An Accessible Lane on the Information Superhighway

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Integrating disabled individuals into society, with dignity, is an ancient social issue. And while each person who is born with or acquires a disability faces an immediate and urgent crisis, society is slow to fix chronic problems even after discovering solutions. This situation is especially tragic considering that some individuals might spend an entire life attempting to surmount problems that already have been solved simply because the institutions in charge of change don't find the problem urgent enough to implement the known solution. For example, solutions exist to solve the information-access problems faced by disabled individuals, but content producers see no urgency in addressing the fundamental issues. Media-production processes must change to incorporate the already-existing solutions, which, for the most part, have minimal costs.

To solve the daily crisis of acquiring information with a disability, it is imperative to close the gap between what has been solved and what is being produced in the realm of media. Without access to media, people with disabilities will remain isolated and underemployed, and will lack basic requirements for good quality of life. Media producers, from individual authors to corporate distributors, must take an active, even urgent, approach to becoming up to date on this vital subject.

A chronic crisis

The unemployment rate for disabled persons between the ages of 18 and 65 is estimated at nearly 70 percent. This astounding statistic makes people with disabilities the largest underemployed group in our country. The US Department of Education reports that more than nine million working-age people with disabilities want to work but aren't able to secure employment. That is, over 40 percent of disabled persons ages 18 to 64 whose disabilities would permit gainful employment with available accommodations are unemployed. The most commonly cited reason for this disparity is inadequate education and training for available positions.[1–2] A major contributing factor is the reluctance of people with disabilities to pursue more marketable professions as a result of a lack of accessible media in the educational system.

Certain disciplines, such as those in science, technology, engineering, and mathematics (STEM), present the greatest barriers. Persons with disabilities remain undereducated, underemployed, and underrepresented in STEM disciplines.[3] The representation of persons with disabilities in STEM fields is less than 50 percent of the population as a whole.[4] Estimates are even bleaker for the engineering professions where only 1.2 percent of working persons with disabilities are represented, although they make up 11.4 percent of the general population.[5]

Prior to well-formed markup languages like the Standard Generalized Markup Language, the structure of accessible media was poorly understood. The emergence of the Web as a key economic and social force compelled markup techniques to mature. The maturation process illuminated the deep syntactic and semantic structure of information, which in turn made it possible to produce truly accessible media that can be retargeted programmatically for any audience, without loss of meaning.

After conducting seminal research on accessibility of information and extensive consultation with all interested stakeholders, the World Wide Web Consortium (W3C) in May 1999 recommended the Web Content Accessibility Guidelines (WCAG) 1.0.[6] This specification provided a clear roadmap on how to build accessible media in a broad domain of discourse—the Web—and established a stan-

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dard to evaluate other media. In the succeeding decade, the standards for accessible media have become more sophisticated, involving national and provincial legislation as well as media-specific guidelines developed for proprietary formats like Adobe Flash and PDF. This year, the W3C recommended WCAG 2.0, which eliminates the ambiguity in earlier guidelines while providing a platform-independent, user-centered approach.[7] This push has already driven new legislative recommendations[8] and set a definite standard for inventors of new media to follow.

As a result of these and other efforts, the problems associated with producing accessible media have been solved and delineated in standards. However, the production processes for print-based, time-based, multimodal, and interactive media all lag far behind the current state of known solutions.

The journey thus far

Regarding the Web and media that can be delivered across the Web, the W3C defines *assistive technology*[7] as

> *hardware and/or software that acts as a user agent (browser or media player), or along with a mainstream user agent, to provide functionality to meet the requirements of users with disabilities that go beyond those offered by mainstream user agents.*

The additional functionality envisioned includes

> *alternative presentations (for example, as synthesized speech or magnified content), alternative input methods (for example, voice), additional navigation or orientation mechanisms, and content transformations (for example, to make tables more accessible).*

Thus, in a clean interface, assistive technologies communicate ''data and messages with mainstream user agents by using and monitoring APIs.''

