Access Technologies and Accessibility for Inclusion

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"Access technology" (AT) is a term used to discuss assistive and adaptive technologies. While these terms are often used interchangeably, "access technology" is proposed insofar as the idea of "assistive" may be understood as redundant and condescending, since every technology can be perceived as assistive in one way or another (Ladner, 2010). The United States Assistive Technology Act (Technology Related Assistance for Individuals with Disabilities Act of 1988, Public Law 100–407, renewed 1998) defines assistive or adaptive technologies as "products, devices, or equipment, whether acquired commercially, modified or customized, that are used to maintain, increase, or improve the functional capabilities of individuals with disabilities" (Section 3.1). While this definition includes a vast range of artifacts extending from wheelchairs to eyeglasses, this entry focuses on computing or digital information based AT.

The growing field of ICT4D examines many ways in which technology can impact on social and economic inclusion in low- and middle-income countries (LMICs). Such work is frequently social commentary and practice focused on the role of technology in social inequality and in service delivery in a range of areas from health care and education to governance and financial services. Among the various conversations on institutional capacity and marginalization, there has been a debate on questions of accessibility in society, particularly for citizens with disabilities. With the recent signing and ratification of the United Nations Convention on the Rights of Persons with Disabilities (UNCRPD), there has been a great deal of work, undertaken with a sense of urgency, on the policy front. This has been particularly the case as countries with no history of disability related policymaking start to build institutions and technologies toward greater social inclusion (Perlin, 2008). A particularly important consequence of the UNCRPD has been a formal recognition of disability in rights terms, rather than the historically prevalent medical or rehabilitational models of disability which addressed disability in terms of impairments and prostheses, as something to be cured rather than as a social phenomenon in which the impairment is created by the broader lack of accessibility in the public sphere.

Although much has been said about the role of technology as an amplifier rather than as a fundamental change agent for marginalized people, it is arguable that access technologies (AT) are an absolutely critical part of accessibility in the public sphere for people with disabilities. From the use of geographical positioning systems (GPS) and motorized wheelchairs for spatial navigation, to augmentative and alternative communication devices for basic computing, and voice or tactile output devices to aid communications, a range of technologies have become a critical element that enables meaningful social and economic interactions for individuals with disabilities, interactions that frequently presented significant challenges in the past. A vast range of computing based AT is currently designed for use by people in higher-income countries: they are both extremely expensive and pose usability challenges; for instance, they are not very adaptable to languages in LMICs. The past few years have seen some work on the role of low-cost assistive technology, specifically around access to technology in response to the UNCRPD in LMICs (Borg, Lindström, & Larsson, 2011; Pal et al., 2011).

For the ICT4D world, there are several important directions that AT suggests. First, the principle of inclusion, which has been used in reference to technologies and services for socially marginalized groups, has long overlooked the issue of varying human ability. Second, the principles of human centered design, which have been a key part of a large body of work on the

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appropriate and wide usability of artifacts on the technical side of ICT4D research, have likewise been less prominent in the canonical work in this space. This entry focuses on the second.

Within the space of AT, there are two broad subcategories – the first refers to the technologies themselves and the second to the enabling environment around the technologies. The discussion here is restricted to digital technologies and discusses in broad terms what kinds of technologies exist for various disabling conditions and what the challenges within the ICT4D space are for creating low-cost, appropriate versions of these. We also discuss the policy environment related to AT, primarily the UNCRPD, which has consequences for LMICs and some of the important practices around the support structure for AT users.

Technology

There is an important specific mention in the UNCRPD of promoting research at affordable costs, which points to the affordability gap for AT users in many LMICs. Most AT research takes place in the high-income nations and, consequently, the technologies are built with users in those countries in mind. From an industry perspective, the major challenge with respect to AT costs is the unique nature of procurement for most AT products. The government in some countries is the biggest buyer of AT and is often obliged by local law to purchase AT for citizens as needed. As a result, producers of AT products have not faced fierce competition in their markets and have not tried to build products at a fraction of their cost to be saleable in low-income markets with much lower purchasing power and less government commitment to procurement. Moreover, many AT products are highly customized for individual users, again making it difficult to build extremely low-cost versions.

There are thousands of AT options available for purchase depending on the nature of access that needs to be facilitated. Common computer related assistive technology products include screen magnifiers, large-key keyboards or phones, alternative input devices or augmentative alternative communication devices (AAC) such as touch screen displays, trackballs and joysticks, eye trackers for use in gesture or pointing based communications, speech recognition programs, and in-text readers and Braille products including displays, printers, notetakers, hearing aids, and a range of cognitive management tools that facilitate daily or task-specific information management for children or adults who face challenges with the output, flow, or scale of information.

