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Accessibility User Research Collective: Engaging Consumers in Ongoing Technology Evaluation

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Abstract

The rapid pace of change in consumer technology requires structures and mechanisms to ensure ongoing engagement of consumers with disabilities so that new and updated products and services are accessible and useful. This article reviews the rationale, creation, operation, and impact of the Accessibility User Research Collective (AURC), a partnership between Microsoft and Shepherd Center, a rehabilitation hospital for traumatic injury and neurodegenerative diseases, to create and maintain a national network of people with all types of disabilities to provide ongoing customer input and testing of Microsoft products and services. The AURC is modeled after the Consumer Advisory Network (CAN) concept developed by Shepherd Center staff under the Rehabilitation Engineering Research Center for Wireless Technologies (Wireless RERC) and continued in recent years by the LiveWell RERC. The concept is to build a national network of consumers with disabilities who can be recruited to participate in targeted usability and needs-discovery studies.

Keywords: information and communication technology, accessibility, usability, user-testing

Introduction

Equitable access to information and communication technology (ICT) goes beyond concern with technological fairness. In the current era and beyond, access to ICT is essential for community and economic participation (job, career, and professional opportunity) and independent living. These days, not having access to ICT severely limits access to work and community. It literally means not being part of the conversation. This is why the United Nations Convention on Rights of Persons with Disabilities (UNCRPD) requires signatory states to: "promote access for persons with disabilities to new information and communications technologies and systems, including the Internet" and "promote the design, development, production and distribution of accessible information and communications technologies and systems at an early stage, so that these technologies and systems become accessible at minimum cost" (United Nations, 2006, p. 10).

The rapid and accelerating pace of innovation in consumer technology poses ever greater challenges to accessibility and usability by people with disabilities. Historically, new consumer technology products usually were aimed first at the general market and later addressed access needs of other consumers. Meanwhile, established mass consumer ICT products are in an almost constant state of updating and revision, which can often undo hard-won accessibility solutions (Wentz & Lazar, 2017; Schroeder & Burton, 2010). This environment of nearly constant technological change and increasing commitment of industry to provide accessible technology requires equally constant engagement with users with disabilities to ensure equitable access.

For ICT vendors, the dual challenge is to include accessibility considerations in the design and development work of new products while making sure that there is no regression – that the accessibility gains in existing products are not broken or undone. Additionally, research focusing on discovery of needs for usefulness is essential. Ideally, efforts to discover needs of users with disabilities and to ensure accessibility should be continuous and programmatic given the rapid pace of technology innovation and constant updating of ICT products.

This article reviews the rationale, creation, operation, and impact of the Accessibility User Research Collective (AURC), a partnership between Microsoft and Shepherd Center, a rehabilitation hospital for traumatic injury and neurodegenerative diseases, to create and maintain a national network of people with a variety of disabilities to provide ongoing customer input and testing of Microsoft products and services. The AURC launched in August 2017 after several months of planning and has been refined in its first year of operation. It was created to establish a channel for direct interaction with consumers with disabilities on an ongoing basis. The foundation of the AURC is a national network (collective) of people with disabilities from which AURC staff at Shepherd Center recruit for specific accessibility, usability, and user needs studies requested by Microsoft product and research teams. To date, the AURC counts over 750 members across multiple disabilities and diverse demographic backgrounds. During its first year the AURC launched 17 studies (completing 14) of various types for Microsoft product and business groups—usability, needs-discovery, and general ideation sessions.

Vendors in the consumer technology space and other industries have multiple options for engaging users, including those with disabilities, in product design. These options include operating onsite testing centers (organized either by major product line or as a company-wide effort) and hiring external market research companies to conduct product testing and user-needs discovery research. Research staff at Shepherd Center has worked with two large ICT vendors who noted that their facilities pose access challenges by people with disabilities because they usually are highly secure environments in large office parks that are not on public transportation lines. Private market research agencies usually do not have the required expertise in disability and accessible/assistive technology. For both, the known available population of people with disabilities in the local area in which they operate can be quickly exhausted, leading to over-engagement of the same finite set of individuals with a specific disability and other inclusion criteria (e.g., demographic and technology profiles). This raises the risk of testing with participants who have developed too much expertise either in the specific product type or in general product testing (i.e., participants become unrepresentative of typical users).