Finally, the distinction between assistive technology and disability-friendly functionality of mainstream user agents is resolved as follows:

> *Many mainstream user agents provide some features to assist individuals with disabilities. The basic difference is that mainstream user agents target broad and diverse audiences that usually include people with and without disabilities. Assistive technologies target narrowly defined populations of users with specific disabilities. The assistance provided by an assistive technology is more specific and appropriate to the needs of its target users. The mainstream user agent may provide important functionality to assistive technologies like retrieving Web content from program objects or parsing markup into identifiable bundles.*

In a nutshell, this definition outlines the state and future of assistive technology. In the context of accessibility, an assistive technology is a presentation interface that translates the semantic analysis of mainstream user agents into formats manageable by people with a specific disability. They do this through application program interfaces (APIs) maintained to facilitate faithful renderings in alternative formats. For this to happen, the original media must contain enough information that the user agent can parse to support a faithful translation.

Assistive technology might fail to translate an accessible medium, usually for one of the two following reasons: the mainstream user agent doesn't pass important information through the API, or the assistive technology fails to use information delivered by the API. Looking at the current state of information delivery, the key elements are media, user agents, access APIs, and assistive technologies. If all pieces of the chain are sound, those working on assistive technology can focus on developing the best interfaces for the intended user group. However, when the chain breaks at any point, developers must look for nonstandard ways to decode the media, an effort that is error-prone, unstable, and wasteful.

The Web

The capabilities currently provided by Web technologies exceed the scope of the API for Web access, a disparity that leads to Web content that isn't accessible. Emergent technologies (media and user agents) are most prone to this problem because they exploit unexpected semantic opportunities without filling the accessibility gaps caused by technology developments. While standards development is slow and careful, technology development is quick and risky. This will always be the case, but access for people with disabilities is often not considered in the risk analysis.

However, the WCAG 2.0, now a candidate recommendation (as of April 2008), create a sustainable framework that anticipates change as much as any document can predict the

unpredictable. The WCAG 2.0 guidelines are well-formed, unambiguous, user-centered, extensible, usable, and well supported (see the ''WCAG 2.0 at a Glance'' sidebar for a summary), but it took a decade to develop them. This period was the appropriate amount of time to develop such a comprehensive document, but technology developers kept moving forward without enough guidance, and users with disabilities were stressed by an endless stream of new gaps that consistently left them out of the current social dialogue.

Recently, the W3C created the Protocols and Formats Working Group of the Web Accessibility Initiative. This group developed a new kind of guideline for Web 2.0—the paradigm for desktop-type functionality provided in Web browser. The *Accessible Rich Internet Applications* guidelines address the gap between the Document Object Model, the API that enables Web accessibility, and the functionality required by desktop applications.[9] The guidelines might not last long, and if they do, they will undergo frequent changes. These guidelines are meant to be flexible and agile to address the problems raised by emergent Web technologies. Developers of new technologies for media should pay attention to this model, which fills the accessibility gap between agile technology and careful standards.

Print-based media

A book or magazine printed on paper is not accessible to the large segment of the population that is unable to perceive or operate the medium; and while multimedia is needed to provide print accessibility, there is no deterministic program that can convert print on paper into API messages usable by assistive technology. Formats such as Daisy (discussed in this issue) provide semantically complete solutions to this problem. Without these solutions, persons with blindness, low vision, and dyslexia will remain estranged from literacy and a vast library of information, with the end result being minimal employment opportunities.

Multimedia

Multimedia and, more generally, time-based media usually require synchronized translation to modes that satisfy the user's perceptual needs. One problem in this area stems from the fact that time-based multimedia content doesn't easily yield to parsing and syntax-directed translation—techniques that are applicable to text and other static media. The Synchronized Multimedia Integration Language provides the foundational support for accessible multimedia as well as for mainstream applications, like mobile devices. Even with a structured framework, significant labor is required for producing synchronized, time-based, text alternatives like captions. While automated techniques are being developed for multimedia content extraction and description, cost-effective production of synchronized alternative media still is an outstanding problem.

Building better ramps

Many of the innovative solutions that were devised initially for persons with special needs have improved substantially the quality of life for society at large. The suggestions presented in this section, following the same pattern, can benefit all of us.

Well-defined formats and interfaces

Accessibility requires design and planning. Some simple actions will take us a long way. For example, when standards exist, we must follow them. As technologies emerge, they should follow the patterns that have succeeded with the Web, and should include accessibility as a routine part of their development. Developers of new multimedia and user agents must incorporate the protocols and formats for accessibility that exist in their area of specialization. To the extent possible, they should apply these standards where applicable, and identify gaps where they occur. This is not to say that a new technology should be held up because gaps exist; however, the research and development community must be aware of the known accessibility gaps.

