CHAPTER 1

INTRODUCTION

But when they came to letters, This, said Theuth, will make the Egyptians wiser and give them better memories; it is a specific both for the memory and for the wit. Thamus replied: O most ingenious Theuth, the parent or inventor of an art is not always the best judge of the utility or inutility of his own inventions to the users of them. And in this instance, you who are the father of letters, from a paternal love of your own children have been led to attribute to them a quality which they cannot have; for this discovery of yours will create forgetfulness in the learners’ souls, because they will not use their memories; they will trust to the external written characters and not remember of themselves. The specific which you have discovered is an aid not to memory, but to reminiscence, and you give your disciples not truth, but only the semblance of truth; they will be hearers of many things and will have learned nothing; they will appear to be omniscient and will generally know nothing; they will be tiresome company, having the show of wisdom without the reality.

— Socrates, as recorded by Plato (trans. 1892, sections 274e–275b)

Nearly 2500 years ago, the great scholar Socrates foresaw that an increasingly popular innovation bode terrible consequences for society if it continued to be used. Human memories would deteriorate. Intellectual skills would crumble. This horrible invention was not a potent, addicting drug nor a contemporary form of social networking, for it was the notion of writing things down that so deeply dismayed Socrates.

Recorded (ironically) in one of Plato’s Dialogues (trans. 1892), Socrates expressed his concerns about writing in a parable. Theuth, the inventor of letters, describes to King Thamus the many great benefits that writing will provide humanity. King Thamus rebukes him; the pride Theuth has in his invention prevents him from seeing the true consequences of letters. While writing aids the recall of simple facts and the recording of what was said, writing cannot provide the depth that comes from dialogue with the original speaker. Writing fails to convey the context and wholeness of actual truth.

Modern society owes its thanks to Socrates’s peers (and perhaps to the cup of hemlock) in that writing was eventually adopted and embraced despite Socrates’s misgivings. His concerns did have and still have
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merit, necessitating the development of new literacy skills to address the limitations of writing (e.g., source evaluation (Britt & Aglinskas, 2002)). Today, writing and reading pervade our society; we even refer to the current era as the Information Age. Theuth’s invention has dramatically impacted our lives in ways predicted and not predicted by King Thamus/Socrates.

At the same time, many innovations and inventions fail to make an impact. Trivia books and Ripley’s *Believe It or Not!* comics are littered with examples of fanciful inventions that trigger laughter (Ripley, 1990). From squirting alarm clocks and Edison’s concrete furniture (Ripley, 1990) to revolving medical beds for facilitating labor via centrifugal force (Abrahams, 2002), the designers of such technologies hoped, like Theuth, to improve and benefit the lives of others. No one adopted these technologies into regular use, though and their impacts have sadly been limited to filing cabinets in various patent offices.

The many elements of this journey from Socrates to Ripley are of concern here in this dissertation. Without question, reading and literacy are critical skills necessary for participation in today’s information society. For the 7–15% of the population with reading disabilities (RDs) (Sands & Buchholz, 1997), however, participation can thus be a challenge and source of stress. As information is increasingly available in digital form, computing technologies seem an increasingly viable means of support and accommodation. However, there is a catch—said technologies must be adopted into regular use. Unfortunately, studies have shown that, on average, at least one third of all assistive technologies are abandoned after purchase (Martin & McCormack, 1999; Riemer-Reiss & Wacker, 2000). When designing technologies expressly for the purpose of benefiting the lives of reading-disabled users, understanding the many factors (sociocultural, technical, economic, environmental, etc.) that influence the adoption, usage, and abandonment of these technologies is crucial. This dissertation is a study of these factors and how they influence the adoption and usage of technologies by adults with reading disabilities. Although the primary focus is on assistive technologies, technologies of all kinds are also considered and studied. In the coming chapters, I investigate the factors that shape technology usage, illustrate, their many nuances, and implement solutions that utilize my findings to better promote adoption and ongoing usage of technologies for users with reading disabilities.

