

Examining how web designers' activity systems address accessibility:

Activity theory as a guide

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**Abstract**

Examining how web designers' activity systems address accessibility:

Activity theory as a guide

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While accessibility of information technologies is often acknowledged as important, it is frequently not well addressed in practice. The purpose of this study was to examine the work of web developers and content managers to explore why and how accessibility is or is not addressed as an objective as websites are planned, built and maintained. Concepts from Activity Theory, particularly as they apply to design, were used to frame the results and discussion of this study. The collective activities of respondents resulted in accessibility issues in their respective sites that were typical of the issues found more generally, such as missing or unhelpful alternative text, missing or misused headings and untagged PDF files. The Human-Artifact Model was used both to explain how and why accessibility barriers are routinely built into information technologies and how altering the design of authoring tools could break this cycle. Implications for accessibility guidelines and future research approaches are discussed.

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## Introduction

The production and distribution of information has evolved as human civilization has unfolded. This historical process has been characterized by a series of innovations that have brought us to the present. Oral traditions were followed by writing. The Guttenberg printing press enabled mass production of information. Digital technologies have recently put the internet in our pockets. Each of these innovations has resulted in tools that can facilitate information access, however, these tools can also block access, particularly to marginalized populations. While the printing press made books possible, this innovation didn't immediately provide information access to the masses. Books were initially an expensive luxury of the elite, however, they influenced the rise of Europe's literate middle class and an increasing number of people with access. It was not until 400 years after the Guttenberg press was invented that Braille extended access of printed materials to people who are blind. This pattern of major innovations followed by adjustments to promote universal access has persisted to the present.

This dissertation examined and tools relating to planning and maintaining websites in the context of higher education. The specific focus was on web accessibility. Web accessibility refers to the qualities of a website that enable users with disabilities access to and use of the site. People have a variety of skills and abilities along with widely varying means of accessing today's web of information technologies. As much of this information is typically displayed visually in text and images, an individual who is blind will not have direct access to this information; however, screen reading applications can read aloud the text on websites as well

as text descriptions of images. While technology is emerging that can automate image descriptions, this is not yet a standard technology (Feng & Lapata, 2013).

Web accessibility is a subset of web usability. Web usability is defined by the ISO as “the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use” (ISO, 1998). In the case of accessibility, “specified users” refers to individuals with one or more disabilities. The web has the potential to open opportunities for individuals with disabilities to access information and functions that may otherwise be difficult or impossible to access offline. When sites are coded in a manner that is consistent with accessibility guidelines, compatible with screen readers and employ usability best practices, users with a wide range of skills and abilities have better access. On the other hand, web pages can be developed in a way that hampers or blocks access for everyone or that may block or impede access for individuals with certain disabilities, particularly those with visual disabilities who rely on screen readers.

Requirements for good web accessibility are outlined in two well-established guidelines, Section 508 (Access Board, 2011) and World Wide Web Consortium (W3C) Web Content Accessibility Guidelines (WCAGs) (W3C, 2008). Two high level components of these guidelines are inclusion of alternative text to all content that is not text based and ensuring content is clearly organized with semantic structure. Alternative text (alt text) describes pictures, audio and other content that is not text, so individuals who cannot see or hear the content can access the information. Semantic structure has a similar function to the levels of headings used in an

academic paper. This structure enables people who use screen readers to scan through the headings and choose what to read without needing to listen to the entire document in linear order.

*Possible explanations for poor accessibility*

While accessibility is frequently acknowledged as important, it is often not well addressed (Lazar, Dudley-Sponaugle, & Greenidge, 2004). There are many possible explanations for the disparity between the importance of web accessibility and the prevalence of accessibility problems on websites. It may be that designers are inadequately trained and do not understand the concept of accessibility. It may be that accessibility is not valued, either by the executive level decision-makers or by the designers who build sites. It may be that the concept of accessibility is understood to some degree, but that technical aspects are not understood well enough to be implemented correctly. It may also be that the complex work systems and tools used to develop a large website lead to a perception that focusing on accessibility might be difficult or expensive (Sierkowski, 2002). It has also been suggested that materials designed to instruct developers on how to improve accessibility are often not well targeted to the audience (Law & McKay, 2007). Ultimately, there is no single or simple explanation of why accessibility issues remain common. The explanation complex due to an evolving mixture of interrelated factors.

Literature on accessibility does not address the insider perspective on how web designer and developer processes influence accessibility. The research questions for this dissertation

focus on gaining insights from this perspective. This study focuses on accessibility for individuals who are blind and use screen readers to access information technologies.

*Research questions*

1. How is accessibility understood and accounted for in the web development process?
  - a. What is the level of awareness of accessibility guidelines among designers, developers, content managers and web accessibility professionals? If there is awareness of the guidelines, how are the guidelines applied? What are the sources of awareness?
  - b. How consistent are the objectives implied by standards and guidelines with the objectives held by designers, developers, content managers and web accessibility professionals?
  - c. Is web accessibility seen as a concept limited to visual disabilities or is it perceived more broadly?
2. What are the activity systems of the following subjects? What are their objectives with regards to the website as the object of their work? What contradictions exist within and among their activity systems?
  - a. Designers
  - b. Developers
  - c. Content managers

- d. Web accessibility professionals
3. What tools and technology are used by designers, developers, content managers and web accessibility professionals?
    - a. How is accessibility addressed within these tools?
    - b. What processes are in place to evaluate sites for accessibility?

*Theoretical framework: Activity theory*

This dissertation explored why and how a certain aspect of accessibility is or is not addressed from the perspectives of managers, web developers and users of content management systems (CMSs), who collectively build and maintain websites in university departments. Activity theory was used as a framework for evaluating the processes of web development in those departments. Activity theory provides a framework for analyzing activities at the individual and group level (Engeström, 1987, 1999; Kaptelinin & Nardi, 2006). The primary goal of this project was to describe the activities that directly affect the accessibility of departmental websites to see if this description might shed light on why accessibility is not well addressed in this context.

Activity theory suggests that the core unit of analysis for research in social sciences is an activity. In its simplest form, an activity consists of an individual actor working to reach an objective by acting on an object toward outcome (Engeström, 1999). In an example relating to web accessibility, a developer or development team works on a website with the desired

outcome to build a site that provides information for individuals with a wide range of skills and abilities and using a wide range of devices.

The classic model of activity was limited because it did not account for context, including rules, community, and division of labor (Engeström, 1999; Leont'ev, 1981; Vygotsky, 1978). Engeström (1999) has extended the classic activity model to include these three elements to illustrate activity in its socio-technical context. Kaptelinin and Nardi (2006) have refocused the activity theory model in a slightly different way to highlight how multiple competing needs influence object-driven activity.

Activity theory has also been extended to account for multiple interrelated activity systems (Engeström, 2001; Kaptelinin & Nardi, 2006). The value of considering multiple systems is that it provides a richer, real-world context for activity analysis, and it can expose where systems are working well and where there are tensions or discrepancies.

#### *Contextual Design workflow model*

Models from activity theory to illustrate collective activity lack the ability to display the flow of artifacts among the multiple actors within an activity system. A diagramming method for illustrating such workflows was adapted from the Contextual Design method to show the relationships among actors and artifacts within activity systems (Beyer & Holtzblatt, 1998).

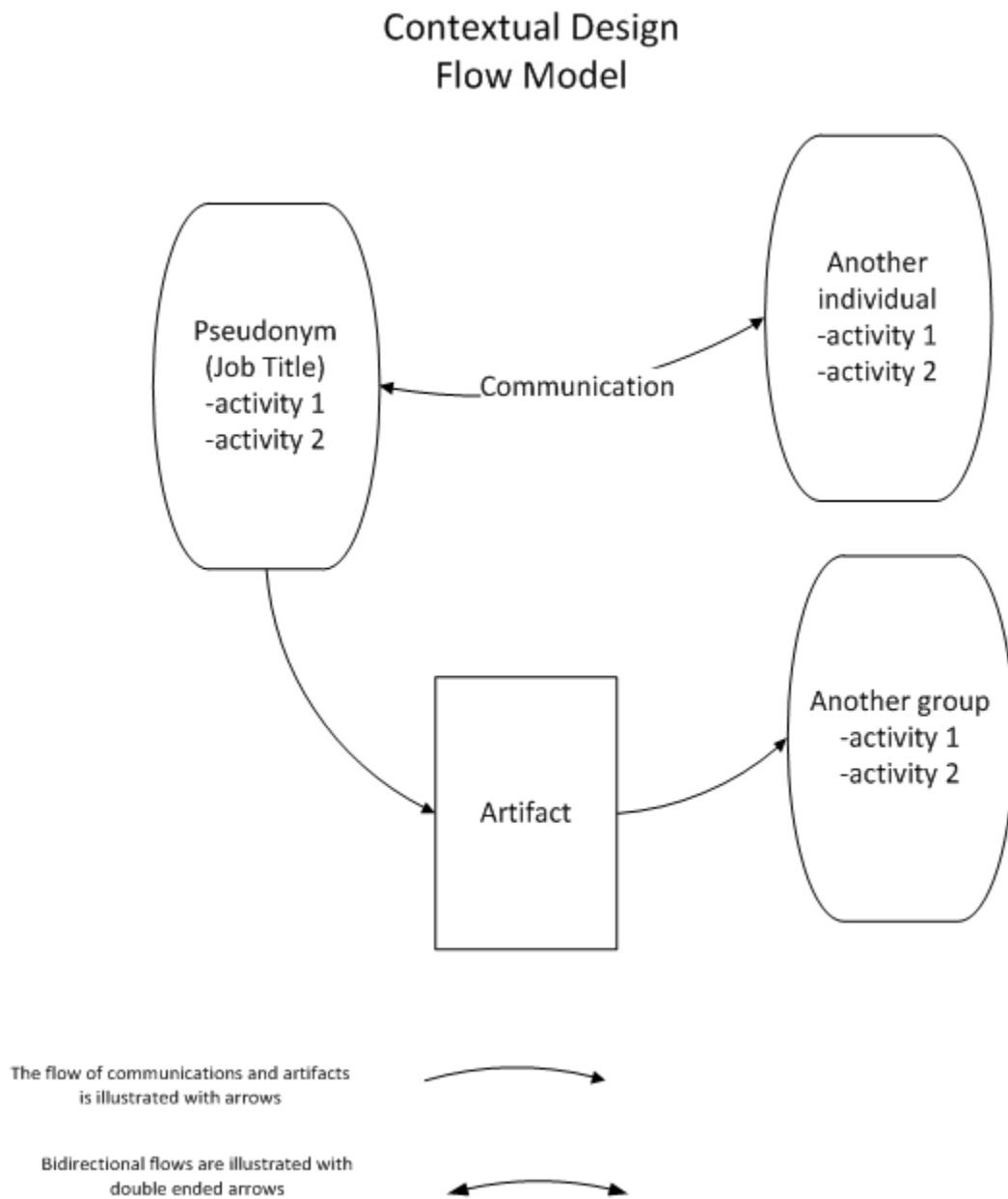


Figure 1. Contextual Design Flow Model.

