system to monitor her overall health and examine her foot to ensure her surgical wound is healing well.*
- *Ronnie uses a robotic walker that helps her get out of bed or up from a chair, is small enough to fit into her bathroom, and is safe to use in the shower.*

This scenario illustrates the potential for technology to support the diverse needs of future older adults. This would be a predictable scenario given the current trajectory of technology development. However, for this to be accomplished there remain important research and development efforts. Some of the groundwork has been accomplished but many design, training, deployment, and policy issues are yet to be addressed.

A more far-reaching and transformative scenario is represented below:

Dave lives alone in remote rural cabin in the northwest. He cannot drive due to vision limitations and the weather conditions often prohibit others from coming to visit. As a result he is rather isolated and has difficulty getting to appointments. He is in relatively good health but he does have a serious heart condition that requires continuous monitoring and periodically electrical stimulation.

- *His transportation needs can be met in a variety of ways depending on the weather and his plans for the day. He can use the ride-share program to find out if any of his neighbors are going to town that week. Or he can reserve the autonomous car to take him on his errands.*

- *His telepresence system is a holograph that enables family members to visit "in person" throughout the day.*
- *Physical therapists visit him every day via touch transmission technology that enables them to remotely provide physical therapy and rehabilitation exercises that require hands-on manipulation and guidance*
- *His personal robot can perform medical procedures such as detecting heart rhythm irregularities and administering defibrillation in emergency situations.*
- *His everyday activities and physiological status are continually recorded and analyzed to predict functional changes and the need for technology interventions.*
- *Dave is in a high-risk category for depression, loneliness, and morbidity. Therefore his emotional state is assessed and evaluated for deviations from his personal norm.*

This scenario is possible for the future but many more hurdles to be overcome before it would be realistic. There are technology challenges, insufficient knowledge of health trajectories, and the analytic side is underdeveloped.

This paper will describe aging trends in terms of characteristics of older adults and their needs and preferences for support, and will posit additional plausible scenarios for older adults of 2050, focusing on a variety of needs and home technology supports. We will specifically address the facilitators and barriers for the successful development and deployment of these technologies.

Participant Notes

Participants reacted very strongly to this paper, perhaps because aging is a condition we will all (if we're lucky) experience. Some participants challenged the idea altogether, suggesting that the future population of elderly will be healthier and independent, citing current trends in the health and wellness of Baby Boomers. Below are some notes to the authors:

- If older adults do not live independently, how might the future of congregate living be transformed?
- As an alternative for now, use a drone. Smaller display, but now can go outdoors.
- Does the robot have a personality? Remember the robot on "*Interstellar*"? You could dial-up or dial-down the humor level.
- Customization – Acceptance – Flexibility
- Increasing independence through greater social access and mobility.
- Increased social connectedness via wireless technologies can decrease vulnerability during disaster recovery.
- Reintroduce the elder as sage storyteller. Respect for elderly renewed.
- Importance of trends to user family / caregiver.
- Can technology provide too much assistance? It could contribute to decline. Need mechanism to challenge user.
- Expensive – robots, telepresence, care network.
- New career – "tailoring your assistive ecosystem: at home, at work, and on the go."

- Make sure family members and caregivers are also involved in the selection of assistive systems.
- Balancing privacy and independence.
- Leverage multi-modal capabilities of smartphones / tablets acting as controller, tied to sensors around the home.
- What about 70 as the new 60 – healthier, more active lifestyles, better meals [meds?] / diet. This tomorrow sounds like today.
- Have / have nots re: installed assistive systems? 2nd hand / used systems market? If so, what problems might *that* create?
- Personalization.
- Shareable robots in community – social /health.
- Solutions for elderly may often be similar to solutions for children – impact on tech adoption rates.

♦♦♦

Accessibility in Disaster Conditions: transforming the cycle of emergency phases

Presented by Brenda Phillips, PhD, Ohio University - Chillicothe
Authors: Brenda Phillips, PhD; DeeDee Bennett, PhD; Elizabeth Davis, JD

Extended Abstract: This paper takes a "flash-forward" approach to 2050 to show how the disability reality has been transformed within the practice of emergency management. By describing a transformed life-cycle of emergency management, the paper re-envisions how emergency managers prepare for, respond to, recover from, and mitigate against disaster impacts. Each phase (preparedness, response, recovery, and mitigation) will be explained, discussed, and reviewed for the transformations that have occurred by the mid-century. As a counterpart, an alternate scenario is presented as a way to demonstrate how failures to change maintained levels of personal risk for people with disabilities and their communities.

Figure 5: Author Five - Icon/Poster Image

To illustrate, discussion over the four phases will include but not be limited to examples of real trends in emergency management such as the few listed below:

- *Preparedness*. How have wireless technologies enhanced preparedness efforts particularly outreach and education of people and communities with disabilities?

- *Response*. How have wireless technologies changed the warning process; sped the rescue process; as well as elongated sheltering practices?
- *Recovery*. How do wireless technologies enable location of accessible shelters and housing? Given the integration of accessible design elements, how have shelters and post-disaster housing become both physically and technologically-accessible?
- *Mitigation*. In what ways have new codes and standards for use of elevators (e.g., generators, safe shafts for evacuation and rescue), for example, and wireless technologies (among other features) become integrated into post-disaster reconstruction as a means to mitigate future risks for people with disabilities?

By using several real examples of trends and practices emerging in 2015 and carrying them through to 2050, we will show the potential outcomes if supported today. This will be woven through the groups of examples built into each phase illustration as listed above. Alternatively, a failure scenario will reveal the ways in which society, policy-makers, and individuals undermined the potential to build resilience with and for people with disabilities and their communities.