Production side compliance

Presently, incorporation of synchronized captions is not a routine part of the production process for commercial multimedia production, and accessible multimedia files are not the preferred file storage formats for book publishers. Additionally, most authors don't produce their print-based materials in accessible formats. All of this means that the vast amount of inaccessible media remains a

daunting backlog for those working on accessibility. However, we can fix this problem by realizing that we don't need to retrofit every publication, especially if accessibility-oriented production techniques are integrated into the planned replacement cycles by media producers. This same refurbishment model works in construction renovations where accessibility upgrades are always factored into major refurbishments.

Interim solutions

Even so, we can't lose a generation while we wait for all production technology to include well-known accessibility processes. Effective, yet simple, actions are available today that were not available in the past. Educational authors can be taught accessible authoring techniques that rely on fairly simple commercial software. At an institution like the California State University where faculty members produce more than a million pages of handouts each year, a dedication to accessibility by using some of these authoring techniques would be a major step forward. Whenever possible, transcript and other text-based translations of multimedia content should be provided to facilitate alternative media for people with disabilities. Doing so would dramatically reduce the cost of providing synchronized alternatives. With planning and cooperation from all stakeholders, people with disabilities can be brought into the mainstream.

The plan

It's time to stop looking at the problem of accessible information as chronic, daunting, and unsolvable. To a great extent, major issues have been resolved, and a framework for new technologies exists. We simply need to be cognizant of the overwhelming body of available media that can't be used by large groups of people. We also need to be aware of the fact that unnecessary social exclusion of any population leads to crisis. While this crisis might not be as severe as some other social-injustice issues, it's certainly significant enough, and can be averted inexpensively with society's unconditional support.

Developing interim solutions might be the most practical approach to addressing the need. Given the state of assistive technology, the Web, and many established tools for providing access, short-term, effective actions can start today. Private and public institutions can implement changes without undue hardship. Individuals can play an important role by producing accessible media that lies within their control. Such interim measures could radically improve the educational environment and help to employ disabled people in satisfying jobs.

In addition, because production technologies must always change to stay competitive, we have the opportunity of capitalizing on the natural economic cycle for inserting accessibility into the production process of large publishers and distributors. New media produced according to standards is usually easier to maintain and is often less expensive. The migration from in-line style to cascading stylesheets is an example of such an improvement. The resulting Web pages are more accessible and they download more quickly.

About this special issue

For this special issue, we have selected five articles, each addressing an important topic related to accessibility of information. The lead article ''Daisy 3: A Standard for Accessible Multimedia Books'' provides an in-depth overview of standards and addresses several fundamental questions related to this important topic. The article ''Two Novel Technologies for Accessible Math and Science Education'' reports on efforts to teach science and mathematics to deaf and hearing students, and compares the acquired results with respect to usability and appeal. ''From Tapping to Touching: Making Touch Screens Accessible to Blind Users'' offers a brief overview of a new entry method on mobile phone and touch screens for vision-impaired persons. The article ''Disability Standards for Multimedia on the Web'' presents how the Web Content Accessibility Guidelines can be employed to provide accessible multimedia content on the Web. Finally, ''Using Speech Recognition for Real-Time Captioning of Multiple Speakers'' reports on two efforts to use speech recognition for automatically providing accessible real-time text transcriptions in multispeaker situations.

We invite your comments and ideas. **MM**

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WCAG 2.0 at a Glance

Perceivable

- Provide **text alternatives** for non-text content.
- Provide **captions and alternatives** for multimedia.
- Make **information adaptable and available** to assistive technologies.
- Use **sufficient contrast** to make things easy to see and hear.

Operable

- Make all functionality **keyboard** accessible.
- Give users **enough time** to read and use content.
- Do **not use content known to cause seizures**.
- Help users **navigate and find** content.

Understandable

- Make text **readable and understandable**.
- Make **content appear and operate** in predictable ways.
- Help users **avoid and correct mistakes**.

Robust

- Maximize **compatibility** with current and future technologies.

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