Another option is to engage a company's disability resource group (DRG), one of several types of employee resource groups (ERGs) that a company (especially large companies) may support. Employee resource groups are identity-based groups staffed by employee volunteers. Originally called "affinity groups," ERGs first appeared in the 1960s when racial tensions were rising in the United States to help businesses promote diversity and inclusion goals (Welbourne, Rolf, & Schlachter, 2017). Since then, companies have expanded their support of ERGs pursuing a broad range of diversity and inclusion goals, including: gender, race, and ethnicity, generational, sexual identity, veterans, faith-based, disability, and more (Mercer, 2011). In recent years, the goals of ERGs have evolved "to include organizational challenges such as leadership development, innovation, and change management, which should translate to significant research from the academic community" (Welbourne, Rolf, & Schlachter, 2015).

Microsoft has a DRG (called disAbility), as do other ICT vendors such as Dell (True Ability), HP (DisAbility), AT&T (Individuals with Disabilities Enabling Advocacy Link, or IDEAL) and Verizon (Disabilities Issues Awareness Leadership, or DIAL). ICT vendors with which research staff at Shepherd Center has worked occasionally engage the membership of their DRGs for input into product development and other initiatives focused on disability and accessibility. Such groups are an important resource for product development, but they represent only one of a set of resources utilized for product testing and user input. ERGs are generally volunteer organizations (Kaplan, Sabin & Smaller-Swift, 2009), despite sometimes receiving corporate financial and other material support. Consequently, participation in group activities is voluntary. The AURC has sent recruiting communications to the membership of Microsoft's disAbility group, but their participation in AURC studies is treated as voluntary, just as with any other private individual not on Microsoft's payroll. Many of these employees have full-time jobs that generally do not involve market research, product testing or development from a disability perspective. Furthermore, companies like Microsoft have large product portfolios which undergo continuous development, making the need for gathering systematic user input much bigger than the ability of DRGs generally to fulfill.

The AURC serves as an additional resource—along with internal product testing operations, external

market research vendors, disability resource groups, and other mechanisms for engaging people with disabilities—to assist with the ongoing and expansive need to engage people with disabilities in product development and evaluation at Microsoft.

Outcomes and Benefits

The AURC partnership between Microsoft and Shepherd Center offers insights into a model for ongoing consumer engagement in product design and development specifically focusing on the accessibility and usability needs of people with disabilities. By providing accessible products and services, Microsoft can help people with disabilities gain access to education, employment and connection with governments, friends, and family. The AURC database and engagement design is based on the Consumer Advisory Network (CAN) network of consumers and Survey of User Needs intake questionnaire that Shepherd Center researchers developed, in order to respond to the fast paced and continuously evolving technology industry (Mueller, et al., 2005). Like the CAN, researchers from the Shepherd Center created and maintain the AURC, but in collaboration with Microsoft. For almost two decades, Shepherd Center researchers have been building and maintaining the CAN for the Rehabilitation Engineering Research Center for Wireless Technologies (Wireless RERC) and currently for the Rehabilitation Engineering Research Center for Community Living, Health and Function (LiveWell RERC). The description of how this model was adapted to support the product accessibility design needs of a single large ICT vendor with its own processes and often urgent timelines should help inform other rehabilitation researchers and ICT vendors interested in launching similar programs.

Target Audience and Relevance

This work is relevant to rehabilitation researchers and engineers in academic or other non-profit organizations and for-profit organizations interested in connecting consumers with disabilities and technology developers, particularly in the private sector. It is also relevant to the assistive technology industry and to consumer-oriented ICT vendors. This article provides insights and a model for how researchers in non-profit organizations and industry can partner to promote accessibility and usefulness of commercial ICT products and services for people of all abilities.

Background

The rapid pace of change and variability of devices with which consumers interact over the course of their day poses substantial challenges to usability, interoperability, and accessibility. Over the last four decades, consumers have experienced the benefits—and challenges—of successive technology innovations, each one appearing more quickly than the previous one and collectively forming complex technology ecosystems. Major technology milestones in this period include the commercialization of personal computers, the internet, laptops, cellphones, smartphones, app stores for mobile apps, personal digital assistants, wearable smart devices and sensors, cloud computing, the Internet of Things (IoT), smart speakers, smart home devices for control and automation, artificial intelligence, and virtual and augmented reality.

These innovations are sometimes referred to as revolutions (Internet revolution, smartphone revolution, etc.). It might be more appropriate to view these major innovations as having a cumulative effect, adding to consumers' personal technology ecosystem, rather than completely overthrowing the previous order. This means that challenges of interoperability, reliability, and usability are multiplied as mature technologies continue to undergo refinement and new technologies are added to the mix. While desktop computers have experienced declining sales for over a decade, and laptops follow a similar pattern, they still sold at a combined rate of 399.7 million units in 2017 (Statista, 2018).

