# Cloud Computing and Disability Communities: How Can Cloud Computing Support a More Accessible Information Age and Society?

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On July 30, 2010, the Coleman Institute for Cognitive Disabilities in partnership with the Silicon Flatirons Center for Law, Technology, and Entrepreneurship hosted a roundtable on "Cloud Computing and Disability Communities: How Can Cloud Computing Support a More Accessible Information Age and Society?" The roundtable, held at the University of Colorado Law School in Boulder, Colorado, brought together leaders in industry, education, public policy, disability advocacy, and government to explore emerging opportunities and challenges presented by "cloud computing," specifically how it might help or hinder a more "accessible" future for people with special access needs.

Cloud computing is not a new technology, but its growing use may be a strategic opportunity for increased access to information and resources for people with disabilities. At the very least, the technology is at a stage where if the correct policy choices are made with respect to accessibility concerns, then intelligent architecture of the technologies involved should work to increasingly include – rather than exclude – people with special access needs. At the roundtable, participants were charged with determining the major issues and opportunities surrounding cloud computing and accessibility. Particular emphasis was placed on identifying significant barriers and what could be done programmatically to help overcome these, as well as identifying necessary items to be included in future discussions on these topics. The roundtable was conducted under a modified form of the Chatham House Rule.[1] (A list of participants can be found in Attachment A).

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[1] The Chatham House Rule is used at meetings or discussions to encourage openness and the sharing of information. The Rule itself reads, "When a meeting, or part thereof, is held under the Chatham House Rule, participants are free to use the information received, but neither the identity nor the affiliation of the speaker(s), nor that of any other participant, may be revealed." For more information, see the Chatham House website at http://www.chathamhouse.org.uk/about/chathamhouserule/ (last visited Oct. 10, 2010). In Silicon

The roundtable proper began with an introduction and welcome by Dale Hatfield, Executive Director of the Silicon Flatirons Center at the University of Colorado Law School and Adjunct Professor in the Interdisciplinary Telecommunications Program at the University of Colorado, and Clayton Lewis, Professor of Computer Science, Fellow of the Institute of Cognitive Science, and Scientist in Residence at the Coleman Institute for Cognitive Disabilities at the University of Colorado, as well as David Braddock, Associate Vice President of the University of Colorado (CU) System and Executive Director of the Coleman Institute for Cognitive Disabilities. The introduction underscored the broad and diverse group of stakeholders assembled to address accessibility issues and pointed out the significant opportunities inherent in the continuing advances in information and communications technology for people with disabilities and special access needs.

The broad and diverse group of stakeholders was a unique strength of the roundtable. These stakeholders could generally be placed within the broad categories of: (1) Technology, (2) Advocacy, and (3) Policy. The goals for the roundtable were to identify opportunities for people with disabilities – especially those with cognitive disabilities – raised by the emergence and continued development of cloud computing technology, to put the discussion and activities of the roundtable in the context of broader efforts taking place, and to point out overlaps in areas where sharing knowledge across various disciplines could be helpful. Finally, the roundtable would also set the stage for and serve to inform upcoming events related to these aims, including the annual Coleman Institute Conference in October 2010.[2]

**Cognitive Disabilities Background**

There are a large number of people in the United States with special access needs – many of whom have physical, sensory, or cognitive disabilities – and this group will only continue to grow. According to data presented to the group, there are over 23 million people with cognitive disabilities in the United States alone, including intellectual disability, severe persistent mental illness, brain injury, Alzheimer's disease, and stroke (Figure **1**). These data gave context to the discussion, conceptualizing the size and extent of cognitive disabilities in the U.S.[3]

Cognitive disability is a broad term that covers many different types of specific disabilities. The breadth of individual needs that must be considered for each type of

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Flatirons roundtable discussions and the resulting report or summary, the list of attendees and their affiliations is customarily published.

[2] The tenth annual Coleman Institute conference on Cognitive Disability and Technology will be held on October 21, 2010. For the proposed agenda, see http://www.colemaninstitute.org/Conferences/Coleman2010/agenda_10.php (last visited Sept. 5, 2010).