1 Assistive Technologies and the Need for Adoption

At face value, successful adoption is important for any technology, be it assistive or not. Consumers do not wish to waste their money. Most designers want their ideas to come to fruition and be used. Manufacturers most certainly want consumers to purchase their wares. Moreover, although a product that gets purchased and is then shortly abandoned does provide some monetary profit, a manufacturer is better favored by long-term usage of a product and the associated return customers and marketing benefits of other consumers seeing the product in use (Rogers, 2003). Plainly put, technology adoption is an important issue to many parties.
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Still, the very nature and purpose of an assistive technology (AT) makes adoption (and concurrently, abandonment) of a far more critical importance than most if not all other technologies. Assistive technologies are tools and applications designed to help people with disabilities participate in work, school, and all other aspects of daily life (King, 1999; Technology-Related Assistance for Individuals with Disabilities Act, 1988). As such, they are often purchased on an individual-by-individual basis with explicit care by many parties, including but not limited to the end user, family members, caregivers, and disability specialists (King, 1999; A. Kintsch & DePaula, 2002). When an AT is abandoned, the time, funds, and effort exerted by all these people is put to waste.

A more dire consequence is the potential psychological effects of AT abandonment. Multiple people, including the user, deliberated over the selection of the AT. Time and care was spent identifying the user’s needs and finding the right technology that best addressed them. The purchased AT was likely lauded as a near-panacea; this was supposed to be a perfect fit between technology and user. However, this supposedly “perfect” technology was not helpful and was abandoned. This can unsurprisingly lead to disillusionment about the potential of any AT to positively impact the life of the user (Martin & McCormack, 1999). While a user might try again with a different assistive technology, repeated failures will likely lead to learned helplessness and feelings of hopelessness (King, 1999). After that, any suggestions of new technologies to try will most certainly be ignored or rejected.

The point here is that AT abandonment is different than the abandonment of mainstream technologies. In the latter case, the focus is typically on a consumer group. An unhappy customer is to be expected, although hopefully a rare occurrence. The goal is to promote usage among most of the consumer group. For ATs, however, the focus is on distinct individuals. As abandonment has serious implications, AT abandonment rates should be made as close to zero as possible.

2 The Complexity of Assistive Technology Abandonment and Usage

AT abandonment rates are not near zero, though. Various studies have estimated the average rate of AT abandonment to be about 35% (Phillips & Zhao, 1993; Martin & McCormack, 1999; Riemer-Reiss & Wacker, 2000), and Tewey, Barnicle, and Perr (1994) reported abandonment rates ranging from 8% to 75% for different types of ATs. Studies with narrower focuses have found differing rates. Koester (2003) found that 7 out of 8 users with disabilities quit using speech recognition software after 6 months. A longitudinal study of usage of a software application for dyslexic users found that only 4 out of 8 users continued to use the software after several months (Elkind, Black, & Murray, 1996).

The varying rates from these and other AT abandonment studies makes translating their findings into workable policies and practices problematic. As Dawe (2006) notes, the studies lump together users with
different disabilities, ranging from mobility impairments to sensory disabilities to cognitive disabilities. Although the findings highlight general themes about AT adoption, the diversity of both the assistive tools and the user populations are obscured. An additional limitation noted by Dawe is that abandonment is a process. These prior AT adoption studies have tended to focus only on whether a technology is adopted or rejected. Emphasizing end states neglects the actual underlying process involved in technology adoption (Rogers, 2003) and thereby limits the identification of potential interventions to prevent rejection.