For people with mobility impairments, wheelchairs and accessibility in the physical environment are a critical part of social inclusion. Within the UNCRPD, there is reference to transportation accessibility, though in much of the world there is very little functional access to wheelchairs on any public transit. Some countries are beginning to create accessible streets for wheelchairs, though access to the actual wheelchairs is often difficult. In several countries the right to wheelchairs that effectively navigate uneven surfaces has been led by disability rights activists (Neff, Pal, & Frix, 2009), though access to motorized wheelchairs is generally negligible in most LMICs. Advanced motorized wheelchairs with sip-and-puff control for management through oral muscles or other forms of technology facilitated navigation by people with limited use of their arms is extremely rare – not just because of the expense (such systems are extremely expensive), but because of the lack of infrastructure to support their movement. Although there is some academic research on various kinds of electronic wheelchairs (Megalingam et al., 2012; Wan & Tam, 2010), the market for these remains highly underdeveloped, and there is very little research on the experience of wheelchair use in LMICs (Bi, 2006; Darcy & Ravinder, 2008).

For much of the world, a text and graphics based digital screen has become a standard output interface for desktop and mobile devices. Output technologies for people with vision impairments are a large category of AT products. Output technologies can be tactile, visual, or audio based depending on what is appropriate for the user. Visual output devices are typically magnifiers that can be handheld or integrated into the computing environment. Audio output AT products typically refer to speech output technologies, such as speech synthesizers which work with screen readers on desktop or mobile systems. Tactile output devices allow users to

perceive through touch, usually through a range of Braille related products, though there are also advanced haptic devices that not only allow access to textual material but also to feedback on shapes, texture, vibrations, and motion.

Screen readers are technologies that manage the computing experience for a print impaired user by offering output channeled through a speech synthesizer or Braille translator. Screen reading technology can revolutionize access to education for blind people in LMICs, since much of the study material that was previously unavailable, typically owing to the lack of Braille printed materials, is now available in accessible formats. Devices such as the portable Kurzweil reader have been available, which can be used to scan and read printed books, but these are much slower to use than a screen reader.

A screen reader is the necessary interface between the computer's operating system, its applications, and a vision impaired user. The most widely used screen readers are Freedom Scientific's JAWS, which historically had a very large market share worldwide and costs roughly US$1000 per license, and the free and open source NVDA (NonVisual Desktop Access). For most people who cannot use a visual interface, a screen reader is necessary for independent digital technology use.

Studies examining the scope of low-cost screen reading technology have found that, while the obstacle to widespread adoption of open source screen reading was the poor quality of speech output in free products, the same low-end products offered much greater flexibility with the incorporation of new scripts and languages (McCarthy, Pal, & Cutrell, 2013). Indeed, the speech output for new languages is a complex problem, because it can be challenging from a machine learning perspective and may require significant human effort. As a result of that, the speech synthesizers are costly to develop and drive up the cost of proprietary screen readers. However, a broader trend that has far-reaching consequences for screen reading technology is the bundling of speech synthesis with the operating system, or its availability as a web application – such as the ChromeVox extension to Google Chrome.

Likewise among tactile output options, the majority of refreshable Braille displays prevalent in the market cost several thousand US dollars. Even Braille output printing tends to be extremely expensive – both the special paper and the printers are rare commodities for blind people in most LMICs. The most significant recent movement in the screen reading space is in the use of mobile devices with screen readers. Smartphones continue to grow in processing and storage capacity, can provide location based services, and have a massive universe of mobile applications that enable a range of functions. Document access and processing are already widely used on mobile devices, and phones are rapidly becoming an all-purpose business device.

Accessibility in technology is used to describe interfaces and artifacts that can be used by anyone to the best of their individual abilities. The issue of document accessibility online has been an area of heavy debate in the past several years. There are several examples of accessibility challenges – from visual navigation related problems such as the overuse of graphics, poor contrast, lack of appropriate tagging of images, and complex web based forms that break the rules of accessible page design. These rules include designing web pages with absolute pixel width instead of fluid width, and not using alt attributes (which are used in web documents to specify alternative text in screen readers). Surprisingly, even though the rules have been in place for years, there is a remarkably high rate of noncompliance with these basic accessibility guidelines. Even when websites are "compliant" with accessibility requirements, this is often done to the bare minimum, and a culture of "accessibility logic" of designing materials that are easily navigable on nonvisual interfaces is extremely rare. Governments themselves are at the center of this issue, which is one of the most important digital accessibility problems – very few e-government sites in LMICs, for instance, comply with international accessibility standards.