[3] For additional context concerning the prevalence of cognitive disabilities, *see* David Braddock, et al., *Emerging Technologies and Cognitive Disability*, JOURNAL OF SPECIAL EDUCATION TECHNOLOGY 19 (4), (2004), pp. 49-56. *See also* Rizzolo, M. and Braddock, D. (2008). *People with Cognitive Disabilities* In A. Helal, M. Mokhtari, and B. Abdulrazak (Eds.) *The Engineering Handbook of Smart Technology for Aging, Disability and Independence.*

cognitive disability significantly increases the complexity of a definition. It was noted that others not included in the 23 million figure cited above have accessibility needs and could benefit from the same increased accessibility-related functionality.

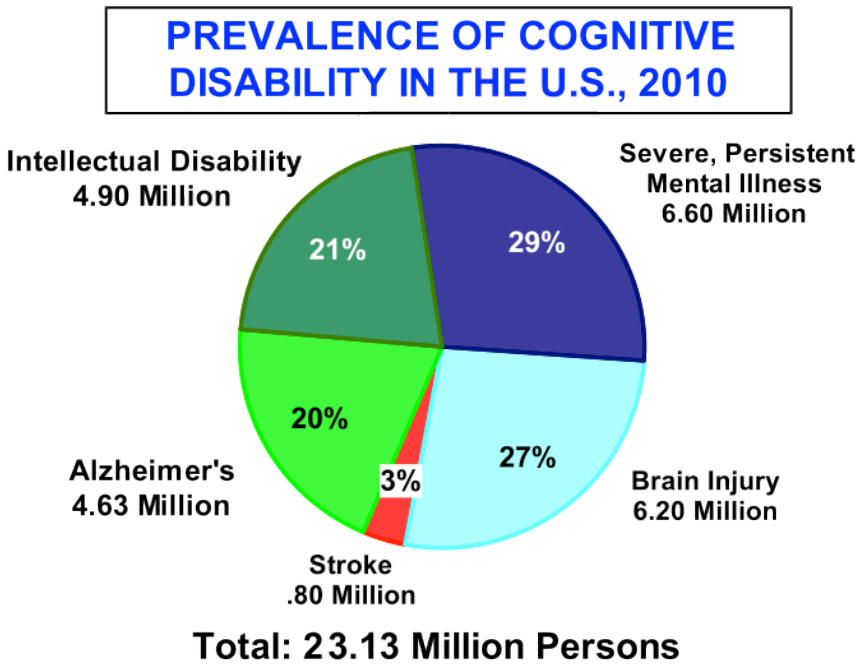


Figure 1: Prevalence of Cognitive Disability in the United States

Rounding out the initial background discussion and setting the stage for the rest of the roundtable, participants highlighted how self-determination – especially for those with cognitive disabilities – would be a key theme for any effort to support and increase accessibility. Along these lines, and underscoring the purpose of the roundtable itself, the moderators asked participants to focus their efforts on identifying opportunities and barriers in cloud computing and to consider and understand – and importantly to help articulate – what can be done programmatically to realize the opportunities. It was thought that any effort requiring a broad-based public policy initiative would need special attention, but the participants generally agreed the discussion and ideas put forth should be placed in the national and international context, to the extent possible.

## Cloud Computing

Turning to the primary topic of discussion, the opportunities and issues faced by Cloud Computing in the accessibility context, one participant asked if it was better to start off by trying to articulate what the general public believed about cloud computing; asking in particular, what did Wikipedia define cloud computing as?[4] Participants felt that, regardless of any specific definition, the term has shifted its meaning over time.

[4] According to Wikipedia, Cloud Computing is "Internet-based computing whereby shared resources are accessed on-demand much like the electricity grid." Wikipedia, Cloud Computing, http://en.wikipedia.org/wiki/Cloud_computing (last visited Oct. 10, 2010).

Originally, according to one participant, the "cloud" terminology was a broad term often used in such a way as to refer to, and ultimately mask, the technical details of the communications infrastructure and transport machinery in the networks making up the Internet. Now, the term refers to "everything" a user may reach via the Internet, including services, storage, applications, and people.

*Definitional Distinctions*

Sharpening the definitions and terminology even further, the participants felt there should be some distinction drawn around the type of user and the particular type of cloud. In terms of the type of user, the "cloud" can be used for different purposes, and mean different things, depending on whether the user is a corporate entity or a private individual. For companies, the cloud is often used for hosting services so as to avoid the costs and difficulties associated with hosting one's own servers and software. For the individual, the cloud can mean a number of things, but is often used to store information in a device- and platform-agnostic manner. In terms of the type of cloud, the participants felt distinctions could be made between a public cloud, private clouds, and community clouds as well, though the general focus of the roundtable discussion was on the publicly accessible cloud.