As an example of an intervention of limited applicability, some studies have found that abandonment is more likely to occur when an AT is incompatible or fits poorly with an activity important to the user (Riemer-Reiss & Wacker, 2000). An obvious recommendation is to pay greater attention to the activities engaged in by disabled users, but this glosses over many complex details. First, each kind of disability affects participation in various activities differently. A person who uses a wheelchair will experience different issues playing in a soccer game than a person with a learning disability. Similarly, writing an e-mail message will involve different issues and challenges for both individuals. Generalization within a single disability type is also problematic as people with the same disability type may have different degrees of limitations and may also not engage in the same activities with the same frequency. Furthermore, a user is likely to use the same AT across multiple activities. Issues of compatibility will likely differ across the activities.

Even when the activity and assistive technology are compatible, additional factors influence its usage. Consider the following scenario: a student who is blind and a student with a reading disability both access their textbooks through text-to-speech (TTS) software. TTS software takes an electronic copy of a text and reads it aloud. While attending a lecture, the need arises for both students to refer to their textbook. Both have their laptops present, so they can use the TTS software. To do so, they must either play the text out loud or wear headphones/earpieces. The former has the potential to be disruptive to other classmates and attract their attention. The latter will make the students stand out as wearing headphones is not typical during a lecture and may be viewed as discourteous to the instructor. Would the two students use their TTS software during the lecture?

The blind student will most likely use TTS to access the textbook. Although either usage option has potentially negative consequences, it is easy to rationalize and accept that the blind student needs to do so because otherwise the textbook is inaccessible. Due to social interactions within the class, the instructor and other students will likely have learned of the student’s blindness and that he needs to use the technology to participate in class. Even if the student has not explicitly indicated his disability to others, he will likely have shown several visible indicators of his blindness.4

For the reading-disabled, however, whether the TTS will be used is not as clear. Unlike blindness, a reading disability is not visually recognizable, and thus the instructor and classmates will only know of the disability if
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Figure 1.1: The PATTC Framework: The complexity of AT adoption and abandonment can be thought of as overlapping instances of the 5-way interaction between the person/user, (dis)ability, task/activity, technology, and the sociocultural-environmental context.

she herself has told them. If she has told them, the same rationalizations as before can apply. Such disclosure is not guaranteed and is perhaps unlikely. Case studies of people with RDs have found that many are reluctant to admit having difficulties with reading due to past experiences where they have been accused of faking, being lazy, or that reading disabilities just plain do not exist (Cory, 2005; Edwards, 1994). In addition to these direct responses, studies have found that associated stigmas can indirectly influence how people relate to a person with a reading disability (Cory, 2005; McDermott, 1993). As such, people with RDs tend to carefully control and limit who knows of their disability (Cory, 2005; Edwards, 1994; Pollak, 2005). The decision to use the TTS software in the public venue of the lecture is thus entwined in the complex social management of her reading disability.

This example only scratches the surface of the many sociocultural and environmental factors that influence AT adoption and abandonment. Some assistive devices are purchased through medical or health services, others through school systems. Each institution has different policies concerning funding and priorities (King, 1999). Individual users may have different responsibilities as well. In the United States, schools hold the responsibility for providing accommodations to students in grades K-12. In postsecondary education and employment, however, the disabled person is responsible for requesting and proving the need for accommodations (Cory, 2005). Finally, and perhaps most importantly, cultural views and stigmas vary across different disabilities and are likely to influence the actions of an individual with a disability (McDermott, 1993; Cory, 2005).

Understanding AT adoption and abandonment can be thought of as a five-way interaction that I refer to as the PATTC framework. I synthesized this model from my readings on the adoption and usage of assistive technologies (discussed in more detail in Chapter 4, Section 4). As shown in Figure 1.1, the model consists of a person with a specific set of (dis)abilities attempting to perform a task or activity with a specific technology framed in a particular sociocultural-environmental context. The interaction of the five components can be
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instantiated many times in many ways due to the breadth and diversity of the components. Fortunately, there is considerable overlap through user profile; similar tasks and technologies; and common contexts. Still, the fact remains that AT adoption and abandonment is a complex, challenging topic for study.