The paper will also review the transformative agents and conditions required for movement toward a newly-envisioned 2050. This section of the paper will rely on an eco-systems approach to reveal the agents of such transformative change, drawing from the examples used in the previous section. To illustrate, discussion will include but not be limited to:

- *Micro-Level Change*. Who were the change agents at the individual and household levels? Where did they come from? How did they effect such transformations? What were the roles of people with disabilities in promoting micro-level change?
- *Meso-Level Change*. Which inter- and intra-organizational arrangements led to new configurations of emergency management practice by 2050 (e.g., legal mandating of continuity of operations planning)? What were the roles of disability and accessibility organizations in meso-level change?
- *Exo-Level Change*. What kinds of innovative policies mandated or enforced transformative change (e.g., permitting prescription/insurance coverage of emergency stockpiles, and for devices used in an evacuation including wheelchairs and scooters)? How were the policies leveraged to modify realities of the early century? What policy modifications were required by the time that emergency management reached mid-century? What were the impacts of various types of disasters on policy-making? How did people with disabilities and disability organizations influence policy design and implementation?
- *Macro-Level Change*. How was a culture of prevention for people with disabilities achieved? For example, personal preparedness has become ingrained as a core value. What conditions fostered movement into a new future, such as demographic shifts, new economic circumstances, heightened risk awareness, or cultural adaptation? For example, preparedness has become part of the core curriculum from kindergarten through high school and all high school graduates are now required to take basic first aid. As another example, accessibility has become a way of life, with curriculum and first aid initiatives incorporating information and training on how to plan, prepare, and

respond in an inclusive manner. How did various disasters influence awareness, increase funding for accessibility initiatives, and transform world views? What were the roles of people with disabilities and disability organizations in inspiring widespread social and cultural change?

The next section of this paper will take a few of the real world examples from each phase at the start of the paper, and then show the impact of the evolution of those outcomes by 2050 based on the interdependencies and interplay among the eco-systems. For example, if a new law is not passed requiring certain changes in prescription medication coverage a great level of the population still cannot afford to follow a basic tenet of personal preparedness to have a few days' supply of medications available at all time. This, in turn, has a positive or negative impact across all the phases of a disaster.

This paper is designed to envision a transformed, mid-century view of emergency management and accessibility. Rather than just an optimistic flash-forward view, the paper will lay out the route most likely to lead toward such an outcome. As such, the paper will reveal a groundbreaking vision coupled with a guide that compels forward movement. The alternative scenario, starkly contrasts what could be with what might be if we fail to act.

Participant Notes

Disability in the practices of emergency management is explored, especially how technology can transform disaster response for people with disabilities. Below are some notes to the authors:

- Options to handle recharging cell phones when power is out.
- Self-driving cars that will pick up people with disabilities prior to or after emergency event.
- Buildings know of resident or visitor presence in emergency.
- Greater participation of people with disabilities in emergency planning design and implementation.
- How do you gain mass adoption of geo-fencing?
- Smart traffic flow in skyscraper evacuations.
- Low tech will always be in play.
- People with disabilities become an asset to the process – not viewed as liability.
- Wireless RERC studies show affordability is close to a non-issue.
- Mobile / wearable to locate and understand specific need of person in disaster.
- Internet of things may help connect first responders with victims with disabilities during response.
- Everyone has a location beacon on them so they can be located in any emergency disaster situation.
- Environments adapt to the person – it's mutable.
- Maze of government funding.
- Greater focus in "recovery" periods on gathering "lessons learned" and sharing that info with manufacturers.

- Recovery – what about digital design of replacement homes and schools and businesses driving architectural 3D printers for faster rebuilds?
- Interoperability extending into culture of use.
- Biometric identification of at-risk persons, triage and priority.
- Specialized and coding lighting can be used for multiple warnings. Lights like "Hue" can change colors to indicate different warnings.
- Geo-fence logical ranges for context.
- Information to assist people with disabilities as threats to privacy? Tension?
- Cheap two-way sensors: send data to hub – temperature for fire, mic for listening for cries of help, and smoke. Relay – send Bluetooth message to accessibility device for emergency messaging.

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Personalizable Wireless Technologies and Standards for Improved Access

Presented and authored by Markku T. Hakkinen, PhD, Educational Testing Service (ETS)

Extended Abstract: Personalization is the hallmark of the next revolution in accessibility, driven by the ability to customize technology, and specifically, mobile, wireless devices. The impact on education for all students, teachers, and content authors will be one that creates new opportunities for personalized, accessible learning. The concept of personalizing information technology emerged for the mainstream with the advent of the mobile phone, initially through the simple mechanism of custom ring tones and vibrations through the current ability to customize appearance and functionality of a tablet or smart phone through the use of apps. While adoption of tablet devices is increasing in education, and an ecosystem of learning apps and eTextBooks has emerged, it can be argued that the full potential of these devices is yet to be leveraged.

Figure 6: Author Six - Icon/Poster Image

For students with visual impairments, for example, off the shelf consumer tablet devices that incorporate built-in accessibility tools, such as a screen reader and support for refreshable braille displays already offer advantages when compared to traditional technologies, such as personal computers and expensive, third party assistive technology applications. But mobile devices are incorporating powerful technical capabilities in the form of sensors and connectivity options that can enable all students, including those with physical, sensory and

cognitive disabilities to interact with their environment in ways that may seem out of science fiction, but in fact are already around the corner. The original Star Trek series envisioned a 23rd century device known as the Tricorder, a tool for examining and learning about the environment. Seeing the next iteration of mobile devices reaching into the territory of the tricorder is exciting, especially if accessibility is a core feature. Apps already enable standard smartphones to identify colors, recognize text, determine geolocation, measure pulse and respiration rates, motion, and even atmospheric pressure. Using Near Field Communication or Bluetooth, Smartphones can communicate with the Internet of Things, whether they are lab instruments or museum exhibits. When the device capabilities reach their limits, the cloud can draw in additional resources, including computation and crowd-sourced sourced human assistance.

And the ways we interact with the devices themselves are evolving from the basics of touch and spoken interaction to gestural, eye-gaze, and brain-computer interfaces, with contextual adaption driven by location, task, time and user preferences. Adaptability of the device is key, as is the resultant ability to support the unique needs of each user.

For students, these devices enable learning in and out of the classroom, augmenting traditional instruction and providing the opportunity to study the world around them. eTextBooks will merge into interactive learning experiences, that engage (and measure engagement), assess, and adapt to meet the needs of the student.

Technical standards that promote and enable accessibility will be key in enabling this vision. Ensuring that devices and content support information consumption and interaction across modalities, displays, and inputs will allow all students, irrespective of ability or disability to benefit.

Participant Notes

For this paper, focus moved the discussion toward market driven innovations and open (i.e. free) standards. Also addressed was the assumed impending ubiquity of wearable technologies and the Internet of Things. Below are some notes to the author:

- Pro-sumer design >>> get users, especially kids, to show how they're adapting common tech to assist them: open source standards.
- Simulated / virtual labs as "second best" vs. real, hands-on labs and learning.
- Tangible technology in learning (including low-vision or blind).
- The "independence scenario" suggests that the growing, ageing population, having grown up with mobile technologies will be both advocates and beneficiaries of new technologies. But each successive generation finds itself somewhat challenged by non-native technology.
- Professional test takers (for certification exams) worry about stigma of using assistive technology – how to resolve this?
- Will view of testing change if wearable augmentations become more ubiquitous? What's allowed decades from now?