Personal computers became established as a staple of professional and personal life in the 1980s, followed by the advent and maturation of internet as an essential medium for information and communication—and later commerce—in the mid-late 1990s. The rapid evolution and diffusion of mobile phones and supporting infrastructure in the 2000s laid the foundation for a transformation in the way we work, play, socialize, and access information. Mobile voice-calling, video chat services, and two-way text messaging also provided an unprecedented boost to the independence of people with disabilities, particularly people with vision and mobility limitations and, in the case of text messaging, people who are deaf.

The era of smart devices could be said to have begun in the early 2000s, led by Research in Motion with its Blackberry devices. But, it was the launch of Apple's iPhone in June 2007 and the first Android smartphone (the HTC Dream/T-Mobile G-1) in September 2008 that dramatically and thoroughly overthrew the established technology order. Within a few years, the two top cellphone handset makers Research in Motion (RIM, maker of the BlackBerry) and Finland-based Nokia became minor players, and eventually became either niche manufacturers of devices running the Android operating system. The new generation of touchscreen smartphones come loaded with global positioning systems (GPS), 3G (then 4G, and soon 5G) telephony, Wi-Fi, Bluetooth, accelerometers, digital personal assistants, and more recently fingerprint recognition, facial recognition, iris-scanning, and more.

Smartphones and their near-cousins, tablets (iPad, Samsung Galaxy Tab, etc.), created the opportunity and need for mobile applications (news, weather, games, email, maps, etc.). Apple established the model for how these apps would be developed and brought to market by launching the AppStore for its iPhone with 552 apps on July 11, 2008. Ten years later, the AppStore boasts over 2 million apps, and has generated $130 billion in revenues for over 170 billion app downloads (Cheney, 2018). The Android Market launched in 2008 and was rebranded as Google Play in 2012 as a way to consolidate Google's online marketplace for apps, movies, music, books, and other digital content. It boasts over 2.7 million apps and games (Callaham, 2017).

In recent years wearable devices and smart speakers have been gaining traction in the marketplace. Smart watches and fitness trackers have been widely available for a number of years and have experienced relatively slow adoption and high rates of abandonment (Gartner, 2016). Smart speakers—relying primarily on a voice/auditory interface driven by a personal digital assistant—were essentially created as a category of consumer electronics by Amazon in 2015 with its Echo device. Others followed, including Google with its Home device and OK Google digital assistant, and the Cortana-powered

Harman-Kardon Invoke. These devices have now formed the hub (along with smartphones) for home automation and control for things like lights, thermostats, doorbells, security cameras, TVs, and more.

Usability challenges remain for the smart home/smart assistant. Controlling multiple smart home hubs (e.g., Echo, Echo Dots, Echo Show) can be confusing on a single mobile app. Having multiple connected devices in your smart home can make learning their dialogue path (e.g., "Alexa, …") and names complicated and confusing for users, family members, and guests (Stinson, 2017). Early versions of Google Home could not set reminders (Murnane, 2017)—a key assistive function for people with difficulty remembering. One reviewer noted that a requested list of ingredients for a recipe was spoken too fast (even at the optional slower rate) to be useful (McGregor, 2017). The Echo Dot and later versions of the regular Echo do not offer the manual volume control that allows the user to turn the entire top of the cylindrical device found on the original Echo. So, changing the volume must be made vocally or by pressing unlighted buttons on the top of the device.

Wearable technology, which is expected to grow from $1.5 billion in 2014 to $34 billion by 2020 (Lamkin 2016) and $51.6 billion by 2022 (Markets and Markets, 2017), also offers great promise and challenges for people with disabilities. However, the technology remains immature. A 2016 Gartner survey of the U.S., U.K., and Australia found that adoption rates remained low for smartwatches (12% or less) and fitness trackers (23% or less) (Gartner, 2016). Meanwhile abandonment rates for smartwatches and fitness trackers remain high (29% and 30%, respectively, across the 3 countries), which, according to Gartner, is the result of the need for wearables to be more useful (Gartner, 2016). Preliminary results of a survey of people with disabilities conducted by the LiveWell RERC found that usability and accessibility concerns of health and fitness tracking apps and devices were common (Jones, Morris & DeRuyter, 2018). Many respondents requested compatibility with existing AT or alternatives to manual keypad entry. Respondents with activity limitations requested diet and exercise apps that could more accurately measure activity levels (e.g., when using a wheelchair or other mobility aid) or allow for adjustments to diet/nutrition goals to suit their more limited caloric intake needs.

These trends and examples of persistent usability barriers point to the pressing need for ongoing usability research and engagement with consumers with disabilities.