3 Studying the Complexity

Studies of AT adoption have addressed this complexity in different ways. Early studies of AT adoption aimed at understanding these many instantiations and overlaps as a whole (Martin & McCormack, 1999; Phillips & Zhao, 1993; Riemer-Reiss & Wacker, 2000). Their work established a foundation from which guidelines could be developed for the design, evaluation, and recommendation of assistive technologies (King, 1999).

To provide deeper insights, more focused studies began to appear in which researchers constrained some of the components in the PATTC framework. Wehmeyer (1995, 1998) concentrated on adults with mental retardation but kept the tasks, technologies, and contexts unconstrained in his survey on AT use by adults with mental retardation. Dawe (2005, 2006, 2007a, 2007b) focused her efforts even further by constraining the technology and tasks in her research on the design and adoption of a personal communication device for young adults with moderate to severe cognitive disabilities such as Down syndrome and autism spectrum disorders. By placing constraints on the PATTC’s components, Dawe and Wehmeyer delved deeper into understanding AT adoption and usage within their specific areas of interest. This deeper understanding then enabled them to design technologies to better meet their users’ needs as well as allowing the researchers to explore more targeted interventions for promoting AT usage.

4 Overview of Dissertation

This dissertation is about understanding and supporting the adoption of assistive technologies by adults with reading disabilities, thus continuing in the same vein as the focused studies of Dawe and Wehmeyer. As with their studies, various components of the PATTC framework are constrained. Only reading disabilities are considered, and persons of interest are constrained to adults with RD, with a particular focus on adults enrolled in postsecondary education. Tasks are constrained to those involving reading and can range from the informal (e.g., reading the newspaper, surfing the web, enjoying a novel) to the formal (e.g., reading for university courses or work). Otherwise, no restrictions are placed on the technologies nor the sociocultural-environmental contexts. All possibilities for these two components are open for consideration. Through this mix of constraints and openness, a deep understanding of the complex factors that lead to the adoption and usage of ATs for adults with reading disabilities is obtained. These insights also provide direction for evaluating current ATs and provide recommendations for future design. A prototype AT based on these recommendations and some preliminary user evaluations are also presented.
Forming the central framework of the dissertation is Value Sensitive Design (VSD) (Friedman, Kahn, & Borning, 2006). An established design methodology, VSD includes and accounts for human values throughout the design process. To date, VSD has been applied to a wide range of technologies and topics, including browser security (Millett, Friedman, & Felten, 2001), urban planning and simulation (Borning, Friedman, Davis, & Lin, 2005), and groupware (Miller, Friedman, & Jancke, 2007). However, this dissertation is the first application of VSD to the design of assistive technology.

Framed as an interactional approach, VSD argues that while social systems and people do shape the development of technology, technology also shapes and influences the behavior of individuals and society (Friedman, Kahn, & Borning, 2006). To capture the complex dynamics at play, VSD uses a tripartite methodology (conceptual, empirical, and technical investigations) derived from many fields of study. Law, philosophy and ethics are brought in during the conceptual investigations. Research methodologies and models from the social sciences are utilized in the empirical investigations. Design, performance, and human factors knowledge from engineering and related sciences are involved in the technical investigations.

The interdisciplinary nature of VSD is particularly important given the many disciplines relevant to the research topic of this dissertation. Education and literacy studies provide the knowledge about reading disabilities and the reading process. Communication studies brings in the theories and methodologies of technology adoption and innovation diffusion. Disability studies gives insights into the social and cultural aspects of disability. Computer science and its sub-field of human-computer interaction address the technologies at play. Each discipline provides critical insights and knowledge, and all had to be brought together to produce the work presented here.