*The separation of motive from object*

Activity is motivated by needs, which when addressed become objectives. Kaptelinin and Nardi (2006) make an important distinction between the objective and the object of activity. They suggest that this distinction is not necessary when analyzing activities of a single actor; however, with collaborative activity it becomes necessary to consider multiple motives for a single activity. Consideration of multiple motives enables an analysis of why some needs are acted on and others are not. needs are acted on and others are not.

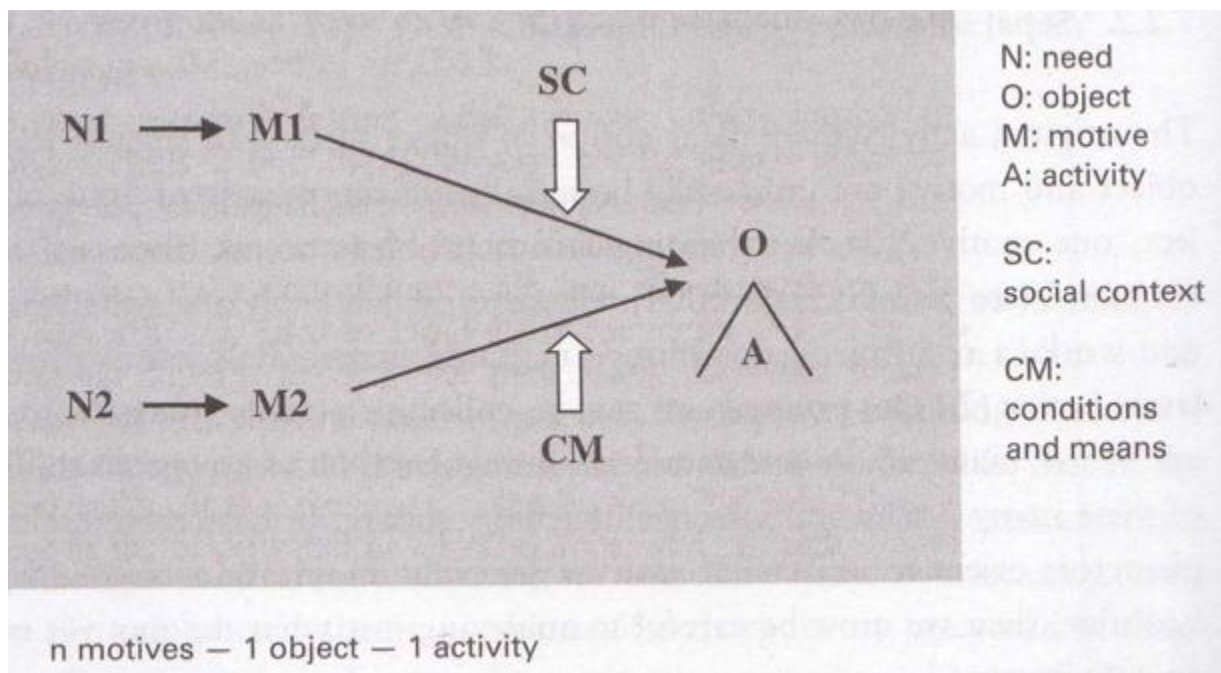


Figure 2. Kaptelinin and Nardi's model of poly-motivated activity.

In a study of a pharmaceutical company, Kaptelinin and Nardi found that the scientists in the company were motivated by humanitarian and purely scientific interests, and that the management was more motivated by the potential for profit. The managers were aware of this motive among the scientists and were continually attempting to get the scientists excited about directions that they saw as potentially profitable. The scientists were aware of the motives of management, which resulted in feeling conflicted about their work. Both sides were attempting to influence the other by carefully sharing and hiding various information while performing a collaborative activity. This example was used to illustrate how social context, conditions and means and multiple motives contribute to what is described as a “bubbling caldron” of collaborative activity. They report that a key finding from this project was that multiple motives were linked to one another. They found that these linked relationships were characterized by things such as conflict, acquiescence, resistance, and power. Analyzing the articulation of linkages among multiple motives enabled them to focus not only on “how” the scientists and managers performed their work, but also on “why” they purposefully hid some facts and emphasized others.

### *Identifying contradictions*

Engeström uses the term “contradictions” to describe a certain type of issue within and among activity systems. Contradictions are “structural tensions,” either within or between activity systems, that develop over time (Engeström, 2001). These tensions can be between any two components of activity. For example there may be tension between the objectives of

different actors as there was between the pharmaceutical managers' profit motive and the humanitarian motive of the scientists. In another example, the tension may be between an actor and rules, such as accessibility guidelines with tension created if the rules are difficult to understand or apply.

Much of the value of activity theory is that it can clarify the tensions among the components of an activity system, with particular attention to the complexity of multiple motivations for a single activity. When tensions and contradictions within and among systems become more clearly visible they become more tractable.

#### *Transformative changes and activity cycles*

Contradictions are the source of changes and innovations that transform activities. Whenever something new, such as a new technology, is introduced into an activity system, there is potential for tension between the new and the old. The desired outcome of any given activity or activity system is not always smoothly achieved with new technology, often solving tensions in some areas and creating new tensions in others. The buildup of contradictions within an activity system over time can lead to transformative changes (Engeström, 2005). Activity systems often cycle between periods of relative stability and disruptive changes that result from the buildup of one or more contradictions within the system. An activity system can be framed as a multi-voiced formation. In that view, the cycle of transformation is a re-orchestration of the system's voices. Engeström (2005) suggests that activity analysis should

include the historical backdrop of the activity, because history can show how an activity has evolved into its present state.

*Human-artifact model*

The human-artifact model was created with concepts from activity theory to explore the details of mediated activity in the context of human-computer interaction. The model focuses on the transactional relationship between expectations that the human has on what the artifact can do, and the possibilities for action afforded by the artifact (Bodeker, 2011). Three levels of analysis are suggested by the model to apply to both the human and artifact: why, what, and how.

<b>Why?</b>	Motivational aspects	Motivational orientation
<b>What?</b>	Instrumental aspects	Goal orientation
<b>How?</b>	Operational aspects - Handling aspects	Operational orientation - Learned Handling
	- Adaptive aspects	- Adaptation
	<b>Artifact</b>	<b>Human</b>

Figure 3. Bodeker’s Human-Artifact Model.

The author suggests two applications for the model. It can be used as an analytic tool to evaluate existing artifacts. It can also be used in the design process to ensure that as new artifacts are designed, that they facilitate interaction. The unique benefit of this model is that it is grounded in activity theory. By mapping the why, what, and how of activity to the human and the artifact it is possible to pinpoint where the interaction has the potential for a mismatch between the end user's objective and the mediating tool resulting in a negative influence on the outcome.

The model is applied as an analytic tool by replacing the table cells in the model with the answers to the why, what, how level questions as they relate to the specific tool mediated interaction from the human and artifact perspectives. For example, the top left cell answers the question: how does the artifact communicate *why* it might be used? The top right cell answers the question: *Why* is the human using this tool? etc. This analysis results in a table that brings both the level (why, what, and how) into focus and identifies possible mismatches at each level between the artifact and the human. The second use of the tool is similar, except that instead of focusing on the current human-artifact interaction, the focus is shifted to what possible changes might be made to the artifact to improve the fit between the human and the artifact at any or all of the three levels.

### *Activity theory and design*

Design is an activity where the objective is to create a tool that will be used to mediate a future activity. Usually, end users of this future tool are different from the designers creating

the tool. For example, websites and information technologies are generally designed to provide access to information for others. The diagram applying activity theory to design models the activity of the designer forming the object which in turn becomes the mediating tool of the end user.