Microsoft in the Current Technology Environment

Microsoft's large and diverse portfolio includes products that are central to consumers' personal and professional lives, including the Windows operating system, the Office suite of productivity applications (Word, Excel, PowerPoint, as well as Access database and Publisher applications), Outlook for email, Skype for voice and video communications, Xbox gaming platform, and more. This broad portfolio of widely used and complex applications requires constant maintenance, updating, and patching for security, functionality, and accessibility.

These products must continue to operate smoothly and reliably within complex and rapidly evolving ecosystems of hardware and software produced by many different vendors. Additionally, they must comply with requirements for data security and privacy, as well as with national and international

requirements for accessibility by people with a range of physical, sensory, and cognitive limitations.

Microsoft's rollout of Office 365, beginning in 2011 for business customers and 2013 for consumers, represents a key response to these imperatives. Office 365 is a subscription-based license (so-called "shrink-wrap" licenses with perpetual ownership by the customer has historically characterized much of consumer software licensing) that also offers cloud computing, cloud data storage (OneDrive), and automatic, no-cost updates for the life of the subscription. From the launch of Office 1.0 in 1990 through Office 2016 this comprehensive suite of productivity tools underwent major version upgrades approximately every 2 years with numerous updates in between (Newegg Business, 2015). The pace of product development for Office 365 is much faster. Microsoft has produced and released 19 builds of Office 365 Pro Plus through its monthly update channel through June 2018. It released 37 builds for the full year in 2017, and 35 builds in 2016 (Microsoft, 2018).

Office 365 is a leading example in the growing industry trend of offering what is known as "software as a service" or SaaS (Vladimirskiy, 2016). Other offerings in Microsoft's broad portfolio of products are under similar demands for constant updating. Managers of various Microsoft products have indicated their urgency for consumer input because of this accelerated tempo of product development. Reasons for such a rapid tempo of product development include: 1) compatibility – ongoing demand for stable functionality and interaction with other technologies; 2) reliability; 3) compliance with standards bodies (e.g., International Organization for Standardization, or ISO) and statutory/regulatory requirements; 4) security and privacy (e.g., new European Union data privacy requirements); and 5) accessibility.

Accessibility User Research Collective

The idea of creating the AURC came from Microsoft's Corporate and External Legal Affairs (CELA) group, which was looking to provide company-wide resources to the individual product teams to increase the quantity and quality of feedback from the disability user community and support inclusive design principles and the accessibility and usability of products and services. Product teams were often responsible for engaging users with disabilities but were faced with some challenges. The central challenge was identifying and recruiting a large, diverse sample of people with disabilities to participate in user research.

One way to accomplish this is to engage national or local disability advocacy organizations (Hearing Loss Association of America, National Foundation of the Blind, etc.). Alternatively, product teams could engage external market research companies to recruit and screen participants to match specific inclusion criteria. These approaches were, and still are, used. But it can be inefficient and redundant to have multiple product teams building and maintaining their own set of relationships with multiple disability organizations and third-party market research firms. Furthermore, some teams found that they had exhausted the available pool of participants and were including many of the same participants in successive studies. As participants became familiar with using Microsoft products and conducting studies with the same teams, they gradually became less representative of the typical user with their same disability.

Accessibility professionals at Microsoft already knew of Shepherd Center due to their long history of serving in an advisory capacity for the Wireless RERC, which created the consumer network model of user-centered research. In 2001, the Wireless RERC launched its Consumer Advisory Network (CAN) of people with disabilities and made it the cornerstone of consumer engagement over the succeeding years (Mueller, Jones, Broderick, and Haberman, 2005). Responding to the needs and challenges that Microsoft product teams faced in engaging users with disabilities, Microsoft's CELA group partnered with Shepherd Center's assistive technology/accessibility researchers to design and launch a national, dynamic, and enduring networking of people with disabilities who are interested in testing and providing feedback on technology products.

Structure

The foundation of the AURC's consumer network model for testing and needs discovery is a large national network whose members complete an intake form, a detailed questionnaire with demographics (age, gender, etc.), disability profile, technology profile, and contact information. The database of information serves as a resource for understanding technology use patterns for a specific consumer profile (e.g., deaf videogame console users, age 18-35). Shepherd Center researchers working on the Wireless and LiveWell grants have produced a number of publications and conference papers on analysis of their Survey of User Needs—the intake questionnaire for their Consumer Advisory Network—to answer specific questions on technology usage by consumers with disabilities (Jones, et al., 2018; Morris, Jones & Sweatman, 2016; Morris & Mueller, 2016; Morris, Mueller, & Jones, 2010).