- The objects in our world will all be talking to each other. Will they be able to spot / diagnose emerging problems people are having?
- Importance of open source for standardization.
- *"Black Mirror"*
- Commercial solutions must still be profitable – that builds the marketplace.
- Centralized pooling and sharing of ideas – knowledge databases available to caregivers > "how to educate" of currently available options.
- Shift in expectations and demand.

Change Process Factors

Making Design Accessible

Presented and authored by Joshua Cole, Engineer & Inventor

Figure 7: Author Seven - Icon/Poster Image

Making Design Accessible
Joshua Cole

Extended Abstract: Fifty years ago it seemed unlikely that consumers would one day be able to build a computer at home, but as the components became both modular and affordable the design of the personal computer passed partly to the end user. A decade ago the prospect of a consumer manufacturing plastic components in their home was just as implausible, and now 3D printers are on the verge of becoming a common household appliance. As technology evolves, the role of specialized knowledge to create devices and systems that leverage that technology diminishes, shifting the center of design away from the etic professional and toward the emic non-professional. In a world where persons without accessibility challenges have already begun to participate in this emic design process, the goals of access and assistive technology programs and proponents must shift toward ensuring that the underlying fundamental technology that allows such emic design is itself accessible.

This need is perhaps most easily observable in the mobile application space, where visual programming environments and "app creation" programs allow the creation of mobile

applications and games without requiring literacy in (or even awareness of) the programming language itself. Skilled programmers (the etic) are no longer required to make relatively simple applications based on predefined libraries of code, but they are still required to create the environment and tools in which non-programmers (the emic) may develop these applications on their own. Those persons, so enabled, can thereby meet their existing needs more easily, and should they so desire still invest the time to learn the programming language itself at their own pace, because their initial success is no longer bound to that understanding. The future of accessible programming must take advantage of the same concepts, providing ease of entry into the design process by enabling programmers regardless of access needs.

Another key point of entry for persons with access needs in this new paradigm is the increasing use of natural language user interfaces in machines. The natural language text to speech and speech to text engines that power search, navigation, and UI products in consumer and mobile electronics are to some extent dependent on the input method for which they are optimized, and current implementations are fragmented by use case; as image processing, computational power, and bandwidth continue to increase the ability of these engines to interpret ASL, eye movement, and signals from electrooculography and other human input mechanisms will also become viable. Natural language interface, already an essential component of mobile technology, will also be a preferred method for interacting with consumer robotics, transportation systems, and automated transactional systems like ATMs and kiosks.

Finally, the interaction between more accurate biometric systems and increasingly standardized open authorization and authentication systems will allow consumers to declare access needs to potential devices automatically via their own personal electronics products, their preferences passed machine-to-machine by the exchange of secure tokens in lieu of personal data.

Participant Notes

For this paper, participants were excited by the prospect of increasing the participation of people with disabilities not only in the design process, but as designers and engineers themselves. Below are some notes to the author:

- How can technology be used for participatory design – e.g., telepresence systems?
- Aesthetics and acceptance in accessible designs.
- Sound visualization of data – *Scientific American.*
- Accessible design – how to make tools accessible.
- Gaining access to PWD for product testing due to privacy constraints.
- Developing a shared framework for blending emic and etic views.
- Participatory design? Action research?
- This is a fundamental paper to this conference, in that it explores the impact of disruptive tech, i.e., "augmentative" vs "assistive" technology. How might this shift affect people whose identities are culturally vested in disability, eg, "The Deaf"?
- If we mitigate a disability with technology, do we diminish them as a person?
- Does technology make the disability irrelevant?

♦♦♦

Imagining FUTURES: Collaborative Policy Design for Wearable Computing

Presented by Maribeth Gandy, PhD, Interactive Media Technology Center, Georgia Tech
Authors: Maribeth Gandy, PhD; Paul M.A. Baker, PhD; Clint Zeagler

Figure 8: Author 8 - Icon/Poster Image

Extended Abstract: The declining cost and increasing processing power of digital and communications technology are reshaping the image of wearable computing devices (wearables), from science fiction devices, to very real artifacts with the promise of significantly impacting the lives of consumers. The capacity of the devices, both as sensors, as well as to provide feedback to users of both personal data, and environmental data is both intriguing in turns of opportunities, and formidable in turns of social, and cultural consequences. Coupled with the changing role in which technology facilitates life functioning and community engagement, these devices represent new options beyond simple assistive and facilitative technologies, for people with disabilities to engage in community participation. However, designers, technologists, and policymakers operate independently with the consequence of products that are out of sync, lack interoperability, or are hindered by well meaning, but obstructive policy.

The developers of wearables, by necessity, are concerned with the specifics of the technology and the ways in which wearable computing interacts with other components of the system. With the exception of regulatory requirements, policy considerations tend to be more focused with the impact of the object's functioning on common public resources (e.g. wireless spectrum) and its interactions within the broader social context in which these things occur.

This paper explores possible futures that could impact the design and deployment of wearable technologies, and that in turn, might be possible by various iterations of wearable

development. We explore the idea of using a futures approach to enhance development of collaborative policy design framework that could facilitate the development of inclusive wearable computing devices.

Participant Notes

The focus on possible futures where various iterations of wearables can facilitate the development of inclusive wearable computing devices is explored. One provocative theme of the participant responses centered on the disappearance/de-stigmatization of disability due to all humans desiring augmentation of their humanness with wearable technology. Below are some notes to the authors:

Preferred outcomes are personal.

- Guiding wearable policy >> get in front of policy roadblocks that might interfere with rollout.
- Wearables should be transparent for the user >>> no need to think.
- Personalizable not obviously augmented – super human.
- Digital divide and wearables.
- From dis*abilities to hyper*abilities?
- What is being done to make wearables affordable?
- Can you tie in open source ideas / policy?
- Disability disappears.
- Does augmentation level the playing field, rendering competition moot?
- Is technology augmentation "the new plastic surgery"?
- Use of sensors being sent back to central databases for 1) data collection >>> learning; and 2) triggering alarms for caregivers.
- Policy issue >>> privacy concerns on individual vs shared data.
- You are already part of the natural environment (as the human animal). You will also be part of the built and information environments (as the human cyborg and human data stream). Vulnerabilities? New digital pandemics; new terrorist hacks. System will also require localized micro-generation of energy.
- Yes – everyone is augmented and hence maybe the people with disabilities stigma goes away.