Another potential distinction was "where" exactly in the various "layers" of the Internet infrastructure, or whether at the edge or the core of the network, would "cloud" accessibility solutions be implemented. According to the participants, a broad continuum of choice exists in terms of balancing an individual's accessibility needs, his or her preferences, and the various technology- or process-oriented solutions, and this balance may change significantly depending on where in the "stack" the focus is placed. For purposes of the roundtable though, and to maintain the cloud abstraction, the discussants generally placed emphasis on viewing the stack as a whole rather than in layers. It was thought that this level of abstraction allows for the "hiding" of certain elements or internal workings of the cloud and avoids requiring individual users from making all the decisions. Drilling down and "breaking up" the cloud into its constitute parts and layers – in the right ways and at the right times – was still a significant concern. Participants felt that a "true solution," in terms of national infrastructure, would need to incorporate a variety of solutions that included the cloud, the web, and other platforms, since no single solution was seen as working in all situations.

Regardless of whether discussing the various layers of the cloud, or simply discussing the cloud itself, the end user must still access the information and services residing in the cloud through a device, such as a phone, computer, television, etc. According to the participants, the options and capabilities of the device itself will always be important, as the device is in some senses the "gateway" to the cloud, but moving forward the "client" (or access device) can become "thinner." As it becomes thinner, less services and information will reside on the device and more can become "remote," residing in the cloud. Finally, some participants thought the exact nature of this device might not be easy to predict as its capabilities may depend on the individual user's personal choice and that could vary widely among users.

*Security and Privacy*

Security was another major concern when it came to operating accessibility services "in the cloud." Participants discussed how certain corporations and governments would likely need additional and specific privacy and security functions – for example when it comes to health data and the privacy requirements of Health Insurance Portability and Accountability Act (HIPAA) or Social Security – and these concerns could be addressed through "sub-clouds" and "secure clone clouds." Security needs could also implicate additional jurisdictional concerns, as many "clouds" find their services and information spread and duplicated across physical locations and servers in multiple countries and geographies.

The privacy laws in different countries can have quite different requirements as well, potentially creating a less secure operating environment from a privacy perspective. Participants thought end users ultimately would not want to trust their data to the cloud if security, privacy, and identity concerns were not addressed in a way that is securable across multiple devices and platforms.

*Historical Centralization- vs. Decentralization-Cycle*

Highlighting the historical perspective, one participant pointed out how there looked to be an "ebb and flow" between centralization and decentralization of data and services, depending on the technology and time period. The recent trend towards cloud computing may simply be pendular movement within a cycle rather than a fixed single direction of progress.

## Opportunities for People with Disabilities

There was general consensus during the roundtable that cloud computing can offer many advantages when it comes to new technologies or approaches to increasing accessibility and could represent significant opportunities for people with disabilities. The group discussed a few examples of these new technologies or approaches, highlighting some "necessary" characteristics of any potential cloud-based solution.

The first example was WebAnywhere,[5] a project that provides a web browser-based text-to-speech reader for website navigation and use. The project utilizes a web server to perform all of the text-to-speech conversions so the "heavy lifting" is done in the cloud and no specialized software would need to be installed on a client machine. The

[5]According to the WebAnywhere website,

> WebAnywhere is a web-based screen reader for the web. It requires no special software to be installed on the client machine and, therefore, enables blind people to access the web from any computer they happen to have access to that has a sound card….WebAnywhere will run on any machine, even heavily locked-down public terminals, regardless of what operating system it is running and regardless of what browsers are installed. WebAnywhere does not seek to replace existing screen readers - it has some big limitations, namely that it will not provide access to desktop applications like word processors or spreadsheets.

*See* WebAnywhere, http://webanywhere.cs.washington.edu/wa.php (last visited Oct. 10, 2010).

project began as a tool for blind users but has been found useful for those with cognitive disabilities as well, regardless of the quality of their sight.

