Rehabilitation Engineering and Research Center on Universal Interface and Information Technology Access

Gregg C. Vanderheiden[1], Amrish Chourasia[1], Yao Ding[1], Jim Tobias[2], and Denis Anson[3]

[1] Trace R&D Center, University of Wisconsin – Madison, USA
{gv,amrish,ding}@trace.wisc.edu
[2] Inclusive Technologies, USA
tobias@inclusive.com
[3] Misericorida University, USA
danson@misericordia.edu

Abstract. The incidence of disability is increasing. As we move to a more digital world, people with disabilities, older people, and those with literacy and digital literacy problems face the prospect of losing out due to lack of access to information and communication technology. The rehabilitation engineering research center (RERC) on universal interface and information technology access seeks to promote a new approach to accessibility. This approach involves creating a new infrastructure for the development and delivery of AT and built-in access features. This effort is known as the Global Public Inclusive Infrastructure (GPII). This RERC will move the idea of GPII from laboratory prototypes to real-world implementation. A library GPII system and a cloud-based decision support tool for assistive technology selection are currently under development. The RERC will also support technology transfer and development of standards to promote accessibility.

Keywords: Accessibility, Information and communication technology, Cloud, Library, Decision Support, Technology Transfer.

1 Introduction

As the population in the United States is aging, the number of people with disabilities is also increasing [1]. There are about 56.7 million people with disabilities (18.7% of the civilian non-institutionalized population) in the United States. Disability affects individuals' employment as well as their economic status. Individuals with disabilities are less likely to be employed and more likely to experience persistent poverty than individuals without disabilities [1].

Accessibility impacts not only people with disabilities but also people with literacy and digital literacy problems and people who are older but who don't consider themselves disabled. We live in a society that is increasingly becoming dependent on

C. Stephanidis and M. Antona (Eds.): UAHCI/HCII 2014, Part IV, LNCS 8516, pp. 483–493, 2014.

technology. Today, digital (computer-based) technologies (and their accompanying digital interfaces) are being incorporated into virtually every aspect of life. Ticket agents are being replaced with ticket machines, and many metro train stations no longer have any human attendants at all. If you can't use the machine, you can't buy a ticket or even get through the gate. Jobs increasingly require access to computers or security pads, touch screens or other electronic interfaces. Even janitors must apply for jobs online and sometimes use computer interfaces at their workplaces. Even devices in our homes are going digital.

For those who can use these digital interfaces, this shift provides new capabilities, features, and designs that enhance our lives and our environments - while saving us money. But for those who cannot understand them, or who cannot see or hear or physically operate them or read or understand them, it is scary to live in a time when fewer and fewer things will be operable by them each year. For those who are aging and also have trouble learning new paradigms, it can increase their feelings of helplessness, hastening the time when they are unable to take care of themselves in what becomes an increasingly unfamiliar and inaccessible world.

1.1 Current Approaches for Addressing Accessibility

There are two broad approaches for providing access for these individuals who cannot use the standard interfaces on technology products and systems. One is to use an assistive technology (AT) that provides an alternate interface that the individual can use in place of the standard interface. This is most often done on computers and sometimes on phones.

Today however there is both a proliferation of operating systems on computers and mobile devices (many more than AT vendors can support) and a spread of digital interfaces across different technologies where AT does not exist and/or cannot even be installed or used. Even for computers where AT is most prevalent, we find that there are so many new platforms (operating systems, etc.) that vendors cannot support them all and users find that the AT they are familiar with won't work on all the computers and other devices they encounter and have to use.

Another problem is that solutions don't exist for types, degrees or combinations of disability. Sometimes there just is no AT or no AT for that platform. And even for those devices and those people for whom AT solutions exist, the cost of AT that is good enough to handle modern information technologies, is often out of reach or people never hear of the AT that would help them. According to estimates by accessibility experts and vendors, only between 3% and 15% of those who need special access products or features have them.

The second approach is to have access features built-into (mainstream) products. This has the advantage of zero additional cost for people with disabilities and it is always there when a person encounters the technology. However most products do

not yet have access features, and on the relatively small number that do, have features that address the needs of only a small percentage of users – usually those with single or mild disabilities. The features are also often too complicated to invoke, set up, and use. Finally, even when the features exist for a person on a device they need, and it is something they could understand, it is likely that they will never know that it is there or know which device has a feature that would allow them to use it.