♦♦♦

Scientific Eventuality or Science Fiction: The Future of Disability

Presented and authored by DeeDee Bennett, PhD, University of Nebraska – Omaha

Figure 9: Author Nine - Icon/Poster Image

Scientific Eventuality or Science Fiction
DeeDee Bennett

"This is not science fiction…its science eventuality"
– Steven Spielberg on his film *Jurassic Park* in 1993

Extended Abstract: Consider this, as seen and read from science fiction, we are living in a future [in-part] imagined over 30 years ago. One may envision that 30 years from now we could live in a future with technology developed from the concepts we see in science fiction today. In this paper, I seek to challenge the concept of disability in the future, based on the technologies imagined in present and past science fiction-based books and film. In fact, the present term disability has been seen to characterize people based on their inability to do something. Perhaps the use of wireless technologies may enable a traditional person with a disability to no longer be classified in the same way. One of the most popular examples is from *Star Trek (*1987), in which previously blind Lt. Geordi La Forge acquired different sight abilities with the use of a special pair of glasses called, VISOR. With the use of VISOR, Lt. La Forge is able to 'see' but not how we typically see, instead the glasses gave him the ability to detect energy wavelengths of animate and inanimate objects allowing him to effectively complete his engineering job. If our past is any indication, our future may lie in the conceptual and slightly implausible figments of our science fiction-based imaginations.

Several compelling articles have been written to compare, discuss and forecast our progress in technology and how that will impact our perception with regards to gender, multiculturalism, geography and disability (Nixon, 1992; McCallum, 2000; Kitchin & Kneale, 2001; Chilcoat, 2004; Moser 2010). With regards to geography, McCallum (200) reviewed several science fiction works to examine geography only to find that science fiction does not provide a futuristic model of geographic spaces, as assumed. Kitchin and Kneale (2001) note that critical review of cyber fiction (a sub-genre of science fiction) is important as it may provide visualizations of our future, or derivations of it, with regards to geography of urban areas. For

example, science fiction has been used by urban planners as a model for future geographical spaces. KItchin and Kneale (2001) cite a public lecture by urban planners in 1990 who would have liked to model future Los Angeles based on the visual representations presented in the cyberpunk film Blade Runner (1982).

A couple of authors discuss the role of gender in science fiction; Nixon (1992) concludes that cyberpunk (a sub-genre of science fiction) does not provide revolutionary ideas with regard to gender politics. Similarly, Chilcoat (2004) reviews cyberpunk cinema and the constraints on traditional gender roles, feminism and gender finding that the traditional roles remain. Finally, one author, Moser (2010), attempts to define what it means to be human, able-bodied or disabled. In one section, she reviews the cyberpunk cult classic "The Neuromancer" by William Gibson and concludes that cyber culture does not negate disability, however, it provides augmentations and extensions to human ability. These enhancements still do not challenge or change what it means to be disabled.

While Moser (2010) examined the concept of disability through science fiction by reviewing "The Neuromancer," I will review the prospective evolution of technology as presented in several science fiction works to determine the future tech enabled human abilities that may facilitate better community living, increased employment and/or improved health for people with present day disabilities. Using a slight variation of Bradley's (2006) Convergence Theory on Information and Communications Technologies (ICT) and Psychosocial Life Environment, I seek to answer the following research question: what do the wireless-based technologies imagined in science fiction yesterday and today tell us about the potential use of these technologies for people with disabilities in the future? Convergence theory looks at the interaction between globalization, ICT, life environment and life roles to "explore the human side of societal change taking advantage of technology to shape a good and balanced life (Bradley, 2010, p. 189)." Bradley uses convergence theory to examine the use of ICT such as computers, telephones, and the media (2010). In my variation, I look at the interaction between possible ICT and wireless technologies, life environment and human beings presented in science fiction films, TV series and books to forecast a potential future with greater respect for diversity. Furthermore, I am not limited to technology by which humans interface, instead I seek to include wireless technologies that are implanted or injected into human beings, as well.

For this conceptual paper, the exploration is limited to science fiction works, set in relatively near future fictional time periods, which incorporated ICT into the story plot and have the potential to influence our perception of human ability and thus disability. Therefore, I only focus on the science fiction sub-genre cyberpunk. As a genre, science fiction is segmented into multiple sub-genre, such as space exploration, time travel, fantasy, supernatural, superhero, or military, and there are several more. Not all of the sub-genres showcase the use of information and communication technologies (ICT) for a near-term future. Cyberpunk is a term used to define the sub-genre of science fiction that is set in the near future and often includes advances in ICT (Nixon, 1992; McCallum, 2000; Kitchin and Kneale, 2001). The overall setting for many cyberpunk books or film is that of dystopian rather than utopian societies (McCallum,

2000). Often in cyberpunk, the manipulation, implementation or enforcement of ICT was the cause for the apocalypse or the means to utopia.

Many popular films fit into this category including *Robocop* (1987), *Minority Report* (2002), and *I, Robot* (2004). In the last ten years, this genre is continuing with *Surrogates* (2009), *Elysium* (2013), and most recent *Automata* (2014). Additionally, TV series have been developed that fit this category, such as *Caprica* (2010) and *Continuum* (2013- present). Several novels have been written in this category, however, "Snow Crash" by Neal Stephenson (2000) and "The Neuromancer" by William Gibson (1986) are on most top cyberpunk books list. ICTs are an integral part of the plot in each of these cyberpunk works. In each of the films alone, *Robocop* (1987) introduces the idea of implantable computers in humans. *Minority Report* (2002) shows how the progressive use of ICTs in society can enable an authoritarian state. *I, Robot* (2004) challenges the intelligence of assistance robots and help us visualize transportation with autonomous vehicles. *Surrogates* (2009) propose a society in which robots are used as avatars. *Elysium* (2013) suggests a new type of society where most poor live on earth and the elite live in orbit. Using the cyberpunk sub-genre as a basis upon which to explore, I will examine the potential future of wireless technologies that can be used to challenge our current perceptions of human abilities.