4.1 Contributions

The research contributions of this dissertation are listed in Table 1.1. Some of the findings add to the fields of assistive technologies and Value Sensitive Design. Primarily, though, this work provides an understanding of the many factors influencing the adoption of assistive technologies by adults with reading disabilities. Through the development of a value-stakeholder framework, it will be shown that the decision by adults with RDs to hide their disability from others is influenced by values of normalcy, literacy, and community. Technology usage reflects this dynamic, but the ATs currently available fail to address these values and the choice to not publicly disclose. Approaches for designing technologies that better support the values of the various stakeholders are developed, including a proposal for a system to help users with reading disabilities to navigate perceptions of normalcy across various social contexts.

4.2 Outline

Before engaging in the VSD process, the next three chapters provide relevant background information and discussions of related work. Chapter 2 provides a thorough foundation on reading disabilities. Assistive
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Table 1.1: Summary of research contributions from this dissertation.

<table>
<thead>
<tr>
<th>CONTRIBUTION</th>
<th>CHAPTER(S)</th>
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<tbody>
<tr>
<td>Applying value sensitive design to adults with reading disabilities, assistive technologies, and technology adoption</td>
<td></td>
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<tr>
<td>• Development and refinement of a value-stakeholder framework to describe factors influencing adoption of assistive technologies by adults with reading disabilities</td>
<td>6–8</td>
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<tr>
<td>• Analyses of online discussions about reading disabilities, technology, and society</td>
<td>7</td>
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<tr>
<td>• Interviews with young adults with reading disabilities about their literacy practices, social interactions, disability impact, technology usage, and values</td>
<td>8</td>
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<tr>
<td>• Value-based reviews of existing reading technologies</td>
<td>9</td>
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<tr>
<td>• Value-based recommendations for designing assistive reading technologies</td>
<td>10</td>
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<tr>
<td>• Proposal for socially-flexible reading tools that support users by promoting self-advocacy with the aid of meta-tools</td>
<td>11</td>
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Insights about assistive technology design and adoption

• Identification, analyses, and discussions about the lack of assistive technologies for adults with reading disabilities | 3          |
• Synthesis of the PATTC framework for understanding technology usage | 4, 5       |
• Applying semiotic engineering to assistive technology design | 11         |

Contributing to and expanding the value sensitive design methodology

• Introduction of theme-value literature analysis as a tool for value identification in conceptual investigations | 6          |
• Expansion of the concept of indirect stakeholders to include individuals who affect the usage of technology by the direct stakeholders | 6          |
• Generalization of the value dams and flows methodology | 6          |

technologies for RDs and their studied effectiveness are then discussed in Chapter 3. Concerns regarding what technologies are commercially available and the level of research interest in technology-driven fields like computer science are also discussed. Following that, Chapter 4 discusses technology adoption and related theories and models. The chapter also focuses on studies of assistive technology adoption and provides arguments for the lack of research on AT adoption for reading disabilities. The PATTC framework is also looked at in greater depth.

The overarching research approach for the dissertation is presented in Chapter 5, and Value Sensitive Design is fully described. The different research activities presented in Chapters 6 through 11 are also introduced in relation to the VSD framework. An initial set of stakeholders and values are developed via a literature review in the conceptual investigation in Chapter 6. Analyses of the values and stakeholders reveal
the complex dynamics shaping AT adoption among adults with reading disabilities. Issues hypothesized to be of critical importance are detailed. Chapters 7 and 8 describe empirical investigations for validating and refining the value and stakeholder analysis. Online discussions about reading disabilities and technologies from message boards and newsgroups are analyzed in Chapter 7. Case studies of adults with reading disabilities and the technologies in their lives are presented in Chapter 8. Technical investigations then begin with value-based evaluations of existing assistive technologies in Chapter 9 and continue with the formulation of new AT design recommendations in Chapter 10. Using these guidelines, a prototype AT is proposed and described in Chapter 11.