Thus we have a rapidly developing crisis where the society is moving digital (in education, employment, travel, health, even household appliances) while it does not have a strategy or systems in place that are capable of providing access for all of those who cannot use the digital interfaces needed to participate in this digital world.

1.2 Our Approach to Address Accessibility

Recognizing this emerging problem a consortium of universities, industry and individuals was built to address this looming issue. The consortium was named the Raising the Floor Consortium – to emphasize the need to ensure that "floor level" AT (AT and other access solutions that was affordable by all) existed and was good enough to provide meaningful access to modern technologies. The problem and the call to form a consortium to address it received widespread recognition by consumers, researchers, mainstream and AT vendors, and the consortium and its supporters grew rapidly. Fairly quickly however it became clear that the goal of the consortium was not attainable with the current accessibility ecosystem. It simply costs too much to develop, distribute and support AT, and reducing the price unilaterally would only serve to run most companies out of business. Similar problems existed with the "built-in" approach. This led to the understanding by the consortium that the only way to address the problem was to create a new infrastructure for the development and delivery of AT and built-in access features. Such an infrastructure would need to address the three central problems blocking widespread, affordable, and usable accessibility:

1. making it much easier for people who need special interface features to be able to find that solutions exist and to find the proper features/aids to allow them to access and use ICT;
2. making it possible for users to invoke the access features they need on any digital technology they encounter and have to use instantly, without requiring users to know how to install, turn on, or configure anything; and
3. making it much easier and less expensive for developers to create, distribute, market, and support new access solutions (AT and built-in features) and to reach the people (internationally) who need their solution(s).

This infrastructure is now known as the Global Public Inclusive Infrastructure (GPII). Major research grants (European Commission grants Cloud4all and Prosperity4all,

U.S. Dept. of Education contract) are working towards building the components of the GPII.

2 Rehabilitation Engineering Research Center (RERC) on Universal Interface and Information Technology Access (UIITA)

The current Universal Interface & Information Technology Access (UIITA) Rehabilitation Engineering Research Center (RERC) at the Trace Center at University of Wisconsin-Madison will use the components built in the other projects and move the GPII from concept, papers and laboratory prototypes to field implementations where we can test the efficacy and viability of the concept with real-world conditions, users and limitations. Fig. 1 illustrates the dependencies between the RERC and the other GPII projects. RERCs conduct programs of advanced research of an engineering or technical nature designed to apply advanced technology, scientific achievement, and psychological and social knowledge to solve rehabilitation problems and remove environmental barriers. RERCs also develop systems for the exchange of technical and engineering information worldwide and improve the distribution of technological devices and equipment to individuals with disabilities [2]

The UIITA-RERC started in October 2013 and is a five-year effort. The RERC will focus its efforts in three areas.

1. Continuing development of the GPII concept – evolving it to address the changing technology landscape and our growing understanding of its role based on discussions with the different accessibility and mainstream stakeholders.
2. Moving the GPII from concept, papers, and laboratory prototypes, through to field implementations. This will include
   (a) The Library-GPII-System (LGS): Development and testing of a package for deploying and applying the GPII in public libraries of all sizes, with a focus on providing libraries with cost-effective ways of serving users with a wider range of abilities – including those with cognitive, memory, and digital-literacy related barriers such as elders and first time users.
   (b) Cloud-Based Decision Support (CBDSS): Development and testing of a decision support tool based on the GPII Unified Listing that can provide users and clinicians with a new capability for tracking and selecting ever-changing solutions for users – including not only comprehensive information on assistive technologies, but also not-previously-available information on the access features that are built into mainstream technologies.
3. Continued work to motivate and facilitate access built directly into mainstream products – through our technology transfer program and our research support of industry standards groups and governmental agencies working on accessibility standards.