Participant Notes

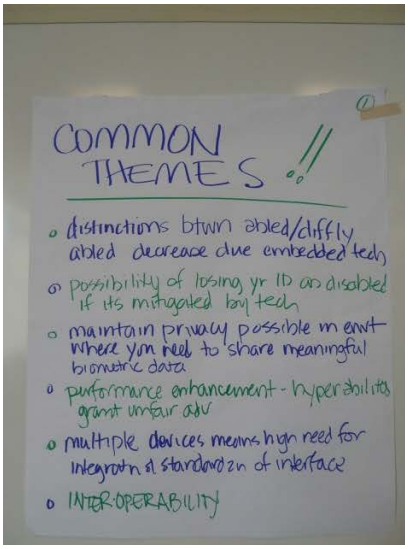
The role of science fiction and science facts, can they add richness for people with disabilities? The topic, among others, is explored. Below are some notes to the author:

- Change the image >>> transform the future!
- Yes, science fiction movies, TV shows, etc. inspire folks to say I want that too! Maybe the future is ahead of the curb >>> development.
- Star Trek notable because of technological optimism.
- Importance of science advisors to artists.
- New awesome abilities.
- Environmental detection: assess the world around you and adapt.
- Is the exchange of ideas two-way? Fiction writers read about science, then write about science, which in turn influences science.
- Transporters for people with disabilities trapped on high-rises? Make it so!
- What are some ideas for influencing artists, writers, and designers to consider the needs of people with disabilities? How about encouraging people with disabilities to be among these professionals?
- Consider social media memes.
- Use crowd-sourcing to filter for pre-emergent invention. Targeted: state problem. Non-targeted: from the field.
- *"Black Mirror,"* BBC
- Look up Transcense.com – one programmer is deaf. Great solution.
- Influencing the "artistic imagination" to anticipate accessible environments including cultural attitudes.

- Should we give preference to inspiration by an enlightened vision of disability vs. a sci-fi futures (i.e., user-driven vs tech-driven design)? "Design meets Disability" by Graham Pullin is a good example of this vision of the future.

DAY ONE WRAP – COMMON THEMES

To close out day one of the Summit and digest all of the information received and exchanged throughout the day, Summit participants brainstormed a list of common themes across all presentations. They included:



- Distinctions between the abled and the differently abled decrease due to embedded technologies.
- Possibility of losing your identity as a disabled person if your disability is mitigated by technology (is someone with a cochlear implant still deaf?).
- Is maintaining privacy possible in an environment where you need to share biometric data for meaningful health output / results.
- Re: performance enhancement – will hyperabilities grant an unfair advantage to the (former) "disabled"?
- Multiple devices addressing different disabilities suggest a high need for integration and standardization of interfaces.
- INTER-OPERABILITY!
- Limits to integration – should be self-determined.
- Whatever tech solution is in play there will be a second consciousness there to assist – development of a new "AI": an assistive intelligence.
- Tech as partner to individuals, but also remember that individuals are embedded in a community: tech solutions need to fit the individual, but also work well within and for the individual's community.
- Too little sensitivity to questioning the need for technology before developing it. We should be asking what SHOULD we do with technology, not what COULD we do with technology. We need a balance.
- Certain skills – we'll lose if we don't use them.
- We should optimize the health and capability of the baseline human FIRST.
- Should have the ability to select how much capability / disability you want enhanced / mitigated

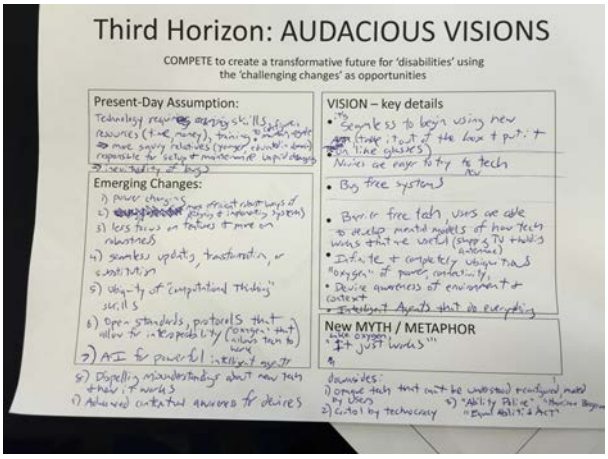
- AUTONOMY – understand user preferences not just their needs – users need to guide what trade-offs are made.
- Challenge for the education and training of care-givers to create the best environment of support by choosing appropriate assistive technologies (hardware, software, orgware).
- "Digital divide" – few of the papers addressed either the differentials in access due to expense or to the education required for choosing and using assistive technologies.
- Transparency >> these technologies should be transparent, usable, affordable (design parameters).
- Human agency >> often people don't know their preferences in advance, before playing with the options on offer. It's why pro-sumption (production by consumers) and co-design and co-tinkering are critical.
- Will wearable devices be collecting data for us, about us, about our environment – rather than us engaging the world with our own in-built senses?
- Will medical advances cause problems for assistive technologies, as innovations surge ahead while ethics and values lag behind?

DAY TWO: THREE HORIZONS WORKSHOP

During the first day, current assumptions or themes that were the most challenged by emerging changes in technology and society were identified. Day two began to dig deeper into creating possible Futures that would identify and advance pathways to a more inclusive future for people with disabilities. The day was divided into three "Horizons" – or what the future might look like if it were inclusive of all citizens. The framework looked at assumptions, paradigms, values, trends, and innovations as presumed life cycles. Horizon One included current events and strong trends; basically covering the paper presentations from day one. Day two participants were asked to focus on overturning 'business as usual' thinking.

THE THIRD HORIZON – AUDACIOUS VISIONS

The facilitator began with the third horizon, explaining that it represented the positive potential of emerging changes.



Overturning "Business as usual" Thinking
The Three Horizons Framework was used to build exploratory futures or visions (preferred futures) based on emerging changes identified on Day One of the Summit; as presented by the authors and respondents, and discussed as a group.