The database questionnaire can be completed either online, by phone, or on paper. The overwhelming majority of members complete the questionnaire online. The questionnaire and database were built in REDCap (Research Electronic Data Capture), a secure web application for building and managing online surveys and databases originally created by Vanderbilt University for clinical research, and now available to other institutions via the REDCap Consortium. Shepherd Center is a member of the consortium, and its clinical research department uses REDCap to track research projects, research participants, and stipend payments. A key part of the service that the AURC provides to Microsoft is payment of participant stipends, which a smaller organization like Shepherd Center (with approximately 1500 employees) can undertake more efficiently than a large multinational technology vendor.

The main intended use of the AURC database, however, is as a resource to recruit individuals with specific demographic, disability, and technology profiles to participate in small individual usability and needs discovery studies. These studies usually include between 10 and 20 participants. Most studies are conducted remotely; data are usually collected via an online survey service like Survey Monkey. Some projects are conducted in person. To date, these have taken place in Atlanta, where Shepherd Center is located. Other locations may be used going forward.

Because the AURC is staffed exclusively by Shepherd Center personnel and stipend payments are made directly from Shepherd Center, the AURC and all individual usability projects must be reviewed by Shepherd Center's Institutional Review Board. This adds time and cost compared to commercial research companies, which do not have to adhere to review requirements for human-subjects protection. However,

the requirement to define the study clearly and organize all the materials upfront ensures that studies are thoroughly considered, and all participants are properly protected including participant data privacy. The pace of product development at Microsoft can compete with careful research design.

This engagement with the IRB process has added to the AURC's original mission, which was solely to create the user network, recruit participants, and pay them for their participation. AURC staff regularly offer feedback and assistance in study design to the leaders of the individual studies at Microsoft, including guidance on what is feasible for human-subjects research review. Also, AURC staff assembles the package for the IRB amendment request for each study and manages all IRB communications. IRB review also means that AURC staff manages the participant consent process and maintains records.

Operations

AURC operations have to address two contradictory forces: complexity and speed. Adapting the consumer network model of engagement of people with disabilities to the Microsoft-Shepherd Center partnership—something that Shepherd Center/RERC personnel managed as a purely internal operation—added complexity to operations. Meanwhile, adapting a model that was developed in an academic setting to that accelerated pace of a multinational ICT vendor imposed intensified productivity.

By design the AURC has numerous clients within Microsoft. For the program to be impactful and show value to sponsors within CELA, it needed to have a steady stream of projects, ideally from a broad set of product and business teams within Microsoft. In order to facilitate engagement with a variety of Microsoft teams, the AURC process for submitting requests for new projects and delivering the results had to be specified in detail. Table 1 shows the workflow for AURC usability projects.

Table 1: AURC Usability Study Workflow

Stage	Description
Create request	Product teams fill out a short request form on SharePoint team collaboration tool AURC staff must check SharePoint account daily
AURC follow-up with requestor	AURC sends requestor an email to learn more details; often sets up conference call
Consultation on study design	AURC staff provides input/recommendations on study design to ensure collection of useful data to ensure approval by Shepherd Center IRB
IRB submission/approval	AURC assembles all documents for submission of amendment request to existing approved protocol for the entire program
Recruiting (often adding to AURC database)	Staff recruits people matching inclusion criteria from AURC database; if not enough individuals match criteria, new targeted recruiting is undertaken
Data collection	Much of the feedback data are collected via online questionnaires built in SurveyMonkey by AURC staff; other studies require online telephone interview or onsite in-person technology testing
Payment to participants	AURC staff pays participants stipends via Amazon gift cards or check request to Shepherd Center Financial Services
Reporting	Data need to be cleaned, anonymized, organized, and sent to project owner at Microsoft
Satisfaction surveys: Project leads and study participants	Satisfaction surveys sent to ensure quality of services to stakeholders and identify problems; results reviewed

To date AURC has completed 14 use and usability studies of various types and has 3 additional studies currently underway. Projects have focused on specific Microsoft products (Windows, Office, Xbox, etc.) as well as general questions of how consumers with specific disabilities access and use technology. The disability focus of projects has varied, with many focusing on vision and hearing, and others focusing on cognitive and language processing difficulties.

AURC Member Profile

In addition to conducting individual usability studies, AURC staff engage in ongoing general recruitment to the AURC network. Outreach efforts include use of social media channels, promotion at conferences like the California State University, Northridge (CSUN) Assistive Technology Conference (Lawrence & Morris, 2018) among others, and staff reaching out personally to their own contacts. Microsoft's CELA staff engage in extensive outreach to promote the AURC among disability organizations and internally within the company.