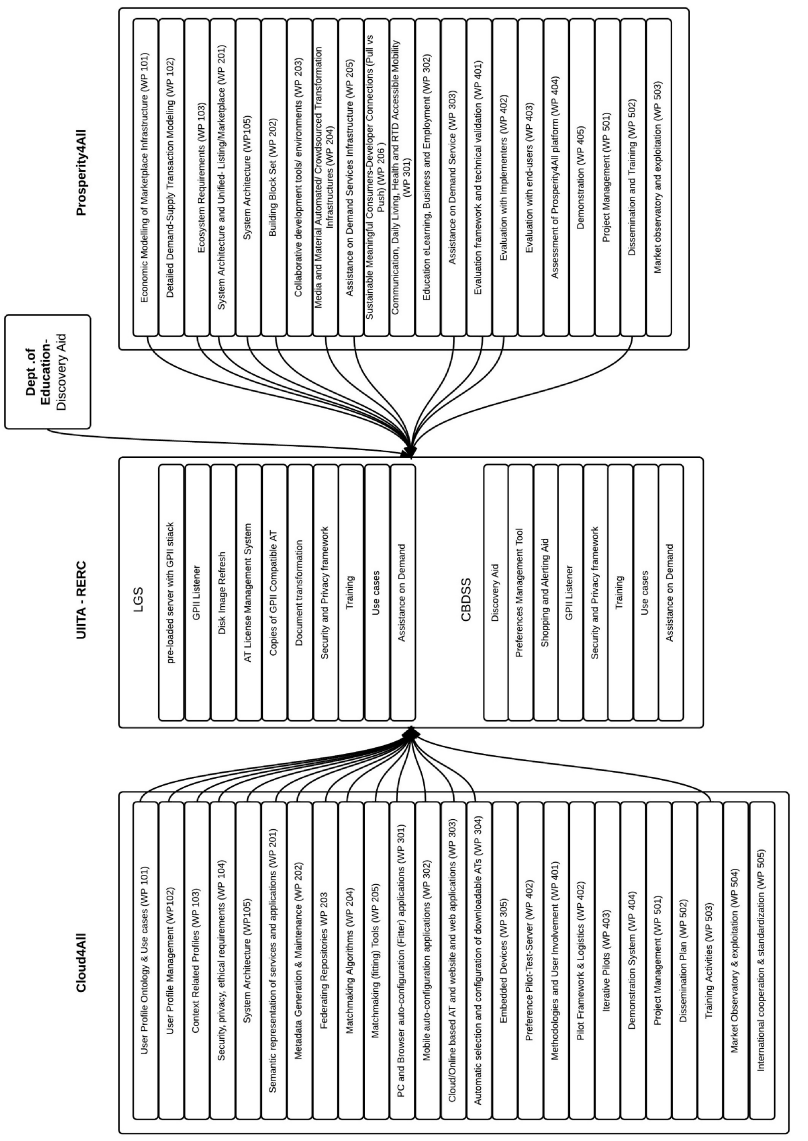

Fig. 1. Dependencies between the GPII projects and the UIITA RERC. (WP = work package, LGS = Library GPII System, CBDSS = Cloud-based decision support system).

3 The Library-GPII-System (LGS)

Libraries have a strong public service professional culture, and many libraries and library organizations have active accessibility programs [3, 4]. The American Library Association as part of its policy on library service for people with disability, strongly recommends that libraries should work with people with disabilities, agencies, organizations and vendors to integrate assistive technology (AT) into their facilities and services to meet the needs of people with a broad range of disabilities, including learning, mobility, sensory and developmental disabilities [3].

However, the desire to serve and the mission to serve are not sufficient if the libraries are not actually able to serve the patron. The diversity of people with disabilities (including all of the different types, degrees and combination of disability) raises the cost to secure all of the technologies needed to address them beyond the means of most libraries. Even if these were all affordable, it is simply beyond the scope of library staff to know which AT is needed for different patrons; to set up and administer them; to resolve ATs that conflict with each other or with the information and communication technologies (ICT) security; then restore the computer when the patron is finished.

Public libraries live in a complex ecosystem with both internal and external forces and realities that affect their ability to deliver service. There are numerous other stakeholders in the ecosystem (publishers, software vendors, information technology staff, software developers, government agencies etc.) that can affect the ability of libraries to provide services to individuals with disabilities.