The next example, the EasyOne Communicator,[6] provides basic email, text chat, video chat, and photo sharing capabilities through a web-based interface. The tools would be as simple as possible and would work across as many platforms as possible. To streamline connection to the service, a helper application could be installed on a USB dongle that when plugged into a computer would automatically open a web browser and connect to the EasyOne Communicator for the user in the cloud. It was touted as a simple way to provide access to the most fundamental web and communications services on any device – and in a form that was consistent across technologies and across time.

Another project, Access for All,[7] would allow for "user profiles" to be stored and accessed in the cloud. Users could define their accessibility preferences and how they would prefer information to be presented to them – such as always presenting text in a larger font size –and compliant services could automatically access these profiles and use them to present information and web pages in the appropriate format. Users or caretakers would create a set of profiles, which could then be ported to compatible services, websites, or devices. Thus those users with disabilities could avoid spending the time and effort on configuring each service individually, and generally avoid repetitive and wasteful negotiation, qualifying, and explanation of their needs.

A few other projects mentioned included a scheduling and calendar system for medical tasks, a USB "plug-in" menu simplification system, and accessibility configuration "wizards." The medical scheduler would automate tasks such as taking pills or monitoring blood pressure, with instructions and reminders that could be generic or customized for the medical needs of the individual user. The USB "dongle" would, once plugged in to the computing device, "overlay" the entire native operating system and present the user with a simple single screen with large buttons leading to the basic

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[6] Though discussed at the roundtable in the context of a technology or approach, according to its website, Easy-One Communicator was originally a "challenge" to create a "very simple, layered communication application for individuals who are older, for individuals with cognitive disabilities, and for anyone that finds current mail, IM and computer communications programs to[o] confusing." *See* Easy-One Communicator, http://raisingthefloor.net/challenges/easy-one (last visited Sept. 5, 2010).

[7] Access For All is more of a "framework" and a series of "specifications" to facilitate other programs and services in providing accessibility,

> AccessForAll…is a framework designed to define and describe resource accessibility. It currently exists as a number of specifications being developed collaboratively by a group of communities interested in interoperable metadata for describing accessibility characteristics of resources and in some contexts related user profile information. Dublin Core metadata is designed to be easy-to-use and ubiquitous. A single DC term should convey important information that can be complemented by other metadata where suitable. For people with disabilities who use assistive technologies, very detailed metadata about their needs and the characteristics of a resource may be necessary if they are to have good access to information.

*See* Access For All, http://www.accessforall.eu/2009/04/accessforall-framework/ (last visited Oct. 10, 2010).

fundamental computing services, such as email or Internet access (similar to the EasyOne Communicator above). In terms of the configuration "wizards," participants thought the configuration of any accessibility solution or service should be made as easy as possible through wizard-based configurations tools that "walk" users through the necessary setup steps, highlighting that the initial "accessibility profile" creation process may be beyond the abilities of those who have the greatest needs. On a related note, one participant mentioned that often the necessary accessibility tools already exist in the device or software and many of the user interface elements are fully configurable, but the average user does not know how to go about enabling or adjusting the tools.

One participant described a collaborative effort to integrate these and other concepts and activities together in a supportable fashion, called National Public Inclusive Infrastructures (NPII).[8] The goal, he said, is to create an accessibility infrastructure that solves some of the problems that have been hindering accessibility efforts, such as lack of awareness of accessibility options and technology, the high cost involved in current solutions, difficulties with the wide range of types of disabilities, difficulties providing solutions across platforms, and difficulties getting new ideas to market. Thinking ahead, another participant floated the idea that accessibility infrastructures like NPII could be implemented within specific countries initially and later possibly "federated" to create a global infrastructure.

In general, participants pointed out how cloud-based applications could offer accessibility solutions that: (1) do not require users to manually install software; (2) do not violate local network or IT policies; (3) can be provided at a significantly reduced cost; and (4) provide accessibility services for those individuals who do not own their own computers or other Internet access devices. However, the participants did raise several technical concerns relating to increased dependence on cloud services and loss of Internet connectivity. For instance, unreliable or slow connections become more disruptive as important accessibility services are increasingly moved online and people become more reliant on them. One participant thought technical remedies such as local caching on a client device or saving data to portable storage devices could address these quality-of-service concerns.