Based on consensus building, the attendees narrowed and then pinpointed several "vulnerable assumptions" to be further explored. Each assumption was assigned a roundtable consisting of a small working group (5-7 people) which was self-selected. To begin the exercise these small working groups took a current status quo assumption to break and turn into an audacious vision. They tackled one of the "vulnerable assumptions" and collaboratively envisioned a transformative, inclusive future/audacious vision. Using their 'challenging changes' as opportunities they identified emerging changes that could catalyze and/or galvanize their future, developed the key details and characteristics of their vision, and then created a new myth or metaphor for the future. For example, the assumption that technology adoption and meaningful use requires technical skill and training was given the new metaphor, "Like oxygen, it just works." Exercise worksheets were provided to each group to facilitate capturing their ideas. Working groups presented the visions in five bullet points and those that were determined to be the most novel and transformative were selected to go onto the next phase that would build common visionary themes.

As the facilitator, Dr. Schultz, pointed out "organizations often become vulnerable when they take the present for granted. People assume that their current working assumptions will remain robust over time – yet emerging change is steadily eroding those assumptions." Participants began by quickly brainstorming an inventory of current working assumptions, business models, stakeholder relationships, infrastructure, etc. What is the current state of play? How have the current working assumptions, business models, and infrastructure arisen from past experiences – and how are the past and present constraining new ideas and practices? They discussed emerging technologies, social and change process factors that challenged the "assumption" in order to build a path to a transformative future for people with disabilities.

Summit participants identified the following ideas that are established thinking at the intersection of disability; technology design, production and deployment; and culture.

Assumptions:

- We don't need to design for people with disabilities because they're not that many
- What's the business case?
- What is minimum compliance?
- Things will be hard and frustrating
- Insurance companies will always struggle with reimbursement for general use technology that are used in a assistive manner
- Cost kills Access to Assistive Technologies (AT)
- Not enough outreach in American Sign Language (ASL) awareness
- Accessibility is too hard, let's fix it later
- Persons without disabilities don't appreciate daily challenges of those with disabilities

- Disability growing, accommodations not keeping up
- Old AT models are good enough, why change?
- Economic disparities will persist
- "Us" versus "Them" situation will persist due to multiple divides rich-poor- with disability, without a disability, language divide
- People with disabilities will always need a caregiver
- Marginalization will always exist
- Political tied to medical outcomes rather than social outcomes
- People love their fragmented silos, my way or the highway
- Perception of disability as a family burden
- Barriers in the environment will always create disability
- Assumption that disability has a greater impact on productivity, mobility and thus creates a disability closet culture.
- Assume aging parents will want functional independence
- Presume that people with disabilities want to be included
- People believe that just because they did something for a person with a disability then they did something great – you should be grateful
- That someone with a disability doing anything is inspirational / heroic

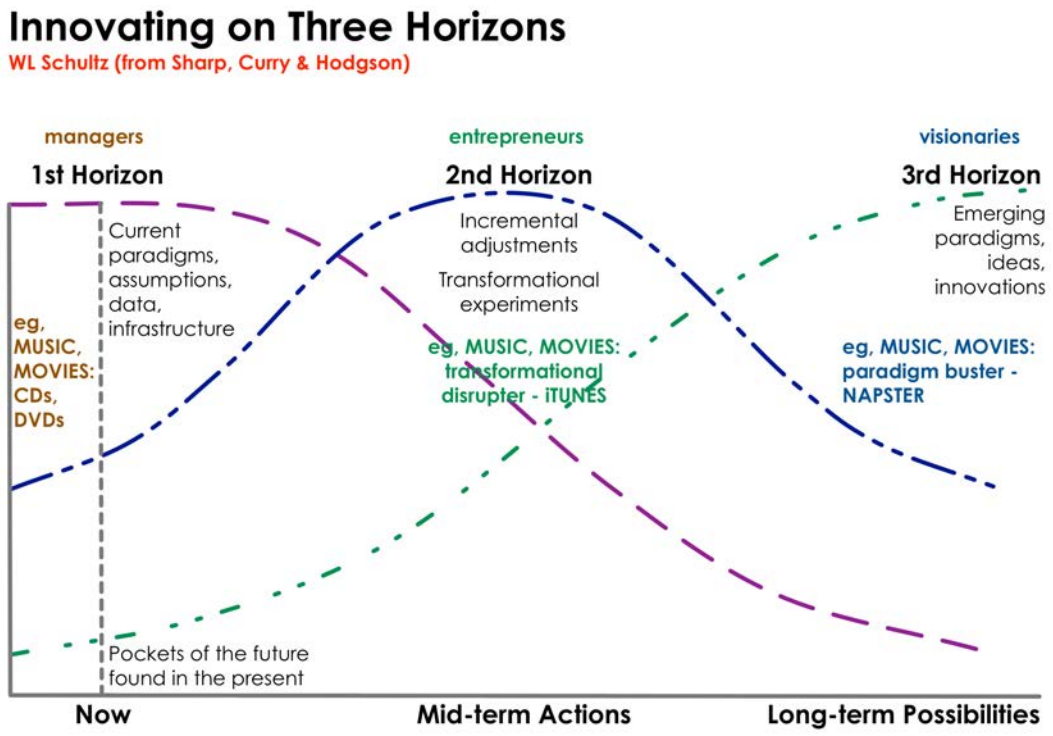
THE SECOND HORIZON – BUILDING NEW FUTURES

From the third horizon the participants began to define the second horizon in which they would build new futures. In the image below Dr. Schultz diagrams the three Horizons approach via the stickers which were placed on the 9 presentations and subsequent feedback from day one discussions.

Horizon Two is where the action takes place that creates a preferred future, but first one has to envision that future in order to know what the goal is (i.e. Horizon Three). In this round of discussions participants determined how to use emerging changes to generate innovations and transformative actions that would create their preferred future. They prioritized three of

the Future visions and began mapping the pathways to those inclusive futures; identifying needed knowledge, resources and allies. Each group shared their discussions and all attendees collaboratively developed a range of innovative inclusive futures in order to craft a Futures research and policy agenda.

As our facilitator Wendy Schultz noted "In the valley between the decline of Horizon One assumptions and conditions, and Horizon Three emerging change, is the turbulence of Horizon Two, where transition technologies, strategies, conflicts, and opportunities may erupt."



The working groups resumed conversation and began to fine tune possible outcomes and conclusions. They were instructed to consider wireless technology access and implications in order to craft a FUTURES research and policy agenda. They were further tasked with answering a series of questions:

1. What ethical challenges might arise?
2. What constraints will we need to overcome?
3. Who is shouldering costs we need to ameliorate/compensate?
4. What jobs/careers will disappear?
5. What new ones will emerge?
6. What resources are needed?
7. Who are our allies?
8. What do we need now to make this vision possible?

