CHAPTER 10

TECHNICAL INVESTIGATION:
DESIGN RECOMMENDATIONS AND GUIDELINES

In many of the more relaxed civilizations on the Outer Eastern Rim of the Galaxy, the Hitchhiker’s Guide has already supplanted the great Encyclopaedia Galactica as the standard repository of all knowledge and wisdom, for though it has many omissions and contains much that is apocryphal, or at least wildly inaccurate, it scores over the older, more pedestrian work in two important respects. First, it is slightly cheaper; and secondly it has the words DON’T PANIC inscribed in large friendly letters on its cover. — The Hitchhiker’s Guide to the Galaxy (D. Adams, 1979, p. 2–3)

In addition to value evaluations of existing reading widgets, the value framework developed in this dissertation provides insight into the design of future reading widgets. This chapter presents several guidelines and recommendations for designing for adults with reading disabilities. First, some existing design recommendations are described. Then, a set of value-informed guidelines generated through a technical investigation are presented.

1 Designing for Users with Reading Disabilities

Because of the unique needs and situations of people with disabilities, designing assistive technologies can pose many challenges. As such, some technology researchers have developed guidelines to aid in this task. King (1999) in particular developed a framework of what he denoted as essential human factors that should be accounted in the design of any AT device. Although King considered all disabilities, other researchers have focused on specific disability groups. For example, both Robertson and Hix (2002) and Dawe (2006) discuss designing technologies for adults with moderate to severe cognitive disabilities/mental retardation.

In the case of reading disabilities, such efforts have focused primarily on the design of texts. Venable (2003) provide a comprehensive overview as to how complex texts may be simplified to reduce the difficulties commonly experienced by K-12 students with RDs/LDs. Their work is unique in that it concerns a wide range of texts, including books, magazines, and newspapers. Other design recommendations for texts tend
to focus on website design. Powell, Moore, Gray, Finley, and Reaney (2004) synthesized a set of twelve recommendations about the format and content of websites for dyslexic students. Other efforts have made recommendations for designing pages to be accessible for users with cognitive disabilities (Jarrett & Grant, 2010; WebAIM, 2010). Such efforts unfortunately concern the full range of cognitive disabilities, and thus the user is often assumed to be low or limited general intelligence which is not true of reading-disabled users.

When it comes to design recommendations for actual reading widgets and not just text design, the literature on designing for adults with RDs is quite sparse. To the best of my knowledge, the only such published work is that from the SeeWord project (Dickinson et al., 2002; Gregor et al., 2003). In their design of a dyslexia-friendly interface for Microsoft Word, user studies identified the importance of controlling or minimizing distractions such as the automatic spellcheck features. Direct manipulation interfaces were also identified as more desirable.

2 Value-Informed Design Recommendations

Given the lack of design recommendations for reading widgets for reading-disabled users, a technical investigation was performed as part of this dissertation. This effort draws upon the value-stakeholder framework developed and refined throughout the past chapters. Some of the insights may have been noted in previous AT design research (Dawe, 2006; King, 1999) but are repeated here with justifications from the VSD analysis. The ten recommendations are listed in Table 10.1 along with the value concerns they address.

2.1 Support the Reading Process and Reading Tasks

Although this recommendation may seem obvious, it is motivated by several reasons. First, this directly addresses and reinforces the explicitly supported value of literacy identified in Chapter 6, Section 4.1. This

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recommendation is about also recognizing one of the key findings of the life stories study in Chapter 8. Many
of the participants clearly articulated how they regularly engage in various reading tasks, and several (Kellie,
Clarissa, Calvin, and Emily) even described reading as one of their great passions in life. Moreover, as
discussed in Chapter 3 and in the online discussions analyzed in Chapter 7, most of the tools recommended for
people with RDs do not address reading but instead address related areas of difficulty: writing, organization,
To summarize, This recommendation redirects the designer to emphasize key aspects of the user population:
difficulty with the desired task of reading.