## Activity theory applied to design

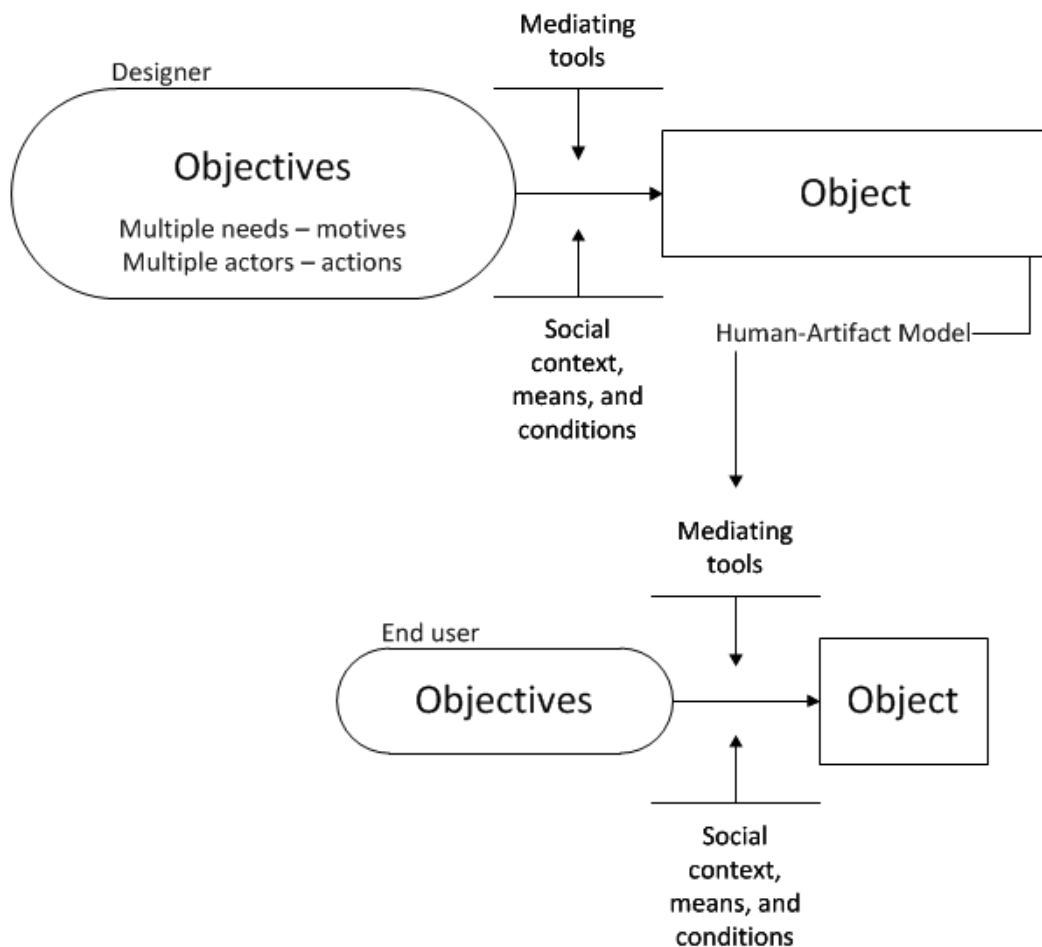


Figure 4. Activity theory applied to design.

## Literature review

*Historical context*

During the timeframe of the civil rights movement, around the end of the 20th century, the cultural understanding of disability of those influencing federal regulations shifted from a medical model, in which disability might be seen as an individual tragedy or condition to be treated with medical intervention, to a social model, where individual differences are disabling as a result of society not being prepared to accommodate these differences. While the medical model continued to influence policy in areas such as education, this shift in understanding moved focus away from an individual's impairment and toward society's accommodation for humans with a variety of skills and abilities. This milestone paved the way for legislation such as the Rehabilitation Act of 1973, which was informed by the socially constructed model of disability, enabling accommodation to be viewed as a right. That act, subsequent amendments and additional regulations set the stage for policy and guidelines relating to accessibility of information technologies (Elcessor, 2010).

Another milestone in the evolution of policy for accessibility of information technologies came several years later when the Rehabilitation act of 1986 introduced Section 508. This regulation defined accommodations as a right, meaning that individuals with a disability are provided with information and data that is comparable to what is provided to those without a disability. Section 508 indicated that guidelines be developed to ensure access. The United

States Access Board (<http://www.access-board.gov/>) was formed for the purpose of specifying these guidelines and continues to do so to the present (Access Board, 2011).

Four years later, 1990 witnessed two major events relevant to accessibility: the Americans with Disabilities Act (ADA) was enacted, and the World Wide Web was created. The web was significant as it introduced hyperlinks to enable navigation through the internet. The ADA addressed telecommunications technology but, as the internet was not pervasive at that point, the regulation did not directly address information technologies. The birth of the web was a boon for individuals who were blind, as screen readers (software applications that read text aloud) provided access to this new world of information. However, three years later, in 1995, Mosaic released as the initial graphical web browser (Ellcessor, 2010). This marked the first innovation on the web that presented a significant barrier for blind users who were faced with content that they couldn't access.

A solution emerged as alternative text was added to the second version of HTML standards. This provided a field for text descriptions of the content presented visually in images. Each picture that was displayed could have text associated with it that provided a description of the image. Alternative text was initially implemented to accommodate for processing constraints and user preference; however, it also enabled access for blind users as screen readers were updated to identify and read this content (Berners-Lee, 1995). When a screen reader encounters an image, it looks for the alternative text information and reads this aloud to the user. This solution was not robust as the alternative text field was not a required

field and was (and still is) often left blank or contained information that did not provide meaning, such as “png123”.

In 1999 the Web Accessibility Initiative (WAI), which is the division of the World Wide Web Consortium (W3C) devoted to accessibility, published its first set of guidelines for web accessibility (W3C, 1999). The guidelines that a small group of W3C staff produced over three years of work aimed to standardize how websites were coded so browsers and screen readers would be compatible. When the standardized guidelines were not followed, it was not possible for screen-readers to meaningfully interpret web content. The three basic requirements, standards for the core technologies, developers following standards with the support of guidelines, and compatible screen readers, remain the same today. However, the accumulation of 20 years of innovations leaves us with a highly complex system with an ever increasing number of places where issues and barriers can occur. Innovations in both browsers and web applications have sometimes taken web standards into account, but in many cases have not.

The proliferation of devices, both assistive technologies and general use devices, complicates access as well. WebAim, a nonprofit organization within the Center for Persons with Disabilities at Utah State University reports a 550% increase in using screen readers on mobile devices in the two years prior to their most recent survey in December, 2010 (WebAim, 2010). The web has increased in complexity and also is evolving with applications that have been the mainstay of traditional desktop based systems emerging as services hosted in the

cloud. For example, Google Docs and Microsoft Office Web Apps provide word processing and spreadsheets applications which run on browsers and function as hosted services.

Accessibility guidelines have evolved in response to the increase in complexity of the web and the increased variety of applications and devices accessing content and services. The W3C WCAGs were updated in 2008 (W3C, 2008) from the original 1.0 guidelines (W3C, 1999) with the goals of broader application and addressing more advanced technologies (W3C, 1999, 2008). While the updated 2.0 guidelines also aim to be easier to understand and more precisely testable, there is inherent tension between these aims and the additional complexity faced by technology developers as they apply the guidelines. The additional complexity to a large degree results from the need for compatibility with the increasing number of technologies and devices.

Given the increasing complexity and number of devices and applications, accessibility guidelines could no longer specify a single technique for ensuring that a given criteria was being met. A single technique might apply only to specific devices and/or application. To accommodate for this change, guidelines shifted from specifying precisely “how” to meet the criteria to “what” compliant websites and web applications must do to meet the criteria. While this may seem like a subtle shift in language, the implication for developers is significant. Because the 1.0 guidelines specified techniques, it was clear for developers how to apply the techniques to the code they were working on. The 2.0 guidelines do not require a specific technique be used to meet a given criterion, making it less clear for developers to be sure they are meeting the criterion (W3C, 2008).

An additional challenge reported by developers working with the WCAG 2.0 guidelines is that the concept “accessibility supported” is not defined in a manner that is easily translated into regulations or a standardized approach to practice (Alonso, Fuertes, Gonzalez, & Martinez, 2010). The clarification given to “accessibility supported” is that it means that the technology works with assistive technologies and works with accessibility features of mainstream technologies. This clarification is clear in concept, but challenging to apply as both mainstream and assistive technologies are evolving over time.

A layer of complexity has emerged with user generated content and the full range of web authoring tools and content management systems. Fifteen years ago it was easy to identify who developed the web; it was the webmaster, and while the standards and browsers may have seemed complex at the time, they were very straight forward compared to today’s standards, browsers and other devices used to access content. Today it is not as easy to pin down who is building the web because it is essentially built by multiple contributors with a wide range of technical skills. This range begins with end users, often with no special skills or training directly generating content, through people with minimal technical skills using content management systems, on through more traditional web developers who may be generalists or specialize in specific areas of web development. Some of these authoring technologies incorporate the possibility for supporting accessibility, but others do not.

The WAI has responded to this trend by developing guidelines for authoring tools as well as user agents which are defined as browsers and assistive devices (Chisholm & Henry,

2005); in addition to updating WCAG, the W3C has also developed guidelines to specifically address accessibility for dynamic content developed with Java Script, Ajax and related technologies. Guidelines for accessibility have responded to the increase in complexity of technologies and have also responded to the new division of labor of who is building the web. Some aspects of web accessibility are rapidly changing and others are not. Technologies are evolving quite rapidly; however, the basic physiological abilities and skills of users are not.

A cyclic pattern of innovation on the web creating accessibility issues which in turn have been addressed by standards and guidelines to inform how sites are coded and by updates to screen readers emerged and has persisted for the last 20 years as the web has become increasingly complex. This evolution of accessibility has brought us to a present state with a high degree of complexity in desktop and mobile systems. In a relatively new innovation screen reading technology is now integrated directly into some operating systems.

In many ways technology has improved dramatically in the past 20 years, yet the first major barrier to blind users, images without alternative text, continues to be an issue. As new innovations have evolved, so have the types of issues encountered by users who are visually impaired. Confusing page layouts, unlabeled or poorly designed forms, and conflicts between screen readers and applications also continue to block access (Lazar, Allen, Kleinman, & Malarkey, 2007). This sample of issues encountered by end users illustrates how some of the innovations on the web can pose barriers. Web pages with barriers are more of the norm than

the exception. In an automated study of 30 million web pages few were found to have reached a high level of conformance to accessibility guidelines (Lopes, Gomes, & Carrico, 2010).

A study evaluating the accessibility of 3251 (virtually all) US higher education institution websites sampled the top 10 web pages and top 10 PDF documents from each institution (Thompson, Comden, Ferguson, Burgstahler, & Moore, 2013). Google searches were used to determine the top pages and PDFs for each institution. This study found a range of issues including missing alternative text for images on at least one image in the 10 page sample in 39.6% of the institutions. They also found that 66.2% of the PDF documents were not tagged for accessibility. In addition the study found that institutions with a formal accessibility policy had higher overall accessibility ratings.