Recruiting new members to the national AURC network has been successful, with over 750 members. AURC staff dedicated considerable resources to general outreach efforts. Membership in the AURC network continued to grow as additional targeted recruiting for new usability projects was conducted. This "organic" growth of the AURC membership is beneficial to new members and the network overall, as it engages these new members in projects right away.

The current AURC membership has a mean age of 45.6 years with a standard deviation of 15.6 years. All recruitment communications and materials make it clear that one must be 18 years of age to be a member in the AURC and to participate in a usability study. The decision to include only legal adults was made to simplify the human subjects review process. The AURC may explore including adolescents going forward. The AURC broadly reflects the general population on other demographic variables, if not necessarily the population of people with disabilities, who tend to be less educated, and have lower income and employment (Table 2). In terms of race/ethnicity, a slightly higher percentage of AURC members are white/Caucasian than the general population. The racial/ethnic group most underrepresented is Hispanics/Latinos.

Table 2: AURC Member Demographics (percentage of members)

Race/Ethnicity – White/Caucasian	71.9
Education – Bachelor's degree or higher	62.6
Income – Annual household income of $50,000 or higher	44.5
Employment – Full time or part time	51.1

A very high percentage of the AURC membership reports difficulty seeing (58.4%). Another 29% report difficulty hearing (Table 3). These disabilities have been the focus of the majority of AURC usability studies to date, which may be driving in part their high representation among members. The survey allowed respondents to report more than one disability.

Table 3: AURC Member Disabilities (percentage of members)

Seeing	58.4
Hearing	29.1
Walking or climbing stairs	21.0
Fatigue/limited stamina	15.2
Frequent worrying, nervousness, or anxiety	14.0
Using hands or fingers	13.1
Concentrating, remembering, or making decisions	11.8
Using arms	9.6
Speaking (so other can understand)	6.3
Learning, or learning disability	6.1
Sensory integration	4.0
Other	5.4

Technology ownership and experience is often an inclusion criterion for the individual usability studies. The AURC intake questionnaire includes more than a dozen questions that map member technology profiles. The core question focuses on ownership of basic ICT platforms (Table 4). Not surprisingly, the most common devices are also the most versatile and mobile: smartphones (owned by 82.8% of members) and laptop computers (75%).

Table 4: AURC Member Technology Ownership Profile (percentage of members)

Smartphone	82.8
Laptop computer	75.0
Tablet computer	58.0
Desktop computer	53.0
Specialized assistive technology	21.9
Smartwatch	16.9
Home automation	15.3
Fitness tracker or sensor	14.4
Home security system	10.3
Basic mobile phone	6.5
Other wearable technology	5.8
Home activity sensor	3.4
Sleep monitor	3.7

Satisfaction – Study Participants and Project Owners

A critical component of the AURC governance model is the conduct of satisfaction surveys for all study participants and for project owners at Microsoft, asking them: 1) to rate the overall experience; 2) whether they would recommend participating (or using, for project owners at Microsoft) the service; and 3) provide comments and suggestions. The two questions on ratings were on a Likert scale of 1-5 with 5 being best. A total of 190 individuals participated in one of the 14 completed usability projects and 108 completed the short satisfaction survey. As of June 30, 2018, 7 of the 14 project owners completed the satisfaction survey. Table 5 provides a summary of their responses.

Additionally, all 108 study participants said they would participate in another usability study. The studies are interesting to the participants and are not invasive or onerous. Participants also often are pleased when technology companies make the effort to get their feedback. It makes them feel their voice is being heard. Operationally, it is AURC policy to pay study participants by the end of the week in which they

completed a study. Comments from participants reflected high levels of satisfaction with all of these aspects of the usability studies.

Table 5: Satisfaction Scores for Study Participants and Project Owners

	Participants (n=108)	Project Owners (n=7)
Would you recommend AURC research to others?	4.75	4.57
How would you rate your overall experience?	4.56	4.43

The project owners were also generally very pleased with AURC service, though a bit more critical than participants. While appreciative of the resources provided by CELA through the AURC, project owners would still prefer faster turnaround on projects. They are responsible for producing updates on a monthly or more frequent basis. However, even the simplest project with the least restrictive inclusion criteria (and, consequently, easiest recruiting) can take more than a month for development, IRB approval, recruiting, data collection, and delivery of results. In more academic environments this would be an impressive pace. At large, multinational IT vendors, it is often too slow. This is a challenge that will need continued attention to speed processes and to set expectations.

Discussion

The AURC represents a distinct approach to engaging users with disabilities into the design process of Microsoft products. Its core features include the organization of a large national network of people with disabilities from which AURC staff recruits for specific, targeted user-needs and usability studies related to Microsoft products. It also builds on and supports user-centered design techniques, as well as the goals of Rehabilitation Engineering Research Centers (RERCs) and their funding agency, the National Institute on Disability, Independent Living and Rehabilitation Research (NIDILRR). The AURC model can be adopted by other research/advocacy organizations and other ICT vendors, but it requires operational and organizational agility and commitment by both organizations.