2.2 Support the Acquisition of Rich Digital Texts

Without material to read, the widget is simply not helpful. Thus, text access is a critical, first-mile issue and
was therefore recognized as a value dam in Chapter 6, Section 4.3. Supporting this design recommendation
requires recognizing the various means by which digital text may be acquired and any related barriers. The
simplest approach is to use a copy of the text that has already been digitized, and, as discussed in the previous
chapter, this is becoming increasingly more common due to the growing popularity of devices like the Kindle
and the Nook. However, issues of copyrights, copying, and digital rights management are still being debated
(Kocher, Jaffe, Jun, Laren, & Lawson, 2002; Doctorow, 2004; Stone, 2009; Bookshare, 2010a). As such,
access to digital text comes in the form of entering the text manually or via scanning and OCR. This itself
can be problematic due to the time involved. Depending on the scanner interface, the process could involve
working word by word, line by line, or page by page. Such time costs have been identified as a factor in
TTS abandonment (Elkind et al., 1996). Moreover, cost can be a further barrier to access as OCR software is
expensive as in the case of Kurzweil 3000 (Laga et al., 2006) or requires specialized hardware (Laga et al.,
2006; Intel, 2010a).

This recommendation also goes beyond just providing a copy of a text. The word ‘rich’ is included to
remind the designer that the texts we read include more than words. Printing and typesetting have been refined
over the centuries to produce well-crafted printed texts (Tinker, 1963, 1965; Knuth, 1999). Aspects of this craft
include well-chosen paragraph formatting, font choices, and page layout to which we have grown accustomed.
These features have been shown to influence reading comprehension, recall, and other interactions with text
(Frase & Schwartz, 1979; Wylie & McGuinness, 2004; Walker et al., 2005; Santos Lonsdale et al., 2006).

Unfortunately, these features are rarely included in the standards for print disability friendly text formats.
Neither the DAISY (NISO, 2005) nor NIMAS (National Center on Accessible Instructional Materials, 2006)
standards mandate replicating all elements of typography. While bolding and italics are mentioned in NIMAS,
elements of typesetting such as line breaks, page breaks, etc. are not explicitly required (features for these are
provided and suggested for use with legal documents, however). The motivation behind these omissions is
two-fold. The first is a legacy of earlier technologies in which data size and memory limitations encouraged parsimony in markup languages, but the development of more efficient languages (e.g., cascading style sheets) and increased data storage capacities for lower costs has lessened the need for such parsimony. The second motivation for not including all typographical features is the scope of access issues faced by people with print disabilities. Most affected are those with visual impairments since seeing the text is an actual barrier for working with the text. Even if the DAISY and NIMAS standards replicated typographical features, these users would not benefit. This is symptomatic of a sadly common view in accessibility efforts. Dr. Wayne Dick, a computer science professor and active contributor to the Web Accessibility Initiative, has commented:

There is a very harmful myth concerning accessibility. It holds that once a problem is solved for blindness then it is also solved for other print disabilities. That is false. (Dick, 2010)

Current standards for accessible versions of texts are flawed copies in that they deliver the content but not the same visual experience. In a sense of fairness and to offer support to sighted people with print disabilities such as RDs/LDs, all aspects of a printed text should be made available to the reading widget user. It is then the user’s choice as to which should be retained. This has design implications for reading widgets as well as file properties and contents of digital texts.

2.3 Provide Multiple Forms of Accommodations

As noted in Chapters 3 and 9, currently available assistive reading devices focus nearly exclusively on text-to-speech. This is problematic for several reasons. First, of the many difficulties associated with reading disabilities listed in Table 2.2 (page 24), TTS addresses only the difficulties associated with the phonological processing deficit. Many other traits are left unsupported. Second, both of the empirical investigations (Chapters 7 and 8), included individuals with RDs who reported dissatisfaction with using TTS systems. Finally, studies have shown that TTS provides reading benefits to only 80–90% of people with RDs (Elkind et al., 1996; Sands & Buchholz, 1997; Elkind, 1998/2001). For the remaining 10–20%, it is only fair that they have the option to receive reading support in forms other than text-to-speech.