#### *Universal design and assistive technologies*

There are two general strategies for improving accessibility: universal design and assistive technologies (Brophy & Craven, 2007). The aim of universal design is to shift the focus of design and development from the average user to a wide range of users on many dimensions such as learning style, ability, disability, etc. (Burgstahler & Cory, 2008). This approach aims for a single design that is flexible enough to accommodate users with a wide range of skills and abilities. It is not always possible or feasible for a single design to meet the needs of all users. Assistive technologies serve as a fallback when specific user needs are not met. An assistive technology is any device, including software that enables or enhances the functional abilities of an individual. When combined, these strategies aim to maximize the abilities of users with the

full range of abilities and skills. The following research and development examples illustrate the universal design and assistive technology strategies used to evolve information technologies.

In the first example automated summaries of web pages provide users with an overview of the contents of a page without scanning down through the headings on the page. These summaries were known as Gist summaries and reportedly were available in a Firefox plugin, Summate (Harper & Patel, 2005). The universal benefit of this concept would be particularly notable for mobile users who have limited screen sizes. A small screen size is associated with a greater need for summarized content and an experience designed for more linear navigation, consistent with the navigational patterns of people using screen readers. A similar study demonstrates the possibility of automated text simplification as a general as a strategy to improve readability and accessibility of text (Candido Jr, De Oliveira, & Aluisio, 2009).

Another example of universal design is the generation of headings instead of summarized or simplified text (Brudvik, Bigham, Cavender, & Ladner, 2008). A broad implementation problem with using headers is that document designers don't agree on what text should be given a heading and what the label of the heading should be. To address this issue a proof of concept study has illustrated that automated text analysis has advanced to the degree where it can do a better job of generating meaningful headings than humans. Headings are very important to accessibility as screen readers can scan through them so users can jump to content sections of interest. Additionally, this project used simple scripts to convert non-text elements into text to incorporate this visual content into the heading generation system.

The above examples focus on users consuming information. Technology is also used to facilitate creating information. Text input is a key component of creating information. Users who are on small mobile devices have text input error rates equal or higher to rates of users with disabilities on desktop systems (Yesilada, Harper, Chen, & Trewin, 2010). This notion inspired a study to determine if there is overlap between some of the specific classes of errors made in both scenarios and to determine if the solutions in place for addressing the desktop errors in the scenarios with users with motor impairments might apply to the mobile device scenario. The results suggested that some but not all classes of errors could be addressed with solutions that exist today in software designed for users with disabilities. The study illustrated how design solutions that benefit users with disabilities can be implemented in a way that benefits all users. In another study of universal design a case example of improving a login page to address accessibility for individuals with cognitive impairments with an iterative design approach that illustrates how all users benefit from the improved simplicity of the process (Halbach, 2010).

In terms of activity theory, universal design connects the objectives of the designer with the social context, means, and conditions of the end users. Universal design is an approach where designs are created with the explicit goal of benefiting all users. When universal design is not feasible or possible, assistive technologies can be considered to enhance or compensate for specific functional impairments.

A screen reader is an example of an assistive technology. Screen readers work in conjunction with browsers and other desktop applications to augment these technologies and provide auditory access to content that is designed to be primarily accessed visually. Research and design is also being conducted on concepts that can improve assistive technologies, however, these examples may very well lead to designs that result in universal benefit.

The following study explored a way to improve screen readers by identifying the typical flow of users through an ecommerce website and then surfacing this flow more prominently through the screen reader. The study used click-stream analysis to explore users' flow patterns through the website. These flow patterns were analyzed with a focus on finding the typical transaction flow (Bigham, Lau, & Nichols, 2009). Once the typical flow was known it was better exposed to the screen reader to facilitate the user's navigation through the online purchase process. This same concept has also been applied to an interactive online help system named Trailblazer (Bigham et al., 2009). This system provides an alternative to linear navigation through a help system that suggests the most likely target to the user. This study found that users wished the system could apply more generally, not just to the specific help system in the study. The study found that in most cases, 75.9% of the time, the option that the user was looking for was in the top 5 suggestions of the optimized system.

Another example of research and development in assistive technologies is a 3d hepatic web browser which is being developed to enable users who are blind to access the web with a touch device that generates a three dimensional interface (Kaklanis, Votis, Moustakas, &

Tzovaras, 2010). A key benefit of this technology is that it enables users to go through a webpage in a nonlinear manner. With traditional screen readers a user can generally navigate to headings but the information access is still slower than accessing information visually with scanning to locate relevant information. The hepatic browser enables users to use touch to scan through the document with their fingertips.

The assistive technology strategy has been complicated by proliferation of devices and the shift in accessibility guidelines from the focus on specific “how” techniques to “what” is required to provide access. However, assistive technologies remain important as they fill needs that are not feasible to address with universal design.

The assistive technology approach has a connection to the concept of functional organs from Kaptelinin and Nardi’s work in activity theory. Functional organs combine artifacts with human abilities to enable or enhance achieving goals. They suggest that eyeglasses and microscopes provide an example of functional organs when combined with the human eye that significantly enhance vision. This concept applies directly to accessibility as assistive technologies serve the same purpose. Functional organs are a key concept of activity theory in relation to interaction design (Kaptelinin & Nardi, 2006; Leontiev, 1978).

*Activities of users with disabilities*

Several studies provide information indicating where web accessibility issues create barriers in the activities of end users as they access information. An online survey on e-learning that included 223 university students with disabilities as well as smaller samples of professors, online learning professionals and campus disability service providers found that the accessibility of the course websites was the most common accessibility problem reported by all four groups of participants (Fichten, Asuncion, Barile, Ferraro, & Wolforth, 2009). PDF accessibility was cited as an issue by individuals in all four groups. Websites using Flash can also pose a barrier to some students (Fichten, Ferraro, et al., 2009). In a study of American online newspapers images without alternative text were commonly found (Xu, 2005). Website complexity poses a barrier to accessibility for individuals with cognitive disabilities (Wachowiak, Wachowiak-Smolikova, & Fryia, 2010).

In a study using diaries to collect data from 100 users of the internet who are blind the top causes of frustration were found to be (Lazar et al., 2007):

- “ (a) page layout causing confusing screen reader feedback;
- (b) conflict between screen reader and application;
- (c) poorly designed/unlabeled forms;
- (d) no alt text for pictures; and
- (e) 3-way tie between misleading links, inaccessible PDF, and a screen reader crash”

The array of issues cited in the studies above points to a contradiction among the subject, the object and the mediating instruments. At a fundamental level the subject is blocked from reaching an objective when the tools used for mediating the activity block access. The case of the screen reader having a conflict with the application illustrates the complexity of relying on multiple tools in an activity system. The complexity of mediation increases with the use of assistive technologies which in effect add additional physical tools beyond the standard set of tools. This added complexity has the side effect of having more opportunities for breakdowns in the system. The proliferation of devices, both assistive technologies and general use devices, complicates access.

#### *Web creation activities and accessibility*

The proliferation of devices and screen sizes, etc. is also resulting in an increase in the complexity of the activities of those who design and develop information technologies. Touch interfaces are replacing mouse and keyboard interactions in many cases, but not all. The division of labor is evolving with highly specialized technical roles focusing on narrow aspects of building information technologies and non-technical content management roles focusing on different aspects of this collaborative activity.

Individuals filling these multiple roles may have limited knowledge of web accessibility or how to improve it. However, there is evidence of their willingness to work toward more accessible designs and recognition of its importance (Brophy & Craven, 2007; Lazar et al., 2004; Roh, 2004). Some developers who do know about accessibility report difficulty implementing

guidelines. Respondents to a survey of developers and service providers indicated low awareness of the concept of web accessibility (Lopes, Van Isacker, & Carrico, 2010). However, the survey found an openness of stakeholders to using assistive technology simulations as a means to incorporate accessibility in the software development process.

#### *Evaluating accessibility with guidelines*

Many webpages are not compliant with accessibility guidelines. A large scale automated evaluation of an archive of 30 million pages found a high degree of variability in conformance to the WCAG 1.0 guidelines and that few pages reached high accessibility levels (Lopes, et al., 2010). They also noted that page complexity, defined by a simple count of HTML elements on a given page, correlated with accessibility issues. Guidelines are perceived by some as overlong, confusing, and not helpful in assisting developers of library websites in achieving their goals (Vandenbark, 2010). Vandenbark suggests that guidelines and standards range from complex to vague and insufficient. Another common response from programmers after an accessibility evaluation is that it would be much easier to consider accessibility proactively instead of working to retrofit the design (Law, Jacko, & Edwards, 2005). It can take more time to fix accessibility issues than it takes to be aware of what is necessary up front when building pages.

Four specific challenges implementing the WCAG 2.0 guidelines are detailed in a way that sheds light on where the issues are within the activity systems of developers (Alonso et al., 2010). The challenges are that “accessibility supported” is not clearly defined, guidelines lack testability, techniques and failures are open-ended, and it is unclear how many techniques

need to be applied to a given problem to ensure conformance. Each of these challenges is described below.

The first challenge is that the concept “accessibility supported” is not defined in a manner that is easily translated into regulations or a standardized approach to practice. The clarification given to “accessibility supported” is that it means that the technology works with assistive technologies and works with accessibility features of mainstream technologies. The lack of clarification is that there is not a list of specific assistive technologies referenced or a specific list of features in the mainstream technologies. In terms of activity theory this could be described as a tension between the rules (accessibility guidelines) and the object (website), or perhaps a tension internal to the guidelines. The authors suggest that a list of specific assistive technologies referenced or a specific list of features in the mainstream technologies would clarify the meaning of “accessibility supported”.

Guidelines are evolving to focus more on “what” and less on “how”. Early guidelines could encompass both what was required in the technology to make it accessible and technically how to produce accessible web pages. This was possible when HTML was the only language for building pages and there were only a handful of browsers, all of which worked similarly. In today’s world of rich and complex systems for displaying information there is no longer a single way (how) to ensure any given guideline (what) is addressed. This has led to “accessibility supported” replacing what was in the past explicit guidelines on “how” and

supporting documents describing multiple techniques for how any given requirement can be met.

The second challenge that Alonso et al. (2010) outlines is the lack of testability of some of the guidelines. While some areas such as color contrast, he points out, are more clearly testable than in the 1.0 version, other areas are less reliably testable. In their own class on accessibility they found that in using their students as research participants, 9 of the 25 primary accessibility guidelines were reliably agreed upon. Reliability was defined as 79% or more of the students and instructors agreeing on whether or not a given guideline was in conformance or not.