## The Most Important Issues

Towards the end of the discussion, the group turned their attention to the most important issues that, in their opinion, should be addressed in order to realize many of the

[8] According to the National Public Inclusive Infrastructures website,

> A coalition of academic, industry and non-governmental organizations and individuals are coming together to promote the creation of National Public Inclusive Infrastructures (NPIIs) – on the way to building a Global Public Inclusive Infrastructure (GPII). The purpose is to ensure that everyone who faces accessibility barriers due to disability, literacy or aging, regardless of economic resources, can access and use the Internet and all its information, communities, and services for education, employment, daily living, civic participation, health and safety.

*See* National Public Inclusive Infrastructures, http://npii.org (last visited Oct. 10, 2010).

accessibility goals. Prefacing the discussion, the participants felt an overarching goal should be inclusion; including those with unique accessibility needs to the greatest extent possible.

*A Prioritized List*

Listing out and prioritizing the issues, the group felt a primary goal should be to create online profile-based preferences for how information was presented, with those profiles available regardless of the device or platform. Next, it was thought that website owners and developers should provide "slimmed down" versions of each web page, similar to those web pages often found on websites customized for mobile devices. Some participants pointed out that this could be challenging though, and felt the "real problem" is how most websites are geared towards packing as much information as possible onto each page. Another goal would be to have "assistive technology" available online without requiring software installation, or truly residing "in the cloud." Next, it was felt much could be done for people with disabilities and those who support them to raise the general level of awareness concerning the accessibility tools already available. Finally, the group felt an active commercial sector in this space could help things move much more quickly. In terms of a time frame for accomplishing these goals, the group felt the horizon would likely only be one or two generations as the U.S. elderly population is growing quickly.

*Real and Potential Hindrances*

The group discussed a number of factors that could be hindering greater accessibility. Initially, it was pointed out that with the growing population of those with disabilities and with the general economic slowdown there would likely not be enough money for the level of investment a broad-based accessibility effort (accomplishing the goals outlined above) would require. Additionally, it was felt that, regardless of the amount of money available, there would be an insufficient labor force to provide the attendant and necessary labor burden that came along with fully addressing accessibility issues. The group also pointed out how there are potentially significant international issues involved as well, since the "cloud is everywhere" and many other countries were also in the process of addressing these issues. Also, many technology companies are international in their operations and customer base.

There were also significant privacy and identity security concerns. Participants thought that if multiple users access their respective personal profiles using a single device, such as a computer terminal or kiosk at a local public library, then some very private and personal information contained in each profile could be at risk of being left on that machine. It was thought that accessibility technology design principles will need to ensure that preferences, profiles, privacy, and security are all handled in an appropriate manner to avoid this result, both on public and private systems.

Another concern was that accessibility services should be integrated into the software and websites used by the general public rather than relegated to special "sections" of a website or to particular specialized software so as to avoid a "separate but equal" approach. Along these lines, participants thought accessibility services should use the same technical infrastructure as traditional or general public oriented services in order to avoid creating a segregated system or a separate "disability cloud."

The group also highlighted that a major hindrance to accessibility technologies could come in the form of intellectual property law and its protections of the content that will need to be used and accessed in new ways. Intellectual property law generally protects the creator of artwork – whether written, visual, or auditory, among other forms – and their ability to control the presentation of their own work. The intent is to allow this control to, in the end, compensate the artist for their creative endeavors and thus incent continued creation. According to the participants, intellectual property law and the current expectations in the accessibility context are centered around the device itself, where feature-rich cloud applications are handled differently than feature-rich end-user devices in terms of copyright, publisher rights, and other protections. For instance, one participant pointed out that converting protected textual content to audio on a client device is legal but when done on a server in the cloud it is not.

Further complicating the matter, when data and services are geographically distributed in the cloud there are often many different political boundaries and different legal systems involved, with potentially very different laws and policies. One participant voiced the fear that there might be a highly effective technical accessibility solution created by computer scientists and software engineers, but that it would run afoul of the legal requirements, particularly here in the U.S. Some felt one of the problems is how publishers and other copyright holders do not yet have a good feel for what "moving" the accessibility solution off the device and onto the cloud would mean, even if the content in the end would actually be *more* secure when streamed instead of residing on the consumer's computer after a download.