In addition to a summary of the work and concluding remarks, Chapter 12 suggests several directions for future work. Additional studies to refine the value-stakeholder framework are discussed as well as implementation plans for the Calico system described in Chapter 11. Further applications of the work and findings are also commented upon, including related topics to which the findings and methodologies of this dissertation may apply.
Notes to Chapter 1

1 A running theme throughout this dissertation involves issues in selecting appropriate terminology. To start, my choice of the term “assistive technology” bears some discussion. Within the field of disability and technology, several adjectives beginning with the letter ‘a’ are frequently used when discussing technologies and people with disabilities—accessible, adaptive, and assistive. Although these terms may seem interchangeable, subtle differences exist.

Accessible technologies do not necessarily support or help people with disabilities. Accessible implies that a technology can be used by people with disabilities either directly or through an intermediary service or device. For example, a web browser is on the surface inaccessible to a blind user, but by providing various software hooks or application programming interfaces (APIs), screen readers can work with the browser to provide access. Thus, the browser is considered to be accessible.

Similarly, the term adaptive is sometimes used to refer to technologies that support users with disabilities. It is also used more generally to mean any technology that adjusts its function and interface to a user’s needs (Gajos, Czerwinski, Tan, & Weld, 2006). This can apply to technology for both non-disabled and non-disabled users, leading to ambiguity in usage of the term “adaptive technology.”

However, assistive is used to describe technologies that directly support and address the needs of users with disabilities. In the United States, assistive technology became an official term when it was legally defined in the Technology-Related Assistance for Individuals with Disabilities Act (1988):

The term “assistive technology device” means any item, piece of equipment, or product system, whether acquired commercially off the shelf, modified, or customized, that is used to increase, maintain, or improve functional capabilities of individuals with disabilities. More generally, the term “assistive technology” can refer to devices as mentioned above or to services that deliver and support the use of such devices.

I use the term “assistive technology” exclusively in this dissertation but not in the same connotation as above. My usage refers only to devices as this dissertation primarily pertains to tools for supporting reading. Services, when mentioned, will be explicitly stated as such.

2 Abandonment, also called discontinuance, is when a user makes the decision to purchase and use a technology for an extended period but stops using said technology well before the expected lifetime of usage (Rogers, 2003). The expected lifetime of usage is a key requirement. A person who stops using crutches after healing from a sprained ankle has not abandoned the crutches.

Substituting one device for another is also generally not abandonment. Replacing a hearing aid that has stopped functioning and upgrading to a newer version of software are not examples of abandonment.
However, switching to a new brand of hearing aid or software may be abandonment of the older brand, depending on the motivation and circumstances. For example, if the old software is obsolete or incompatible with a newer operating system, then the user really had no choice but to change. This would be a simple matter of replacement, not abandonment.

Adding to this careful consideration of terminology, abandonment is also different from rejection, which is the decision to not purchase and thus not use a technology. Understanding abandonment, replacement, and rejection are both critical components of technology adoption theory and are discussed in greater detail in Chapter 4.

Unfortunately, Mainstream is a magazine targeted towards people with disabilities and not a scholarly journal. As such, Tewey et al. (1994) fail to cite the studies or provide detail on the abandonment rates they reported. However, common sense and personal communications with Dr. Richard Ladner (professor of computer science and engineering, University of Washington) can suggest some possibilities. The 8% abandonment rate was likely for more life-critical technologies, such as breathing or feeding aids. The higher abandonment rates were likely for hearing aids, which have a reputation for poor acceptance among first-time users.

Blindness is generally recognizable in others due to common signs and traits, such as a usage of a white cane, dark glasses, or lack of eye contact and focus. To be fair, exceptions do exist. One notable example is Stephen Kuusisto. In his memoir (1998), Kuusisto relates how, despite being born legally blind, he actively denied and hid his blindness from others, even riding a bicycle well into his 20s. Although he often wore thick glasses that provided only minor help, only family members and a few close friends were privy to the extent of his vision problems. Kuusisto chose not to engage in any activities that would label him as a blind man until his 30s. Only then did he start using a cane and eventually received his first guide dog.