Each group presented summaries of their visions. Many of the groups focused on describing their preferred futures and determining what current trends and emerging changes would contribute to the realization of their aspirational visions for the future.

1. If you had to have a metaphor or tagline for your preferred future, what would it be?
2. What are the emerging changes that will negate the identified assumption?

Following are some samples from each group's preferred futures.

"Living, learning, earning!"

- 'Just part of the landscape' – stigma goes, disability remains
- Federal, state, local regulations changing
- Employment – shifts in attitudes more widely as both employers and workers have more positive experiences with disabled workers
- Assistive technologies are becoming better, faster, smaller, cheaper > this means that the obvious signs of disability will diminish over time, as ATs become 'invisible'
- Increasing public education and awareness
- Increasing incorporation of inclusion re: disability in corporate and business equality / inclusiveness
- General acceptance of disability, increasing socialization regarding diversity
- Futures is with the next generation >> their values are more inclusive and less stigmatizing

"What disability?"

- Universal design; access to technology a basic civil right; ubiquitous communication
- "I'll have my SAR contact your SAR"; hyper-abilities; ability to adjust environment via real-time data; social communication technologies = a basic right; assistive technologies will not always be necessary – use will be a personal preference
- Assumptions to overcome: disability will always be a stigma; some AT is good enough – why change?; people with disabilities will always need caregivers
- Changes that could contribute to the new future:
- Everyone will want these technologies! – transporters at home, work, leisure, community (beam me up; gateways), also exo-skeletons, jet-packs, autonomous vehicles
- Drones flying ahead of you to sense the environment, your response to it, and your interactions with it, in order to assist you
- 'From disabilities to hyper-abilities': could really affect the ADA fundamentally

"New Prometheus"

- New norms (functioning of society is normative); 'all sparrows fly' – from medical to functional outcomes
- Assumptions to overcome: basic ADA definition of disability; public policy tied to medical outcomes rather than functional and societal outcomes
- Changes that could contribute to the new future:
- New technologies are equivalent to receiving fire: they will transform the individual and society
- Humans, technologies, and the environment will blur together >> seamless, pervasive
- Technology is rapidly evolving – power, computing, new materials, biochemistry, etc.
- With wireless Internet of Things, wired up humans are simply another node in the IOT
- Policy changes can drive change
- Eliminate distinctions between humans and technology: don't isolate people from technology, make it a basic right
- Apply societal outcomes to the entire system

"Like oxygen, it just works"

- "I am not my mother-in-law's robot's keeper."
- Power, connectivity, technical updates – all just work BY THEMSELVES
- Novices are EAGER to begin using innovative technologies
- Bug-free systems
- Users understand basic design concepts (camera must be pointing at me to see me)
- "If this, then do this, then do that" – computational thinking necessary to be successful user of the Internet of Things
- All this accomplished by your staff … a crowd of intelligent agents
- Assumption to overcome: technology requires expertise and training – technical bugs are inevitable
- Allies: An always on, always ready, always working technology ecosystem will require a lot of power, so power companies would need to be early allies.

"Augmentation becomes universal and UNEXCEPTIONAL"

- Assumption to overcome: disability implies disadvantage
- Changes that could contribute to the new future:
- Transformed relationships between people and the environment
- Human learn with, from, about their environment
- All technology is assistive and ubiquitous
- Environment is responsive to everyone in it, eg, smart cities
- We learn in radical new ways from the environment via extended, extensive new sensory capabilities
- Levelling the playing field of abilities
- Tailored, personalised, and readily accessible technologies

"Universal usability!"

- Assumption to overcome: accessibility is too hard
- Changes that could contribute to the new future:
- Discoverability – what's available to address my issue? The assistive technology finds YOU.
- People with disabilities involved throughout the innovation process
- Disability is not a special case of use
- Produce, service, package designers – all aware of the full diversity of usability / disability issue, resulting in end-to-end friendliness / usability of design
- Requires accessible education and skills training, and tools, to get there
- Best practices in usability and accessible design need to be available to create the success criteria for usable design

CONCLUSIONS & RECOMMENDATIONS

A variety of technological solutions exist whether discussing the present or the future, and more are under development, to facilitate the ability of people with disabilities to engage in life activities. The potential of many of these technologies, particularly those based on wireless connectivity and communications technologies are growing or morphing into the Internet of Things. In order to truly conceptualize the liberating value of these technologies, the Summit steering committee decided new innovative thinking needed to be encouraged and reinforced. This "thinking" gravitated toward *systems* of accessibility, rather than on aspects of the individual user, the technology, the context, or a single design factor.

Recognizing the need for new, unconventional, creative thinking, the Wireless RERC's State of Technology (SoT) Summit: *Envisioning Inclusive FUTURES*, was designed using a different approach -- "Futures Thinking" -- as a departure from the traditional assessment of the state of the science and associated presentation of findings common in the field. The Summit brought together forty-five subject matter experts with a variety of backgrounds: disability advocacy, wireless technology, communications policy, emergency management, sensory access, aging and disability, wearable computing in order to engage in a deliberative exercise to imagine possible futures for wireless technologies, and what they might enable.

The Summit was grounded in research carried out in 2014 by the Wireless RERC, as well as in earlier studies, and focused on: 1) key social, economic, political and technological forces at play in the migration from legacy, analog technologies to mobile, digital technologies, and 2) exploration of the consequential futures for people with disabilities. Two rounds of Delphi polling (discussed earlier in the proceedings) collected and aggregated expert opinions on complex or ambiguous forecasting problems that often exceeded the capabilities of any one-

area expert. Building on these findings, the Summit was structured as a futures study, dialogic meeting, and served as the final phase of the assessment and forecasting process.

The "dialogic meeting" approach, as implemented for the Summit, was a dynamic process open to conversations, comments and clarifications. The philosophical basis of the futures studies approach was that many ideas about potential futures exist (Rowland & Spaniol, 2015). The purpose of the futures process was to explore, analyze, compare, and critique competing concepts of "the future." The Summit attendees engaged in dialog on the alternative possible inclusive future(s) of people with disabilities, in the context of technological migration, and explored innovative paths to a transformative future for people with disabilities.