The LGS will attempt to address the challenges faced by libraries by providing them with a system that uses the GPII "auto-personalization from preferences" (APfP) capability and access-technology-delivery-system. The LGS is expected to:

- make access to library materials and equipment much easier (for staff and patrons) to set-up and use.
- meet the needs of patrons with very diverse needs and abilities in an affordable manner for libraries large and small.
- make materials accessible on demand so that any material that a person needs can be made accessible if it is not already.
- enable workstations to instantly set up, not just with the type of AT a person needs, but with that user's AT settings, each time they come in.
- to have diverse AT work integrally with the ICT systems in libraries, in a stable and secure manner.
- for libraries to keep up with the rapid change of assistive technologies and access features in their mainstream technologies.

There are three phases to the LGS project

1. Needs Analysis – work with stakeholders to define the needs, constraints and specifications for the LGS; the subjects are library patrons, staff, and other library stakeholders specified in the Stakeholder Sample section below.

2. LGS Development and User Testing – results of the stakeholder research on the accessibility needs and issues in libraries and the stakeholder input on the potential use of cloud computing-based accessibility in libraries will be uses to create a prototype cloud-based access solution for libraries.
3. Empirical Field Testing of the LGS in Libraries – Quantitative and qualitative testing of the LGS in diverse libraries (based on size and resources) to determine the LGS's viability and ability to address the issues outlined above.

The Library-GPII-System will be the first real world implementation of the GPII idea. The results from this project will provide us with valuable lessons for other implementations of the GPII in terms of costs, scaling requirements, and perceived benefits. It is expected that the LGS will make it easier for library patrons to use ICT and increase their confidence that they will get the resources and services that they need when they arrive at the library, thereby increasing their use of the library.

If successful the proposed LGS will allow libraries to offer a range of assistive services to their users and either pay a small set cost or pay only for the services that the users actually use. This represents a radical departure from the traditional approach of buying individual software licenses for selected software packages and then only offering those packages to patrons.

We will document the potential impact of the LGS for different library stakeholders (users with disabilities, librarians, library staff, library ICT support, government, publishers, library associations) as a tool to continue the engagement with key stakeholders as GPII approaches implementation. The research findings will help guide development decisions and lead to increased likelihood of adoption and utilization.

More details on the LGS can be found in Vanderheiden et al. [5]

4 Cloud-Based Decision Support (CBDSS)

Most people who need access technologies in order to use ICT often cannot afford a professional evaluation to discover their access technology needs. This problem is particularly serious for elders who often do not qualify for evaluations because they are no longer of employment or school age and hence disqualified from education or vocation based evaluations.

Professionals also have difficulty keeping up with the ever-changing variety of access aids and devices for all the different types, degrees, and combinations of disability that a client might have. This is further complicated by the proliferation of different platforms that each have different solutions that work or don't work on them. Professionals that focus on access AT evaluations are having difficulty, and professionals for whom access AT is only a portion of their practice have no chance of keeping up.

Decision support systems have been widely used in clinical settings [6, 7]. Systematic reviews of studies on clinical decision support systems (CDSS) showed improved practitioner performance, improved patient outcomes, less medication errors, and improved compliance with care standards [6-9].

Despite increasing implementations of CDSS in health care, those for AT selection are few (such as the CAP [10] and Computer Access Selector [11]). To the best of our knowledge, no CDSS for AT selection has been empirically evaluated in clinical settings. Potential needs and constraints of individual consumers and practitioners when using AT decisions support systems are unknown, but the potential, if they can be made to work, is great. Whether computerized decision support for AT selection can be effectively employed in clinical practice, and which factors are important for clear clinical impact needs to be examined.

To address these problems, we proposed a cloud-based decision support to help consumers and practitioners sort through information on all solutions, learn more about them, and select AT (or access solutions built into mainstream products) with less effort and better outcomes.

The project will be carried out in three phases:

- AT Selection Modeling and Needs Analysis: An exploration among consumers and professionals of how decisions are made, and preferred techniques or approaches for supporting the decision-making process.
- Development and Usability testing of a Cloud-Based Decision Support System for ICT access solutions: Creation of a decision support tool (the Tracking/Shopping Aid) based on phase 1 findings, with continual user testing and participation in the design of its interface and functionality.
- Evaluation of the Use of CBDSS in Real-World Settings: Empirically testing the ability of the CBDSS to improve the decision making abilities of individual consumers, and to comparatively test its ability to meet or exceed the selection of aided and un-aided evaluations carried out by professionals who recommend these AT but it is not the bulk of their practice.