Discourses on accessibility that relate to issues in LMICs range from challenges to compliance with international accessibility standards on file formats and problems with language/script support for languages with a smaller presence online, to issues around intellectual property rights for published materials, particularly with regard to the right to convert published materials into accessible formats. Access to materials for people with print impairments continues to be a significant challenge, and it is estimated

that only about 5% of published books are ever available in accessible formats; in LMICs these percentages are even lower. As a result, debate in major international fora on intellectual property rights is concerned with exposing this problem as a fundamental denial of information rights. There are some radical approaches, like that of the Indian social network for print impaired people, Inclusive Planet (inclusiveplanet.com), which briefly operated on the basic principle of openly flouting international intellectual property laws to enable access to print material.

Users with needs for AAC technologies traditionally had very few options in LMICs. While several low-tech AAC technologies are inexpensive, many – such as speech generating devices, high-tech AAC boards with pointers, eye tracking devices, and so on – tend to be very expensive. Worse still, the lack of appropriate diagnosis of neuromotor conditions often led to the conflation of motor conditions with various forms of intellectual impairment, and individuals who typically would use AAC devices are frequently institutionalized or excluded from the formal education system in many LMICs. Schools rarely have the ability to provide quality accessible education, and even the most basic facilities, such as trained teachers or low-cost paper based communication aids, are rarely available for children with neuromuscular or cognitive impairments. In recent years there has been an increase in the recognition of autism, in part because of portrayals of autism in popular media, though the challenges of changing perceptions and beliefs continue to be massive. With aging populations, another important issue in the coming years is likely to be AT for seniors with cognitive impairments and their caregivers. There has been some work on low-cost AT for managing caregiving, but with the increase in institutionalization of seniors with Alzheimer's or forms of vascular dementia in LMICs, that is, a move away from a home based care system, it is likely that there will be pressure to build new AT for the caregiving process.

For people with hearing impairments, an important trend has started increasing access to materials. The first has been the increase in awareness of the need for captioning visual material, both through efforts at source and through automated text translation (such as Google's text translator used for captioning YouTube videos). There is immense scope for work on the crowdsourcing of translation and transcription of visual material online, particularly in view of the increasing number of venues offering distributed higher education resources online. Ways of using technology to make these more accessible and available in more languages will require innovative means of using a combination of human endeavor and machine learning.

Free and open source software (FOSS) has been at the center of the ICT4D discourse for a range of reasons: cost; the overall potential for customizing technologies to the specific needs of populations not adequately served by proprietary software; and the philosophical values of openness. In the accessibility space, the problem with access to commercial assistive technologies is often exacerbated by extremely high off-the-shelf costs, given that paying customers are often a small fraction of the population and state purchases of AT under welfare mechanisms typically reduce the incentive for building low-cost devices. In some cases, there are short-term reasons for supporting FOSS approaches, such as with speech synthesis and speech recognition technologies, where new languages can be well supported but where solutions offered through market mechanisms do not offer options. This can be the case, for example, when there are an insufficient number of speakers of a language to yield an attractive market proposition. More broadly, the design of new technologies that are made open and freely available to users can be very valuable for easy replication and dissemination.

Environment

One of the most important missing pieces when it comes to access to technology in LMICs is the lack of a widespread disability culture in the public sphere. Studies repeatedly show that people in many parts of the world hold to traditional, often regressive and discriminatory, beliefs about disability. This in turn gives rise to a systematic exclusion and marginalization of people with disabilities, framing disability most commonly in terms of divine punishment and of dependency on charity. There is a resulting "negative visibility of disability" wherein people with disabilities are structurally disempowered from presenting

their own narratives in the public sphere, and are consequently seen or portrayed in the media as set apart from the mainstream (Dauncey, 2007; DePauw, 1997). The consequences of this are what is fundamentally disabling, ranging from the unwillingness of employers to give jobs to qualified candidates with disabilities because they do not believe someone with a disability can be effective in the workplace, to a more general attitude of condescension and othering in society as a whole. In the United States and in several countries in the global North, there is a significant disability rights movement that has brought the idea of disability culture to the mainstream by emphasizing ability and the right to independence and self-determination. The gradual spread of disability studies courses in universities, the increase in the number of people with disabilities in public life, and in particular the growth of an artistic and performance culture among people with disabilities are vital pieces of the growing disability culture. The challenges of building a disability culture in the global South are emphasized in the work of Steven Brown, a rights activist, on disability culture in South Africa:

> The struggle for inclusion is going to be a long one as the evolution of "disability culture" is still in an infant stage in our country. A key function of "disability culture" is the celebration of the uniqueness of disability. It is my belief however that it will blossom as people with disabilities increasingly identify with each other and begin to express themselves more artistically and participate in the cultural life of society as a whole. (2002, p. 34)

It is imperative that the ICT4D community looks beyond AT to broader environmental questions of what technology can do to encourage a greater consciousness of accessibility throughout society, and how it can empower people with disabilities to express themselves. Social media and web based multimedia tools, alongside mobile phones, are vital in making performative work easier to produce and disseminate (Cochrane & Bateman, 2010), and research has started examining the role of online networks like YouTube for disability awareness (Columna et al., 2009). While stakeholders consider direct funding for AT, institutional development, policy, and services, it is crucial to ensure that people are empowered to create and broadcast the kinds of self-expressive media that contribute to laying the ground for a greater consciousness of accessibility in society.

In the context of the changing international policy environment, the UNCRPD has been progressive in defining a broad range of rights across the spectrum and in noting the importance of cultural expression (Article 30) and participation in public life (Article 29). Section 2 of Article 30 specifically asks state parties to enable persons with disabilities to have the opportunity to create cultural materials for their creative expression and for the enrichment of society. In addition to the recognition of the importance of creating media, the UNCRPD contains a number of clauses that recognize that AT plays a role in a range of aspects of daily life from basic spatial navigation, to communications, computing, and workplace access. There are both explicit and implicit roles for assistive tools in implementing this Convention in the spirit in which it was written. Given that governance and the economy are increasingly technology-heavy, the right to work or the right to political and public life – both defined in the Convention – may not be actionable without adequate access to computing resources.

Article 4 (General Obligations) of the UNCRPD tells states to promote research and the development of new technology, and to give priority to technologies at affordable cost. Article 9 (Accessibility) commits states to promoting the design, development, production, and distribution of accessible ICTs at an early stage, such that these technologies become accessible at minimal cost. Article 20 (Personal mobility) commits states to facilitating access to quality mobility aids and assistive technologies for persons with disability, and to encouraging entities that provide assistive technologies to conduct needs assessments of people with disabilities. Article 21 (Freedom of expression and opinion, and access to information) commits states to facilitate augmentative and alternative communication (e.g., AAC), urges private entities with an internet presence to provide information in accessible and usable formats, and specifically calls for the same response from the mass media. Article 26 (Habilitation and rehabilitation), section 3, requires that states

promote assistive technologies for rehabilitation; and, finally, Article 27 (Work and employment) commits states to enabling persons with disabilities to have effective access to technical and vocational guidance, and to ensuring that reasonable accommodation is provided to persons with disabilities in the workplace.

The centrality of AT in the UNCRPD is far-reaching and for many of the 136 countries that had ratified the Convention by September 2013, the stress on technology as one of the components of social inclusion is a critical first. This is particularly so for several LMICs that have not had access to AT owing to cost or localization problems. Noting various ways of accessing information, including through the mass media, access to low-cost technology itself, and access not only through state institutions but also through workplace accommodation, the UNCRPD thus emphasizes the complex nature of exclusion. However, mentions of AT in the Convention are frequently worded as recommendations rather than as stipulations, so measuring the extent to which technological accessibility will become a priority remains a task for the future.

It is important to emphasize that the broader environment around the use of technology is a critical part of what has made industrialized societies relatively more accessible in recent years. There are usually vast repositories of materials in accessible formats stored in libraries, guidelines for teachers in providing AT and accessible instruction in classrooms, borrowing material for children and their parents, lifelong learning resources for older individuals with disabilities – all of which come together to offer the range of support resources that make the technology actionable.

Conclusion

From mobile handheld devices that allow sign language speakers to communicate either with others directly or with visual interfaces, to systems that allow mediated communication for sign language users with either a human intermediary or an algorithm that recognizes spoken language, to speech recognition software, to advanced motorized prostheses for people with amputations – there is a massive array of technologies that can enable greater social inclusion. The technological innovations are, however, a very small part of the challenge of social inclusion in this area, particularly in situations where medical models of disability prevail, where an indigenous positive disability culture has not yet developed, and where a basic introduction to disability studies may not exist in the education system. The quest for solutions that yield more inclusive societies does not lie in the technology, or only in action by the community of people with disabilities or by thought leaders. Change will come only when the public sphere evolves and societies give greater emphasis to the will to be inclusive.

SEE ALSO: Digital Divide(s); ICT4D; ICT4D and Economic Development; ICT4D and Ethics; ICT4D and Political Participation; ICT4D and Poverty Reduction; Multistakeholder Partnerships

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