The third challenge that was identified by Alonso et al. (2010) was the open-ended nature of the techniques and failures section of the guidelines. There are two issues that are described here. The first is that only non-proprietary technologies are included in the techniques and failures section. The group creating the WCAG guidelines hopes that more technology vendors will provide examples for how to improve the accessibility of their respective products; however, this isn't something they have control over. The second issue is that technologies evolve over time and so the techniques and failures section has a process for updating its content over time. The challenge with this is that it is hard to hit a moving target as devices are evolving. A technique that works today, may not be compatible with tomorrow's technology.

Alonso et al. (2010) describe “aggregation of partial results” as the final challenge. The 2.0 guidelines recognize that a single barrier can be addressed with multiple techniques. They suggest that it is not always clear if you need to use one technique or another or apply both in order to conform. It is also not clear how to address non-documented techniques as it is possible for a site to conform to a given guideline without using any of the documented techniques. This complexity is described as a significant challenge for automating accessibility checking tools.

Alonso et al. (2010) outlined developer issues relating to the objective of evaluating information technology for accessibility. This approach helps define the problem. In a different approach Trewin’s research focused both on defining the problem and on looking for solutions. Trewin surveyed web developers at IBM to explore features that they might find useful to help them consider accessibility when they are developing websites (Trewin, Cragun, Swart, Brezin, & Richards, 2010). Some of the top challenges faced by developers in Trewin’s survey were designing for accessibility, testing for accessibility, and finding workarounds and solutions that worked across multiple browsers. Developers found the tools to test for accessibility to be hard to use, unclear, and cumbersome. The survey generated 15 ideas for features that would assist developers in addressing accessibility. Ideas generated from this approach included listing and explaining each problem detected through automated testing, visualizing the experience of the person with a disability, explaining why a given code fragment might cause problems, and generating a checklist for items that need to be manually checked.

In a study focused on manually evaluating sites for accessibility it was found that students are not as accurate in conducting manual assessments of accessibility as experts are (Brajnik, 2008), and manual evaluation for accessibility guidelines that can't be programmatically assessed has been demonstrated to be faster and more accurate when conducted by expert evaluators than by non-expert judges (Yesilada, Brajnik, & Harper, 2009).

*Research connecting multiple activity systems*

In addition to examining activity within a system, the interactions among systems can shed light on contradictions between systems. Research in accessibility has taken a new direction, along with research and trends in technology and society. This area of research acknowledges the increasing participation of end users in the development of the web. With the rise of user-generated content and online social networking, new opportunities and challenges are evolving for web accessibility. These trends connect the systems of end users with those of developers as both systems are now playing a role in building and creating information. User testing is another example of how the activity systems of users with disabilities and the systems of developers can interact to improve accessibility.

Crowd sourcing is a specific example of how the activity systems of users with and without visual disabilities can work together to improve accessibility. Two projects in this category explore crowd sourcing as a means to improve accessibility (Champin et al., 2010; Sato, Kobayashi, Takagi, & Asakawa, 2010). Sato et al. (2010) enabled users who are unable to access content to request that text alternatives be generated. The request is then posted to a

central list of requests. Next, a volunteer annotates the content, which triggers a notification to be sent to the requestor indicating that the request has been fulfilled. This project is a proof of concept project and would need to evolve if it were to scale. One key limitation is that the annotations that are generated are technically completely separate from the original websites. This means that original website remains inaccessible. Champin et al. (2010) describes a similar project, but is focused specifically on video annotation, rather than general accessibility issues. In addition to being interesting as this research is focused on new developments in technology, it is also significant in that it is an example of the distinct activity systems of developers, volunteers, and end users sharing an overlapping objective.

User testing is another example of an interaction between activity systems. User testing is an interaction between the activity system of the web designer and the system of an end user. User testing is an established method to ensure that content, particularly rich content, is designed in a way that makes it accessible to a wide audience (Connor, 2010). User testing can also be used to explore how assistive technologies can be improved. For example, screen reader users have a range of strategies to work around accessibility and usability issues on the web. As users learn, they tend to use more advanced strategies (Borodin, Bigham, Dausch, & Ramakrishnan, 2010). Exploring the range of strategies can inform the development of new screen reader features to both assist advanced users and also help new users overcome the learning curve (Borodin et al., 2010).

*Activity theory and accessibility literature*

There are many complex activity systems that relate to web accessibility. This survey of literature has only touched on the systems of developers and users with disabilities. Many other systems exist: for example, activity systems around accessibility education, accessibility policy, and accessibility advocacy were not addressed. Another important factor is that the systems focusing on accessibility exist within the broader context of technology development. Systems focused on accessibility and tool development in general ultimately are producing information technologies that create barriers for end users accessing information.

Designers and developers are not consistently aware of accessibility. This lack of awareness influences the work of designers and developers. Lack of awareness precludes accessibility considerations from being integrated into the conscious objectives that mediate the work of producing information technologies. This can result in barriers for end users accessing information.

Accessibility guidelines are perceived as hard to understand and apply. Awareness of guidelines may be a step, but it does not ensure that they will be understood or followed. The need to consider accessibility can still be unmet, not integrated into the objectives of the actor and result in barriers for end users. The specific tension between the desire for a comprehensive list of specific techniques describing how to conform to accessibility guidelines for all technologies and the exponential growth in different types of technologies is a prime example of what Engeström (2001) describes as a contradiction. Because of the proliferation

types of devices accessing content including assistive devices and the increased complexity of these technologies, such a list would not be feasible to create or use. Engeström suggests that when the tension is great enough, at some point a transformative innovation can resolve the tension. The differences in the means, conditions and social context of individuals working in different roles creating information technologies are not explicitly described in literature; however activity theory suggests that these differences have an important influence on how accessibility is or is not considered and addressed.

## Methods

This study was conducted within a large university with a complex and evolving hierarchy of colleges, departments and academic areas. Information technologies produced by and providing support for the university included thousands of websites which were developed and maintained by the numerous groups within this hierarchy. Three approaches were initially taken to identify participants, however, only one of these approaches was successful. All three approaches used the same solicitation content and eligibility script. These materials (Appendix A) were approved through the human subjects review process along with the rest of the methods of this project.

The first approach used to identify participants was to attend a monthly meeting where support is provided to designers and developers who are interested in learning about IT accessibility. Individuals who were potentially eligible contacted me after this meeting, however, when they learned that the scope included multiple interviews not only for them, but also for their colleagues, they declined to participate. The second approach was to send email to the distribution list associated with this same monthly meeting as this is a much larger group than those who attended the meetings. This did not result in any responses. The third approach which ultimately resulted in two eligible groups who were willing to participate was to send the same content to a few staff around the university that I have previously met in other contexts with the request to forward it onwards if they knew people who might be interested and willing to participate.

While activity theory provides an analytical framework for understanding the evolution of work systems, it does not prescribe any single method. Methods which have been used include ethnography, product design research, retrospective analysis of empirical studies, and the notions of boundary crossing and change laboratories (Engeström, 2005; Kaptelinin & Nardi, 2006). Contextual Design is a methodology which has been specifically developed for designing technology systems (Beyer & Holtzblatt, 1998; Holtzblatt, Wendell, & Wood, 2004; Wixon, Holtzblatt, & Knox, 1990). Contextual design provides instructions for conducting semi-structured interviews in the context of a respondent's work environment and for observing actual work activities being performed. Elements from both activity theory and contextual design were used to inform the methods and analytic strategy for this dissertation, as each offer a useful framework for making work activities visible.

In addition to contextual interviews, websites were evaluated for accessibility. An individual using a screen reader was instructed to access the sites and make a verbal recording of what was accessed on the home page of the site being evaluated. A functional approach was taken rather than using guidelines as a rubric in order to better emphasize issues that would have a functional impact as opposed to a comprehensive listing of issues. The second approach to evaluating the sites was to inspect the code to identify issues with alternative text that might be hidden from the screen reader.

The goal of this project was to understand activity from the perspective of those collectively performing this activity. Contextual interviews were conducted with multiple

respondents who were collectively engaged in planning and building websites. The following sections describe participants, the interview approach, data collection and transcription, and accessibility evaluations.

### *Identifying activity systems*

Participants all had a role in designing, developing or managing content for their respective websites. Individuals from two separate departments at the University were initially identified for this study. Once one individual was identified others within the system were contacted and included as participants. Identifying multiple individuals working collectively on the same site was an important factor as it is what defines an activity system. The goal was to locate activity systems where enough different individuals could participate to paint a clear picture of the interrelationships among individuals within the activity systems.

Another important factor in identifying participants was the relationship between the substantive area of the department in focus and the concept of accessibility. The goal of this dissertation was primarily not to explore the activities of accessibility experts as it was expected that their objectives and the sites that they build would have better accessibility than might be typical. The first two activity systems that were explored were in areas of the university that did not have a substantive connection to accessibility, disability or web design.

Several prospective respondents were hesitant to participate in this project for a reason that became more apparent as I began conducting interviews. Given that accessibility is a topic that was not central to the focus of the people in the study it was often an unfamiliar topic. It is

more comfortable to talk about familiar topics. Once this became apparent, I began interviews by reassuring participants that my goal was not to talk to experts about this topic, but rather to talk to people who are not experts on accessibility to see what is naturally happening.

Because the individuals in the first two systems included in this study had a limited knowledge of accessibility, were engaged in few activities to address accessibility and were not engaged in any activities to evaluate the accessibility of their sites, a third activity system was added with specific focus on promoting accessibility and providing support services for students with disabilities. A system filling this role was easily identified with eager respondents. This third system was comprised of a group of individuals who were involved with both evaluating university websites outside their specific department and building a website that specifically addresses web accessibility by providing guidance for others who are building sites around the university.