Thus, a single reading widget will simply not suffice. Because of the complex diversity in how RDs manifest across individuals, a similar range should be seen in the available assistive technologies. This need if further motivated by the multiplicity of possible reading tasks. To truly provide a technology that supports the needs of the user, multiple options need to be provided.

2.4 Typography Matters

Connected to the previous two recommendations is the need to pay attention to typography. Mentioned already, centuries of typography efforts have refined how text is printed to the point that we take most typesetting and layout for granted (Tinker, 1963, 1965; Knuth, 1999). However, we know that reading performance in all readers can be manipulated by changing fonts, line widths, and other text features (Frase & Schwartz, 1979;
Dyson & Kipping, 1998; Santos Lonsdale et al., 2006). The effects are small but present. Moreover, growing evidence suggests that people who struggle with reading are even more sensitive to slight changes in text formatting (O’Brien et al., 2005; A. Wilkins et al., 2009). The SeeWord project further demonstrated the potential benefits from letting readers choose how text is rendered (Dickinson et al., 2002; Gregor et al., 2003), leading several to recommend that when designing texts for dyslexic individuals, typography choices should be left up to the reader (Powell, Moore, Gray, Finley, & Reaney, 2004; WebAIM, 2010).

Because of both the legacy of typesetting and the scientific findings, developers of a reading widget should prioritize text rendering. One form of accommodation should be the option to select type features such as fonts, sizes, spacings, and colors just like in the SeeWord system (Dickinson et al., 2002; Gregor et al., 2003). Additionally, prioritizing typography means that the care should be taken in selecting the software engine that handles text rendering should be high quality. Most of the default text display systems in programming languages like Java and C# are legacy software designed decades ago. Using little computation power, they display text without the finesse, style, or art seen in traditional printing efforts. In fact, Knuth (1999) resolved to develop the *T*\text{\small e}X and Metafont typesetting languages after becoming disgusted by the results of other computer typesetting efforts. These systems allow for digital typography to approximate and at times replicate the quality seen in text typset by skilled humans. His systems do require additional computation time to achieve such quality. Given that readers with RDs seem to be more sensitive to typography and the goal of a reading widget is to provide an equitable experience to the “normal” experience of reading from printed text, the implementation effort and computation costs of Knuth-like text rendering is more than justified.

2.5 Recognize and Control Disclosure Due to Technology Usage

Another design recommendation concerns the value flow regarding privacy. If the user desires to maintain an appearance of normalcy, any reading widget that broadcasts to others about the user’s disability will not be adopted by such a user. For example, during the interviews described in Chapter 8, Calvin and Nigel were adamant about controlling disclosure to employers.

Designers thus must remain conscious of the social impact or weight (Toney et al., 2003) that a widget may bring to bear on the user. This is by far not an easy task, however. Different users will differ in their personal perceptions of what is too revealing or too labeling. How to best allow users to select their level of disclosure requires a concerted research and development effort. One solution may be the previous design recommendation to provide an array of accommodations. The user could then select the tool that, according to his opinion, discloses the least while still meeting his needs.

2.6 Support and Adapt to Multiple Usage Contexts

To truly realize the previous design recommendation, such disclosure controls must also be flexible to the context. Reading can take place in many contexts. Sometimes the user will be alone, with trusted friends,
with fellow classmates or employers, or with complete strangers. Depending on the situation, different levels of disclosure will be tolerated. One could design for the worst case: usage in a public venue where privacy and stigma are rampant concerns to the user. If the resulting tool only provides a small benefit to the reader, it becomes wasteful if the user is limited to only that tool. A more helpful but also more labeling tool may not be used in the worst case, but may be used in other contexts. Nigel stated this explicitly in his interview when he stated that while he would feel comfortable using TTS in the privacy of his own home, he would not use it at work due the impact it would have on his disability disclosure (Chapter 8, Section 4.3.1). Designers should thus provide users with the ability to adjust to different contexts in order to best meet the users’ needs and comfort levels. Such adjustments could be manual or could be automated as usage contexts tend to be correlated with locations and times.