User Centered Design, Usability, and Accessibility

The AURC contributes to a long tradition of user-centered design (UCD) which also finds expression in U.S. statutory law and regulatory policy. Jeffrey Rubin's seminal *Handbook of Usability Testing: How to Plan, Design, and Conduct Effective Tests* (1984) identifies 3 core principles of the UCD process: 1) early focus on users and tasks; 2) empirical measurement and testing of product usage; and 3) iterative design. Rubin also identifies four usability goals: 1) usefulness; 2) effectiveness (ease of use); 3) learnability; and 4) attitude (likeability).

UCD principles and goals are reflected in U.S. statutory law and regulation. The Americans with Disabilities Act (ADA) of 1990 prohibited discrimination in employment and access to places of public accommodation, services, programs, public transportation, and telecommunications. As information and communication technology (ICT) has grown in importance in our personal and professional lives, legislation and regulation to ensure accessibility and usability have followed. The Telecommunications Act of 1996 required that telecommunications services and equipment and "customer premises

equipment" be "designed, developed, and fabricated to be accessible to and usable by individuals with disabilities, if readily achievable." The 1998 amendment to the Rehabilitation Act of 1973 required Federal agencies to make their electronic and information technology (EIT) accessible to people with disabilities.

In 2017, a final rule updating Section 508 of the Rehabilitation Act and Section 255 of the Telecommunication Act in response to market trends and innovations in technology was adopted (Information and Communication Technology (ICT) Standards and Guidelines, 2017). This "refresh" harmonized requirements with other guidelines and standards in the U.S. and internationally, including standards issued by the European Commission, and the World Wide Web Consortium (W3C) Web Content Accessibility Guidelines (WCAG 2.0).

The 2017 refresh includes a subsection on user needs (E203.2), stating: "When agencies procure, develop, maintain or use ICT they shall identify the needs of users with disabilities to determine:

A. How users with disabilities will perform the functions supported by the ICT; and
B. How the ICT will be developed, installed, configured, and maintained to support users with disabilities."

Earlier, the 21st Century Communications and Video Accessibility Act of 2010 (CVAA) was adopted. CVAA is focused mainly on communications software and equipment manufacturers, video service providers, and producers of video content. The act requires that all communications and video programming be provided in an accessible manner to individuals with disabilities. It specifically references consultation with users to provide accessible communications and video technology solutions, including: "information about the manufacturer's or provider's efforts to consult with individuals with disabilities."

The current consumer technology environment – proliferating ICT devices, cloud-based computing, intensifying competition among technological companies, and short update cycles for enhanced functionality, interoperability, and security – give greater urgency to UCD. These same forces also can pose substantial challenges to UCD. Continuous development and rapid updates match the UCD ideal of design and development as an ongoing iterative process. Yet, the tempo of development – particularly for software – challenges usability researchers to develop innovative processes to make consumer input timely. In today's consumer technology development environment, UCD's emphasis on being process-driven (e.g., Horton and Sloan, 2014) is especially well placed.

AURC and the Mission of the National Institute on Rehabilitation, Independent Living, and Rehabilitation Research

The AURC and similar partnerships support the mission of centers funded by the National Institute on Rehabilitation, Independent Living, and Rehabilitation Research (NIDILRR) to:

> … generate new knowledge and to promote its effective use to improve the abilities of individuals with disabilities to perform activities of their choice in the community, and to expand society's capacity to provide full opportunities and accommodations for its citizens

> with disabilities….by providing for research, demonstration, training, technical assistance and related activities, … promoting the transfer of, use and adoption of rehabilitation technology for individuals with disabilities in a timely manner; and ensuring the widespread distribution, in usable formats, of practical scientific and technological (NIDILRR, 2018).

NIDILRR's website also describes the purpose of the Rehabilitation Engineering Research Centers (RERCs):

> … to improve the effectiveness of services authorized under the Rehabilitation Act by conducting advanced engineering research and development of innovative technologies designed to solve particular rehabilitation problems or remove environmental barriers. RERCs also demonstrate and evaluate such technologies, facilitate service delivery systems changes, stimulate the production and distribution of equipment in the private sector, and provide training opportunities to enable individuals (including individuals with disabilities) to become researchers and practitioners of rehabilitation technology.