If successful, this project will transform the experience of end-users and practitioners in selecting assistive technologies for ICT applications. The proposed system will provide immediate access to all current assistive technology, with information about its features that is updated regularly. The system will select, from the universe of available products, those that are relevant to the needs of a particular client, and assist in making decisions between products of similar function. The system will use information about its users to identify common needs patterns (syndromes). This information can be used by AT developers to create solutions that address multiple related needs, rather than providing a collection of independent accommodations. This information could also be used to suggest to individuals that additional components of their needs pattern could be addressed.

5 Technology Transfer

Although there is much written about the need for products to be more accessible to people with disabilities, and a fair number of papers published and prototypes shown at disability and even mainstream conferences, none of this information or knowledge will directly impact the lives of anybody with a disability until it is built into actual

commercial products. When talking about universal design or access to mainstream products, this means that the ideas must be transferred to and implemented by mainstream product manufacturers and available to consumers in the marketplace. However transferring research to commercial implementation is so difficult it is often referred to as the "Valley of Death" [12].

Technology transfer in the area of "universal" or "inclusive" design is particularly difficult. It is a multidimensional effort that needs to occur in many places within an organization in order to be effective. In discussing the development of the BS7000 Part 6 Guide to Managing Inclusive Design, Keates [13] talks about the importance of it being incorporated into the "company ethos" and emphasizes that inclusive design must be a priority at multiple levels within an organization (executive, management, and design) in order to succeed. This is echoed in most every study of technology transfer dealing with universal design or design for all [14-16].

Successful technology transfer has to overcome barriers such as lack of adherence to access regulations; weak business case for universal design (UD); lack of a standard, tested UD process; unrealistic UD guidelines; lack of quantitative measures for comparing solutions or evaluating absolute or sufficient access; poor communication between departments; lack of champions in positions of authority; conflict between UD and push to market and budget; lack of people with disabilities in design or evaluation processes [17]. In addition, successful and consistent practice of universal design is most affected by simple profit, with many of the other factors falling in line if clear profit is perceived [17].

5.1 Project Objective

The objective of this project is to move accessibility advances beyond research so that it is available to users in their everyday lives by:

- Moving the new concept of a Global Public Inclusive Infrastructure (GPII) from research and prototypes to widespread adoption in the field;
- Increasing the building of key accessibility features into mainstream ICT;
- Supporting policy, consumer and consulting groups who foster and support accessibility;
- Facilitating the ability of consumers to discover, select and afford both AT and built-in access features of mainstream technologies.

Specifically we expect to focus on:

- Transfer of the successful aspects of LGS and CBDSS into widespread adoption in the field as part of the broader GPII;
- Coordinating and supporting the work of others who are building the GPII, and creating real-world implementations;
- Continued support of the Access Board, FCC, and other policy makers engaged in development of accessibility guidelines – particularly 508, 255, and M376 (Europe);

- Work with industry on standards around improved APIs and standards to support user definable alternate interfaces for mainstream devices and web services;
- Providing people within companies, and the consultants working with them, with the research, information, tools, and other resources they need to explore, test, sell the concept, implement, and incorporate accessibility features into companies' mainstream products.

6 Conclusion

The RERC is expected to move the GPII from theory and laboratory prototypes and out in the real world. If successful, it will help enable entirely new service and solution delivery options as well as enhance the ability of existing clinical programs to keep up with rapid technology changes in their field. It will also contribute to the innovation and distribution of new and existing technologies that enable individuals with disabilities to access ICT. The RERC is also expected to influence and contribute to accessibility standards and support industry, consumers and the government is achieving their accessibility objectives.

Acknowledgement. Different components of the body of work described in this paper was, and/or is being, funded by the European Union's Seventh Framework Programme (FP7/2007-2013) grant agreement n° 289016 (Cloud4all) and 610510 (Prosperity4All), by the National Institute on Disability and Rehabilitation Research, US Dept of Education under Grants H133E080022 (RERC-IT) and H133E130028 (UIITA-RERC) and contract ED-OSE-12-D-0013 (Preferences for Global Access), by the Flora Hewlett Foundation, the Ontario Ministry of Research and Innovation, and the Canadian Foundation for Innovation. The opinions and results herein are those of the authors and not necessarily those of the funding agencies.

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