#### *Interview approach*

The meaning of “contextual” in Contextual Design is that interviews and observations are made while participants are actively engaged in the activity that is the focus of research (Beyer & Holtzblatt, 1998). There are many benefits of this approach over interviews that are conducted out of context. People tend to abstract and summarize their work and often miss important details when they are out of context. In terms of activity theory, actions that become automatic to the user move to the unconscious level becoming operations. Having the participant show you their work also slows down the process enough to make operations more

visible and helps address the discrepancy between what people think and say they are doing with what they are actually doing. Initial interviews were all conducted in the context of the participant's work environment. Some follow-up interviews were conducted over the phone.

### *Discussion Guide*

I used the following questions and topics to guide the Contextual Interviews. Accessibility also was discussed as a topic near the beginning of each interview to explore how the idea was understood and if and how it was considered as each person was working on their web projects.

1. What is your role as it relates to web design and development?
  - a. What specific tasks are you responsible for? I.e. collecting requirements, building wireframes, interaction design, visual design, user research, etc.? What processes do you follow when accomplishing these tasks?
2. What are your relationships with others who are involved with this process?
3. How is the work prioritized and divided among you and others involved in this the process?
4. What tools do you use to accomplish this work?
5. How do you personally evaluate the success of the work you perform?
6. How is your work evaluated by others in your organization?
7. How is your work evaluated by end users? What kinds of feedback exist from end users?
8. Are you familiar with the concept of web accessibility? If so:

- a. Where did you learn about this?
  - b. What does accessibility mean to you?
  - c. What tools and guidelines do you use that relate to accessibility?
  - d. How is accessibility prioritized in your work?
9. Show me an example of your work.
- a. At this point the respondent was encouraged to show work that they were currently doing on their site.

*Accessibility evaluations*

As accessibility is a broad concept, even as it specifically relates to website development, it became evident as the data from this project was analyzed that a more focused definition was necessary to aid in making the connection between the activities that were observed and their influence on accessibility. To better understand this connection an evaluation was performed by a blind individual who navigated through the homepages of the current live websites in the first two activity systems. The goal was not to perform a comprehensive assessment of all potential accessibility barriers, but rather to see which issues naturally surfaced as actual functional barriers. In addition to this evaluation, the code was inspected to look for potential alternative text issues. This was necessary because the evaluator using a screen reader would miss items if they were coded in a way to instruct the screen reader to skip over them.

*Summary of data forms*

## Forms of Data

Interview transcriptions	Audio recordings of contextual interviews were transcribed. These transcriptions served as the primary source of data.
Artifacts	Respondents were asked for screenshots of their work when potential issues were discovered. To maintain confidentiality, these images have been either sketched or personally identifying data was removed.
Websites from Cases 1 & 2	The actual current live websites were used as data to compare what respondents relayed in interview, compared to what was produced on the sites they were building and maintaining.
Accessibility evaluation transcriptions	Accessibility evaluations were transcribed.

Table 1. Forms of data.

*Description of setting and respondents*

The activity systems analyzed in this dissertation were within a large research university. The university's vision statement highlights the importance of servicing a diverse student body. The inclusive vision and value of diversity was also articulated by campus leaders in a video posted within the university's site. While there was a stated vision for valuing diversity at the university, there was not a formal policy regarding accessibility. The research questions in this dissertation relate accessible web design which is a specific component of servicing a diverse student body.

Collaborative activities relating to creating websites were identified and examined in this dissertation. Activities of maintaining and planning websites were identified in the first two cases. Neither of these systems engaged in evaluating accessibility of the sites that were being built. This activity was occurring in a separate system.

Interviews were conducted over a period of 6 months. One hundred and fifty seven pages of text were transcribed and analyzed. Pseudonyms were used to protect the identity of respondents. The table below lists the respondents and their roles.

Respondents and their roles

Case 1	College website
	Andy      Web Manager
	Ann      Communications Manager
Case 2	Department website
	Bill      Director of Computing services
	Ben      Associate Program Director
	Bea      Student Intern (for Ben)
	Beth      Outreach Coordinator
Case 3	Group that was promoting and evaluating accessibility
	Debbie      Web Accessibility Specialist
	Devin      Technology Accessibility Specialist
	Denny      Access Technology Consultant
Case 4	An individual promoting and evaluating accessibility
	Dave      Senior Webmaster

Table 2. Respondents and their roles.

The contents of the sites in the first two cases was roughly parallel. Both included information for current, prospective and past students and also included information for faculty and staff. The key difference between the two sites was that there was a significant amount of content that was in the substantive area covered by the department. The third and fourth cases

were not included in this table as the websites associated with these cases were not analyzed in detail.

Website contents and targeted users of the college and department websites

Case 1 & 2	Information for current, prospective and past students
	Information for faculty and staff
Case 2	Materials to create K-14 curriculum relating to the academic areas covered by this department

Table 3. Website contents and targeted users of the college and department websites.

*Analytic strategy*

An analytic framework was devised to draw connections between the research questions and the methods, results, discussion and conclusions of this project. Cultural historical activity theory provides a framework for linking the activities of individuals and groups to broader cultural patterns (Engeström, 2005). Activity theory “ties insights into larger wholes to provide a clarifying framework for the bigger picture” (Kaptelinin & Nardi, 2006). The activities of planning and building websites were framed in this dissertation with the following assumptions derived from activity theory:

1. Activity is mediated by:
  - a. Tools which both afford and constrain practice.
  - b. The means and conditions, and the political-social negotiation of motives among actors.
2. Tools are a product of collective activity; they embody components of the culture of those who design and create them.
3. Contradictions are structural tensions that can occur among or within activity systems.

Here in the methods section the theoretical assumptions are tied back to the core question of research: How is accessibility understood and accounted for (question 1) through the lens of activity theory (question 2) with specific focus on authoring tools (question 3)? In the analysis section these assumptions were tied to the results, discussion and conclusion.

<b>Theoretical Assumptions</b>	<b>How theoretical assumptions influenced methods</b>
Cultural tools are the <i>products</i> of social/political negotiation	The authoring tools used to produce websites as well as the products, the websites and PDF documents themselves, are cultural tools. Contextual interviews explored the competing needs and motives for the respective website redesign projects and ongoing site maintenance work. Contextual interviews focused on how work was prioritized in general and specifically how accessibility was or was not addressed in the sites being produced.
Cultural tools both afford and constrain practice	Observations were made during the contextual interviews with specific focus on how accessibility related features within authoring tools afforded/constrained the accessibility of the sites being produced.
How tools are used is affected by subjects' motivations, and a variety of social/contextual factors (e.g., policy, community/institution values, division of labor)	Contextual interviews explored the roles, motives, and social context of respondents with specific focus on awareness, technical understanding, and perceived value of accessibility.
Contradictions emerge as structural tensions within or among activity systems	Contextual interviews explored the collaborative activities of planning and maintaining websites with a sensitivity toward identifying structural tensions within and among the activity systems. Interviews were conducted with individuals and groups specifically addressing web accessibility at the university to explore possible contrasts between those specifically focused on accessibility and groups which were not.

Table 4. Analytic framework: Methods.

The following table is progressively filled out in the respective sections with an approach similar to Engeström's in his article proposing expansive learning theory (Engeström, 2005). Connections to theoretical assumption influences are described, as above, then summarized for comparison.

Analytic framework: Summary table of methods

<b>Theoretical Assumptions</b>	<b>Methods</b>	<b>Results</b>	<b>Discussion</b>	<b>Conclusion</b>
Cultural tools are the <i>products</i> of social/political negotiation	How is work, specifically consideration for accessibility, prioritized?			
Cultural tools both afford and constrain practice	How do authoring tools help and hinder addressing accessibility?			
How tools are used is affected by subjects' motivations, and a variety of social/contextual factors (e.g., policy, community/institution values, division of labor)	How do social and contextual factors affect how tools are used, specifically in relation to accessibility considerations?			
Contradictions emerge as structural tensions within or among activity systems	What contradictions exist that specifically relate to accessibility?			

Table 5. Analytic framework: Summary table of methods.

## Results

The accessibility issues found in the websites in this project were consistent with the issues documented in literature as being typical. The aim of this project was explore how and why sites are evolving with poor accessibility. As the research questions suggest, it was expected that limited awareness of the concept of accessibility and guidelines would be conditions that would influence the consideration for accessibility as sites were maintained and designed.

### *Case 1: Planning and maintaining a college website*

The core of the first activity system consisted of a two-person team sharing an office within a college with approximately 100 faculty members. Ann, the communications manager for the college, described her role as primarily writing feature articles, with the college's website being one location where these communications were distributed. Andy, the Web Manager for the college, described his role as developing and maintaining the college's website, which supports all areas and programs.

The college was comprised of several departments and was in process of reorganizing its faculty, staff, and programs to shift the focus from academic areas to programs. In the new organizational structure there were five Associate Deans who were going to be assuming responsibility for the contents of the college's website. Andy described decision making within the college as fairly decentralized, with the dean having ultimate authority.

Both Ann and Andy commented that resources constrained their work. Ann stated that the change in the economy a few years back resulted in job cuts leaving them with only two people to cover a heavy workload. Andy similarly described his job as very busy balancing the maintenance of their current site with his primary activity, which he described as designing a new site to replace the old one.

Key actors and activities contributing to the college website

Maintaining the current site	Andy & Ann	Andy posted all content to the current site for the college using Dreamweaver. Ann provided a significant portion of the content updates to Andy.
Planning the future site	Andy & Ann	Andy and Ann were planning the future site under the direction of the Dean of the college. They obtained advice, job aides and design services from others in the university including the communications department and others with similar roles to their own. Plans included shifting from Dreamweaver to a CMS, Drupal, to distribute the work of maintaining content to other in the department.

Table 6. Key actors and activities contributing to the college website.

*Maintaining the current website*

Andy and Ann were collectively engaged maintaining the current website. Components of this collective activity are illustrated in the following workflow diagram.