2.7 Include Support for Fairness Arbitration and Usage Negotiations

One potential usage context deserves specific attention—the university classroom. Due to the value dam around fairness, some instructors object to providing accommodations to students with RDs/LDs. This can occur even if the students are within their legal rights (W. M. Williams & Ceci, 1999; Zirkel, 2000; Vickers, 2010). Such resistance is likely to deter the student from using a reading widget in the classroom context and could negatively influence overall usage and adoption. Although this research found that this issue primarily arose in university classroom situations, such fairness debates are likely to occur in other contexts as well.

This design recommendation suggests that efforts should be made to identify mediation approaches to prevent such situations. Ideally, aspects of the widget or its deployment could be implemented to aid in such a negotiation process. Negotiation outcomes could include successfully demonstrating the legitimate need for a particular widget or finding an alternative accommodation that both parties find acceptable.

2.8 Bring Expert Knowledge to the End User

This research also identified that not all adults with RDs/LDs seek out help from disability services. Reasons for this include a desire to hide from or escape the disability label (Cory, 2005), the costs associated with formal evaluation (Gross, 2002; Vickers, 2010), and lack of knowledge of available ATs (mentioned by many of the participants in Chapter 8). Regardless of the motivation, not working with disability services comes at a significant cost for a reading-disabled person. Disability services and experts have backgrounds and the knowledge to help identify what tools are most likely to help an individual. They also support configuring and fine-tuning a device to the user’s needs, a task known to be difficult and prone to mistakes (Dickinson et al., 2002; Dawe, 2006).

If the users will not go to the experts, then perhaps the widget can bring the experts or their knowledge to the users. Expert knowledge systems (Bobrow, Mittal, & Stefik, 1986) and recommender systems (Montaner, López, & Rosa, 2003; Adomavicius & Tuzhilin, 2005) should be explored as a means of empowering adults
with RDs/LDs in their search and configuration of reading widgets (Deibel, 2007a). Involving disability personnel in the design process is one potential way to get at this expert knowledge.

### 2.9 Mitigate Purchase and Usage Costs

One of the more common complaints about the commercial systems reviewed in the previous chapter was regarding their costs. Due to the small economic markets associated with disability, AT prices tend to remain high and thus pose a major barrier to adoption and usage (Dawe, 2006; Bigham et al., 2008). To better promote access, designers should explore ways of reducing or eliminating such costs. One approach may be to go the route of WebAnywhere and provide reading support as a free web service that requires only a normal computer and browser software (Bigham et al., 2008). Another approach would be to focus on and encourage the development and use of open-source components (Bigham et al., 2008; Frost et al., 2008). Another advantage of open-source is that it would allow other people, including direct stakeholders, to add to the technology and promote choice, community, and communication among people with RDs (Bigham & Ladner, 2007).

### 2.10 Design For All Readers

A final recommendation for the design of a reading widget for adults with RDs/LDs is to take a universal design approach (Newell & Gregor, 2000; Burgstahler & Cory, 2008) and stop focusing solely on reading disabilities. Instead, designers should consider developing reading widgets for everyone and not just people with RDs/LDs. Not only does this latch on to the recent popularity of electronic reading devices, it takes advantage of the pervasive value of normalcy in our society. By designing a technology desirable and useful to everyone, the widget would no longer be an assistive device associated with RDs. Its usage would no longer be potentially stigmatizing, and, by being used publicly and openly by the general population, diffusion of the technology would occur more readily.

However, this recommendation does not mean that a general purpose reading widget is sufficient for users with RDs. People with RDs experience difficulties with reading distinctly different than those experienced by the general population. Designers must still consider these needs as well as the needs of the general reader when designing a widget.

### 3 Chapter Summary

This chapter concerned design recommendations for technologies for people with reading disabilities. After a brief review of existing design guidelines, ten design recommendations were described. These recommendations are grounded in the value framework and analyses conducted and discussed in this dissertation.