Key Themes

Participants discussed and identified the most novel and transformative ideas and common visionary themes across groups. Rising to the top were concerns for wireless technologies and systems that could stimulate inclusive solutions such as robotics, wearables, the Internet of Things, next-generation emergency communications and alerts, and assistive intelligence for auditory and visual navigation. Looking to an inclusive future, not only were research and policy agenda items identified, but also challenges and recommendations on how to reach a future of inclusiveness. Several broad themes emerged from exploring the interrelationships of technological factors, use/user factors, connectivity factors, and social and policy factors.

- Technological factors were those in which wireless technologies become less device dependent, and increasingly a part of a universally designed "setting" that responds to, or even anticipates, the needs of the user. Functional limitations are mitigated by technology enhanced environments. Ideas here also included the vision that shifts from assistive to facilitative and augmentative, in which individuals were less limited by characteristics than enabled (or enhanced) by augmentative technology.

- Use/User factors related to the way a user interacts with information, alerts and environmental sensors. The Internet of Things (IoT) discussions facilitated contexts that enhance learning and workplace functioning – including new "displays" (interfaces) and ways of interacting with technology. Innovative approaches to informing, guiding and assisting people with disabilities to navigate during emergency and disasters were viewed as an important concern.

- Connectivity factors were those that impacted the underlying wireless technologies, platforms, and protocols that power connected environments. The focus was less on devices but rather systems and approaches to device use. The Internet of Things

approach which positions devices and information display at the point of need or use rather than requiring change in behavior to accommodate the device constraints and limitations was again brought to the forefront.

- Social and policy factors were those which anticipate social changes that are driven by new technologies, as well as providing input to the design and imagining of new technologies. These factors are both driven by policy and regulatory considerations, and in turn, can inform necessary change in the regulatory context to enhance the opportunities the technologies offer people with disabilities to fully engage and participate in society. An emergent idea from the Summit was rethinking the role of policy and policymaking from a "hammer" wielded after product completion, to a key component in the product design and development process. More broadly this theme invited a more expansive role for design and design thinking in policy and product development.

Challenges and Barriers to Inclusivity

In speculating about factors that influenced the implementation of new ideas, technologies and process, several challenges came to the forefront. These included:

- *Perceptions and Assumptions* –
    - These included factors that were technology specific as well as those dealing with use and context. Reliability of the devices was seen as a major factor. What happens if a device becomes critical but is subject to failure, or is unpredictable in its reliability? What processes are in place as failsafe, or backups.
    - Small or impractical markets – concern was expressed that device innovation would be limited by the perception that these were small or complicated markets that were not worth designing for.
    - People with disabilities will always need a caregiver, on the other hand, technology could offer support (for instance, socially assistive robotics) to substitute for or aid caregivers.
    - "Us" versus "Them" situation will persist due to multiple divides rich-poor- with disability, without a disability, language divide.
- *Philosophical/ Ethical*
    - The current approaches to technology make significant distinctions between human and technology. Will "post-universal design approaches" apply connected technologies to further sidestep the divides? Is there a limit to what modification would make you no longer human?

    - Can a user be required to use technology? Will there be new kinds of technological divides?
    - When does assistive technology become augmentative? How does the design process need to take into account what constitutes baseline abilities? Could assistive devices become "unfair advantages" relative to the un-augmented?
    - What are the ethical consequences of hacking or disruption of the flow of information/data flowing over connectivity links? Who is responsible if something happens?
- *Economic/Policy*
    - What is the impact on employment if hiring becomes based upon how enhanced a person is?
    - Who shoulders the accommodation cost (employer provided vs Bring Your Own Devices)?
    - What regulatory and reimburse changes need to take place to avoid inhibiting technology development and increasing adoption?
    - Privacy issues (constraint), who "sees" data, who can aggregate or use data, who "owns" data streams? What rights or control abilities do the users have?
- *Technological*
    - Do different types of data get handled differently?
    - What design features get chosen (usability vs accessibility); scalable and modular?
    - What standards and protocols govern device development and adoption?
    - What processes can help re-envision the concept of "display" or presentation of data.
    - How can devices be re-imagined to optimally promote inclusion and engagement.

Recommendations

The Summit process also produced a number of recommendations and observations that could help advance the innovation and development in accessible/usability wireless technologies.

- Usability is critical – technology needs to be "out of the box" ready. The design process should be enhanced so that devices be intuitively usable, or conversely, be easily personalizable?
- Devices could be pre-configured not to a single setting but to a range of user-types and use cases. It was suggested that this could be done through narrowing the ecosystem of solutions pertinent to that user.

- Proactively expand the design process to bring in a greater range of stakeholders – scientists, users, manufactures, regulators and policymakers.
- Education, outreach and awareness efforts should be dynamic and integral to both ongoing and adaptive/changing environments. This is in reference to not only technology, but to the changing circumstances of people with disabilities.
- Encourage greater harmonization between U.S. and global entities, in private (industry) as well as governmental frames.
- Take a broader view of markets – what might be of incremental benefit here in the U.S., could be of direct benefit to people with disabilities in developing countries.
- Products and services should be universally designed and also take into account cultural sensitivity.
- Think beyond the "usual players" - An always on, always ready, always working technology ecosystem will require a lot of power, so power companies would need to be early allies.

Developing Future Research and Policy Approaches

A set of opportunities and challenges that impact development of Inclusive Futures are noted above. While an important first step, these variables also lend themselves to potential policy solutions for addressing short gaps. A few possible research questions with policy implications emergent at the Summit are mentioned below.

- Present state- disability can be stigmatizing. What social and awareness steps can be undertaken to minimize this perception?
- What kinds of social research can be undertaken to help inform evidence-based policy and design policy incentives that facilitate innovation instead of prescribe outcomes?
- Can design parameters be developed that take into account the philosophy that humans, technology and environment not be separated but be inter related; how can systems be designed that are holistic and inclusive in nature?
- How can policy be designed to take into account system level societal outcomes as an innovation driver?
- How do we research and understand the social model of disability in the future?
- Can stakeholder and participatory processes address the logistical challenge of getting everyone on the same page?
- Can legislative and regulatory approaches be designed to address current constraints, using collaborative design processes?
- What new online approaches can be developed that use social media to enhance data collection as well as dissemination modes?

- How can wireless devices enhance information flow using new and novel wireless interfaces and display technologies?

In closing, the visionary theme from the opening to the concluding dialog emphasized: ***A transformative future is an inclusive future***. This became the Summit take-away for reinforcing the Wireless RERC's commitment to ensure an accessible mobile wireless future for people with disabilities.