### Flow Diagram for Andy and Ann

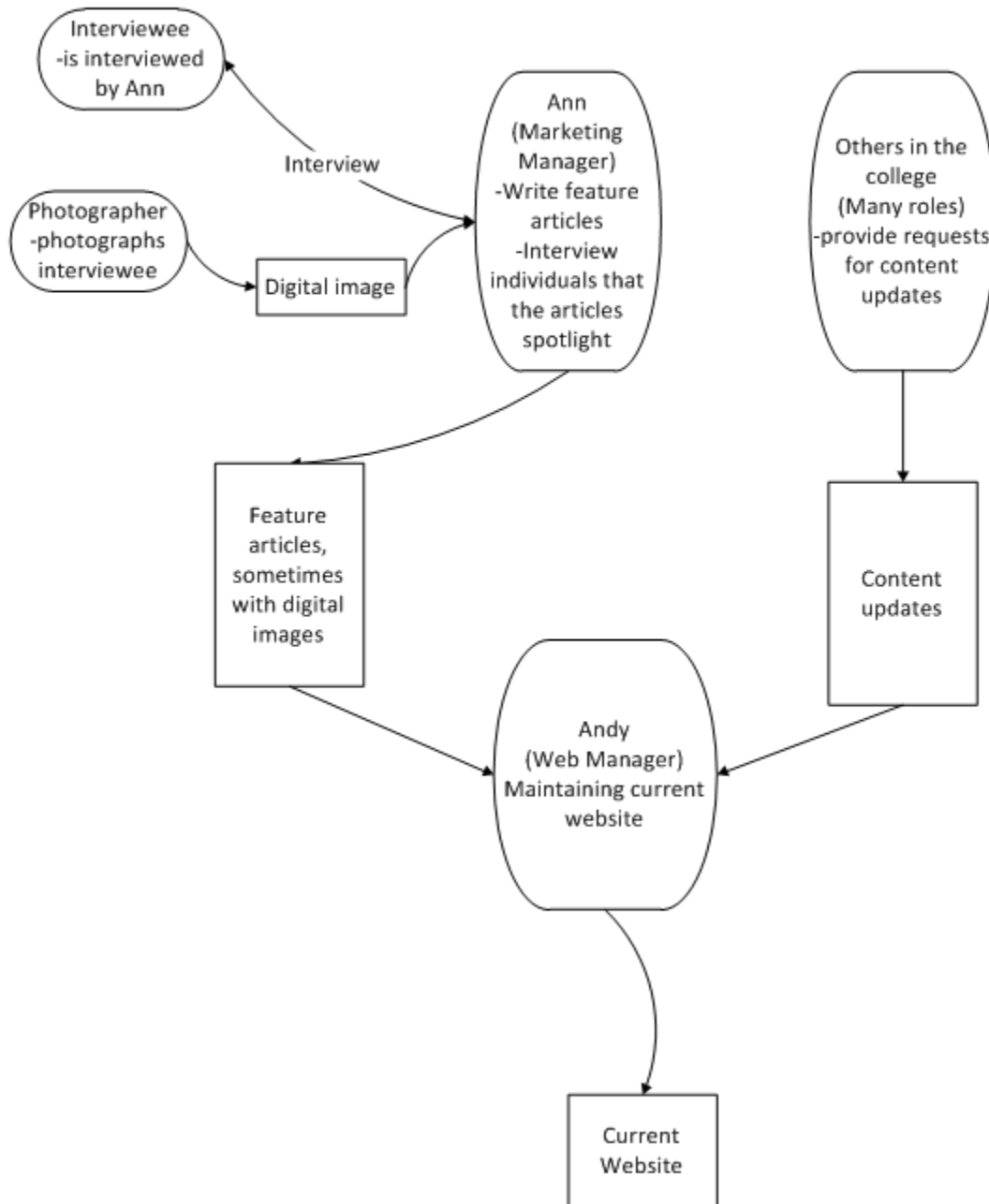


Figure 5. Flow diagram for Andy and Ann.

Andy built and maintained the current website over the past 4 to 5 years he had been with the college. The current website was built in Dreamweaver and contained content targeting several different types of users including prospective, current, and past students, as well as the community. Contents for prospective students included marketing material as well as information about the application process and deadlines. Contents for current students included course information, degree completion steps and additional student services. Contents for alumni included opportunities for social networking, newsletter subscriptions and opportunities for giving. The website also contained information about research centers and activities within the college and included feature articles highlighting activities and achievements of alumni.

Ann shared that the purpose of the feature articles she wrote was to inform students, faculty and staff on a variety of topics including faculty and alumni profiles, faculty research, and grants and funding for the college. Her work involved conducting interviews and gathering content to inform her writing, which is done in MS Word, and then emailing her finished articles to Andy, the Web Manager. Ann did not post any content herself in the current website.

Andy posted all content to the college's current website for all of the areas and departments. Andy created new pages within the Dreamweaver site for the articles and images that Ann emailed. In addition to content from Ann, Andy also updated existing web content based on requests that came in from many other people from around the college.

*How accessibility is accounted for while maintaining the current site*

Ann and Andy were found to have differing perspectives regarding the concept of accessibility. Details of how they understand accessibility are described to clarify how this understanding mediates their work activities. Ann stated that she didn't know much about accessibility and wanted to be informed when we had our meeting. This motivated her to do some research between when we scheduled our interview and when I actually interviewed her. This research resulted in awareness that accessibility of technology relates to individuals with disabilities and access to websites; however, when asked about how alternative text for images was managed on their website, Ann appeared slightly uncomfortable and began talking about technical limits of captioning in their current system. I clarified the purpose of alternative text and Ann replied, "So we don't have that, I don't believe." This response provided further evidence that Ann had a low level of awareness of web accessibility in addition to her initial comments to me on the topic.

Andy evidenced more awareness of web accessibility than Ann as he was able to describe how his awareness influenced his work. The initial contextual interview with Andy made it clear that he was aware of why and how to include alternative text for images. Andy commented, "We certainly do alt text for every image. We haven't codified how we do it. I do it as much with an eye toward SEO as I do toward accessibility. I just try, and I just write them on the fly because I'm doing all this stuff myself so I will just come up with the alt text and I try and balance between just getting key words and have something legible, that would make sense. . .

I have to say that like for a lot of people in my situation, and you're constantly triaging, and accessibility is definitely something that is a bit far down on the triage ladder for me. I'll trust that, it's like a lot of things, I trust that initial decisions are good and that I'll keep making decisions to make things legible. But I just don't even have time to do what I have to do anyway. Maybe that's something you are studying, like where people make the cut. I try to make sure it's functional but I'm almost certain our sites are not optimized for accessibility but hopefully they're usable.”

Andy indicated that time constraints, the low position on the “trriage ladder,” and SEO are conditions that influence and challenge how accessibility is factored into Andy’s work. Andy is aware of the importance of accessibility at the university level, as evidenced by the following comment: “Well you know there's really kind of a big push for accessibility at the University. There's a couple of people that are really big in disability. Dave, I think is the major one. At every web council he's bringing it up. Anytime somebody has a site they're planning he's sitting there going through it. He's big on that. It's something that at least, it's a little more than lip service at the university. There are people who take it very seriously. I think it <accessibility issues within the university’s websites> has gone down a little bit according to the statistics with just him being there at the web council just talking about it has made me more cognizant of it.” Andy’s comments evidence tension between the importance of accessibility to Dave and the degree to which Andy considers and addresses accessibility in his work. Interviews were

conducted with Dave and his activities are described below along with the others in the third activity system promoting accessibility.

Andy and Ann worked together to maintain the college's website with the goal of providing information for the college's prospective students, current students, faculty, and staff. Evidence within their collective activity pointed to Ann's lack of awareness and Andy's lack of giving priority to web accessibility as conditions which might challenge the site's accessibility. However, from interviewing and observing Andy and Ann's work, it was not possible to clearly see how these potential challenges to accessibility influenced the website they were working on.

#### *Accessibility evaluation of the current site*

As there were no activities within this system to validate the accessibility of the site, it was necessary to evaluate the site to understand the effects of what Andy and Ann said was and wasn't being done on the website relating to accessibility. Several issues were identified through this process. The logo for the college did have alternative text to describe the image; however, an abbreviation is used which did not communicate the same information that the graphical logo communicated. The graphical logo had embedded text that was abbreviated unclearly in the alternative text. Several other images on the page were labeled with the same unclear abbreviation for the name of the college followed by a more descriptive word. The result was that it was not clear what any of these images were illustrating. This would block access to the meaning and purpose of these images from individuals using screen readers.

Examining a feature article which was written and posted during the period of time that the interviews were conducted within this system found that alternative text was missing on the associated picture.

A barrier on the home page was found in a form for prospective students to request information about the college through email. A text input field was found without the proper connection to the submit button. The input field was labeled, so it was clear that the field was for an email address, however, there was not a clear means to submit the email address after typing it in the field. This barrier would prevent a user from using this form through a screen reader to request information about the college.

Headings were used within the content of the home page; however, the evaluator found elements that should have been assigned headings but were not. The elements that were labeled were not well organized. Elements were identified at the heading-1 level and heading-5 level with no elements identified at any other levels. This would result in difficulty in scanning for information which should have been under a heading. It would also be confusing to find information with only levels 1 and 5 in the hierarchy. It would roughly be like reading an academic paper where only level 1 and 5 heading were used to structure the paper. This misuse of headings would not block access, but would make it more difficult to scan through the contents of the page.

When moving up and down through the homepage content the user noticed that some of the text was changing. At first this was confusing, but then he realized that it was likely a

slide show with rotating content. The key issue here was that unless he moved back up, he would not have noticed that he was missing content. When accessing the website visually, it is clear that the content is rotating. This barrier would block access of some content to individuals using screen readers to access the page.

Overall, several issues impeded or blocked access to the content on the homepage and blocked navigation from the homepage to deeper pages within the site. This evaluation provided evidence that the lack of priority given to accessibility potentially resulted in a website with accessibility issues that blocked and impeded access for people using screen readers. The needs and motives driving the site maintenance activity did not include building a site accessible to end users with a wide range of means and conditions.