Finally, there are eligibility and funding issues when it comes to accessibility services and need-based accessibility products. For example, one participant felt some donors fund expensive specialized or purpose-built devices but not general service or mainstream consumer product accessibility devices. Thus, many individuals currently only receive government subsidies or donations for expensive specialized devices. Given that cloud computing emphasizes general access across multiple device platforms, one concern was donations and financial support may "dry up" as these devices become less special-purpose.

*Looking Forward*

The participants were somewhat concerned with the inability to predict future technical challenges and the difficulty this caused in planning the most effective "next steps," but felt this should not prevent action. One comment was how the changes made to devices and technology in the near future – to support greater accessibility – would likely not be the same changes necessary in ten years. In order to identify the changes needed now, one possible approach would be to perform a "task down" analysis. This analysis would involved mapping out all the actions necessary in an individual's daily life and overlay this onto existing information technology solutions. The result would provide an inventory of current efforts and highlight those areas that are not yet being addressed, providing for a near- and long-term plan to be developed. The participants felt research in the special access area must be fluid, flexible, and include input from actual users. Additionally, the proper tools, technologies, and education need to be provided to developers in the form of tool kits and guidelines for accessibility.

There was general consensus that the "big picture" and core principles for any broad accessibility "solution" should have a cohesive statement of intent, such as the principle of "inclusion" mentioned above, with "actionable" levels of granularity beneath each. One participant mentioned how cloud computing is just one of a large number of tools to help people with disabilities and it should be used "when it fits." Other solutions, including natural user interfaces and education of schoolteachers or counselors, warrant continued investigation and should also be used where appropriate. In the same vein, it would be helpful to engage policy makers and one participant suggested that a potential catalyst could be for a federal agency within the government to initiate a "challenge" – i.e., a series of action steps or project to be accomplished within some specific and relatively short time frame. Building on this, one participant felt the challenge could also leverage crowd-sourcing efforts by taking advantage of the multitude and diversity of resources connected to and by the Internet.

## Conclusion

Wrapping up the discussion, the participants felt many of the issues and actions discussed should be pursued simply because they are the "right things to do." They emphasized how addressing the issues involved in providing for better, quicker, and more comprehensive accessibility for those individuals with special accessibility needs, whether because of disabilities or other causes, will benefit those directly affected through reduced costs and greater liberty. The participants also highlighted how our entire society benefits indirectly through greater inclusiveness and increased individual liberty. More broadly, the participants felt these issues are of international importance because the causes of special accessibility needs know no geographic or political boundaries and since the "cloud" is everywhere, many groups and individuals around the world are looking at how to address these issues as well.

**Attachment A:**
Cloud Computing and Accessibility Communities Roundtable Attendees
(Alphabetical by Last Name)

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| Enid Ablowitz | *Coleman Institute for Cognitive Disabilities* |
| Antranig Basman | *University of Cambridge* |
| Jeff Bigham | *University of Rochester* |
| Cathy Bodine | *Assistive Technology Partners* |
| David Braddock | *Coleman Institute for Cognitive Disabilities* |
| Judy Brewer | *Web Accessibility Initiative* |
| Ralph Brown | *CableLabs* |
| Ann C. Caldwell | *The Arc of the United States* |
| Bill Coleman | *Alsop Louie Partners* |
| Dan Davies | *AbleLink Technologies* |
| Mark Emery | *Imagine! Colorado* |
| Dale Hatfield | *Silicon Flatirons Center* |
| Jeffery Hoehl | *Coleman Institute for Cognitive Disabilities* |
| Richard Ladner | *University of Washington* |
| Clayton Lewis | *Coleman Institute for Cognitive Disabilities* |
| Alex Li | *Microsoft* |
| Elizabeth Lyle | *Federal Communications Commission* |
| Susan Mazrui | *AT&T* |
| David O'Hara | *Westchester Institute for Human Development* |
| Laura Ruby | *Microsoft* |
| Kaleb Sieh | *Silicon Flatirons Center* |
| Jim Sullivan | *Coleman Institute for Cognitive Disabilities* |
| Lynne Tamor | *TheArcLink Incorporated* |
| Jutta Treviranus | *Ontario College of Art and Design* |
| Gregg Vanderheiden | *TRACE, University of Wisconsin* |
| Michele Van Doozer | *Oracle* |
| Mike Wehmeyer | *Beach Center, University of Kansas* |