The LiveWell RERC is funded under one NIDILRR's four field-initiated funding areas focusing on Information and Communications Technology (ICT) Access. This was established in 2013 to: "…research, develop, and evaluate innovative technologies and strategies that will optimize accessibility and usability of one or more of the following: telecommunications products; wireless technologies; technology interfaces; computer systems; software; and networks for individuals with disabilities" (Federal Register, 2013).

The consumer network model for UCD is a strategy to optimize accessibility and usability of technology. NIDILRR funds do not support the AURC directly. However, the AURC is conceptually based on the Consumer Advisory Network model of user-centered research which has been developed and refined over the years by researchers at Shepherd Center with support from the NIDILRR-funded Wireless RERC and LiveWell RERC. This is an unanticipated outcome from NIDILRR's investment in the exploration and discovery, practical implementation, and knowledge creation related to this UCD model. Futhermore, it is highly impactful given the extensiveness of Microsoft's product and services portfolio, and the high number of Microsoft users worldwide.

Prospects for Generalizing the AURC Model

Other research and advocacy organizations with expertise and interest in accessible and assistive technologies could adopt the AURC model. The fundamental requirement for any organization interested in forming their own user-centered research lab to support usability and usefulness of ICT products is agility. The AURC team's experience working with partners at large research institutions is that their administrative systems can be overly rigid and slow. Shepherd Center, by contrast, is relatively small with only 1500 employees overall, and about 50 working primarily in the research department. AURC staff scoped, gained IRB approval, and completed 14 individual usability projects in less than 12 months. The AURC paid 190 individual participant stipends, ranging from $25 to $150, for those projects. This high rate of production requires high levels of responsiveness on the part of supporting departments and

review boards at the research institution.

For large ICT vendors, the key to success is to have a champion with a corporate-wide mandate to promote inclusive design and accessibility. Microsoft's Corporate and External Legal Affairs (CELA) group is that champion. It can provide the financial support for the AURC, promote AURC services to the company's numerous product and business teams, and help establish policies and procedures. Groups like CELA and its Accessibility Technical Evangelists act as key liaisons between the AURC and company product teams by providing deep knowledge of disability and accessibility as well as knowledge of corporate structure, processes, and initiatives.

Ongoing Evolution of the Consumer Network Model for User-Centered Design

AURC staff, in consultation with CELA, has identified a number of challenges and opportunities for the program to continue to grow. First and foremost is setting expectations with product managers on project timelines, and finding ways to design projects that shorten timelines, perhaps dividing projects into multiple parts and delivering on the more straightforward components first.

Additionally, now that the AURC membership has grown to a substantial number, we need to find ways to communicate more systematically and meaningfully with the membership. The AURC maintains social media channels, but their effectiveness may be limited. Direct engagement seems to be more meaningful and rewarding to participants. The team created a quarterly newsletter as a way to continue to keep the membership engaged. Also, the AURC has launched additional research projects designed to engage the entire membership, including: 1) a survey on needs (fulfilled and not yet fulfilled) for accessibility and use of Microsoft products; and 2) the experiences with the first-ever joint national test of the Emergency Alert System (EAS) and Wireless Emergency Alerts (WEA) held on October 3, 2018. This test of the Presidential Alert offered a unique opportunity to engage AURC members of all ages and disabilities in a research project that was in the national news and affected the entire country.

Broader challenges involve adding new types of projects that the AURC supports. The original concept of the AURC was, at its simplest, to recruit study participants and pay them, and simultaneously build the larger network of people with disabilities. The scope of responsibilities has expanded due to institutional and stakeholder needs on both sides (e.g., IRB review processes at Shepherd Center; the extensive demand for consumer input at Microsoft). The breadth and complexity of usability projects is likely to grow, and the AURC will need to respond to new stakeholder needs. As the AURC embarks on its second year of activity, the project team, with the support of Microsoft's CELA group and various engineering product teams, has begun exploring the development of new structures and processes to speed the gathering of user feedback.

Conclusion

The AURC has completed its first year of operation. The projects conducted had several positive impacts on products at Microsoft. The program increased the voice of the customer into design, engineering, and research at Microsoft, and created a scalable mechanism to implement inclusive design at Microsoft. The

AURC helped teams across the company prioritize accessibility work and provided feedback to build engineering roadmaps. Additionally, the AURC gave product teams more confidence that they were working on the right things and built more empathy for people with disabilities using Microsoft products.

For the ICT industry in general, the challenge of engaging consumers with disabilities is becoming ever more critical. Regulatory and technology imperatives related to compliance, reliability, interoperability, and accessibility will only grow more intensive. Additionally, as the populations of many countries grow older and as people with disabilities live longer lives, there will be even greater need for accessible and useful consumer technologies.

Declarations

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