## Accessibility of the college site

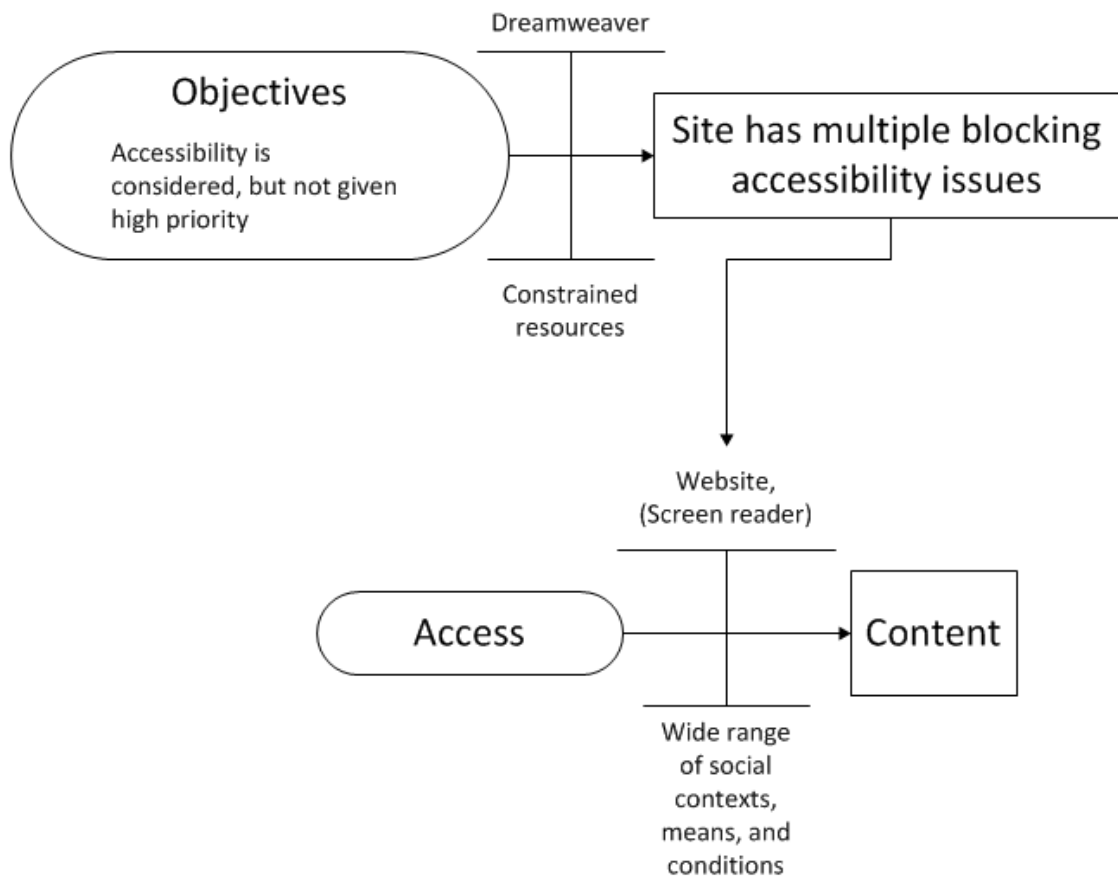


Figure 6. Accessibility of the college site.

### *Planning the future site*

While Andy was responsible for posting updates to the current site, his primary focus was on the college’s website redesign project. Andy reported two factors that triggered the

redesign. The first factor was the reorganization of the college, as the current site was soon to be out of sync with the organizational structure of the college. The second factor was that the current site was built and maintained in Dreamweaver, an application that facilitates web design and development, but does not facilitate workflows to distribute content management among multiple individuals. These factors led to the decision to redesign the site using a content management system (CMS).

Andy described three general imperatives which were developed to guide the redesign effort. In terms of activity theory these imperative were the objectives of the redesign activity. The first imperative was to ensure the design was in line with university branding guidelines. The second was to define and focus on the needs of the biggest user groups. The third was to realign the content to map to the new organizational structure. These imperatives were not top-down mandates, but rather evolved out of a meeting he had with Ann and the Dean of the college. Andy also stated that he was given a high degree of freedom in how he went about meeting these imperatives.

Among the three imperatives Andy reported that he was initially “most apprehensive” about the design aspects of the project which included following brand guidelines. Andy and Ann had been meeting with designers in the creative communications department at the university to address this area. The creative communications department provided Andy with PDF files to illustrate designs they had used Photoshop to create. Andy used these PDFs to

inform the design of the new site. While Andy was initially apprehensive about the design aspect of the site, as the project progressed he found that this “has been the easiest part”.

While the first imperative regarding branding guidelines influenced the visual design plans for the site, the second two imperatives influenced plans for the information architecture of the site. Andy described that over time he has seen the focus of college and departmental websites changing. Andy described the biggest user groups as increasingly being current and prospective students, which resulted in making content for these groups more prominent in the architecture of the new designs.

The reorganization of the college also influenced the redesign plans. The current site navigation was patterned after the old organizational structure of 4 areas within the college. Andy was building the new site to reflect the new organizational structure of 3 large programs: undergraduate, graduate, and professional. Andy and Ann sketched information architecture concepts on the board during their process to focus the information on the needs of students while accounting for the new organizational structure. Andy and Ann had begun to take steps toward fleshing out how the three imperatives could evolve the new website.

Andy’s planning process had also begun to address a content strategy for the new site. The workflow for the current site was fairly simple and centralized, with Andy and Ann creating and posting all content. The new workflow required distributing parts of this work to individuals around the college, resulting in the need to plan how this would be done, who would be involved, and how they would be trained. The five associate deans of the college were

identified as “content supervisors.” These supervisors were in the process of identifying content experts who would ultimately be using the CMS to create and update content for the new site. Content would not be posted live to the website until reviewed by either Andy or Ann. The goal for this review step was to ensure consistent voice and tone throughout the site.

In addition to reviewing content before it is posted to the live site, Andy and Ann were considering a style guide and training for the content experts. The training would cover how to use the system as well as voice and tone considerations.

The following workflow diagram illustrates Andy’s description of how the future site would be maintained. This demonstrates the changes in which actors are responsible for posting content to the site. In the current system, only Andy posted content. The future plans were for this task to be distributed among several others around the college.

### Future flow of maintaining the college website

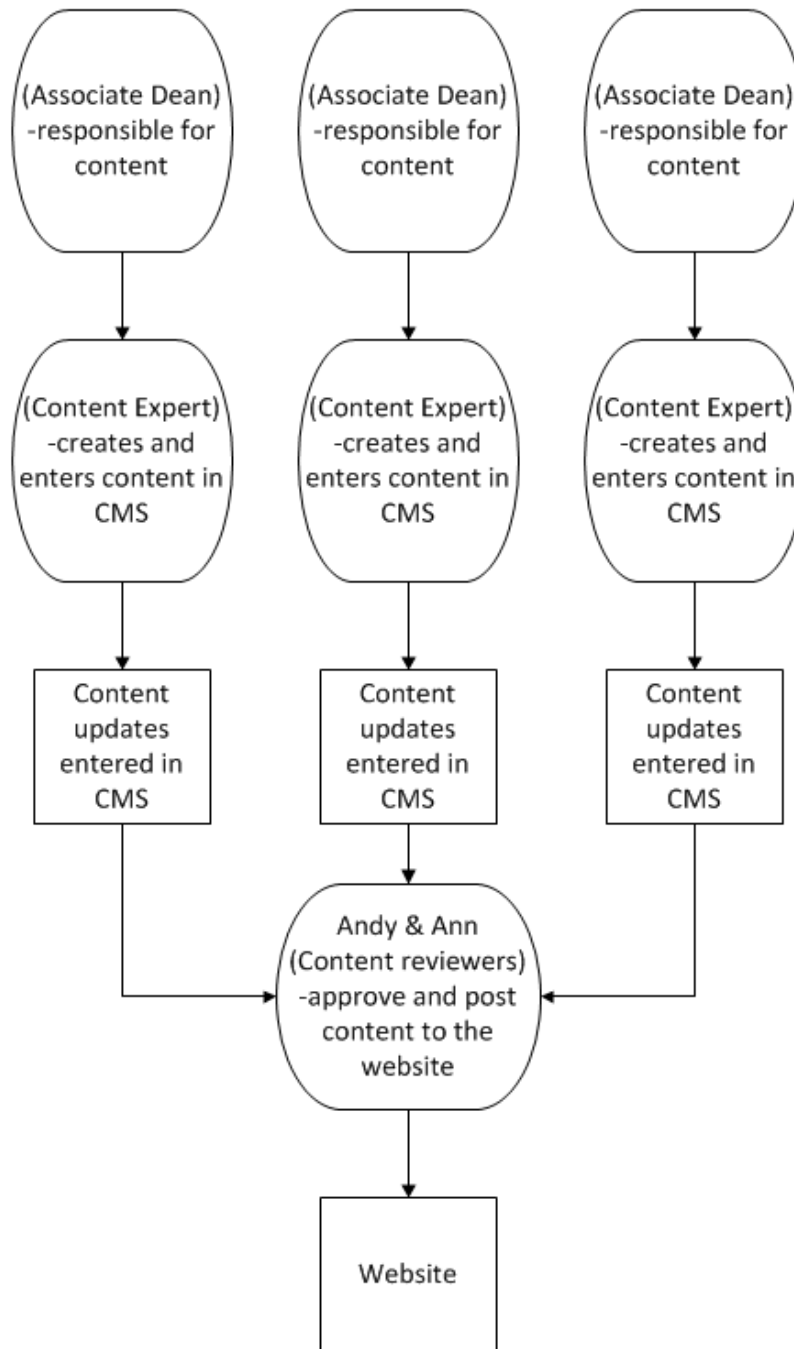


Figure 7. Future flow of maintaining the college website.

Andy was using Drupal to build template pages that could be used by the content experts. Templates would enable Andy to standardize some elements, such as logos, branding colors, and top-level navigation across the site. Templates would enable content managers (experts) to add and edit contents. Templates also dictate or encourage the use of specified text styles and formatting for body text and various levels of headings. The following screenshot was provided by Andy of the Drupal template he was working with. Identifying content has been blotted out. This screenshot illustrates the image properties dialog box which would be used to upload and tag images with formatting and alternative text.

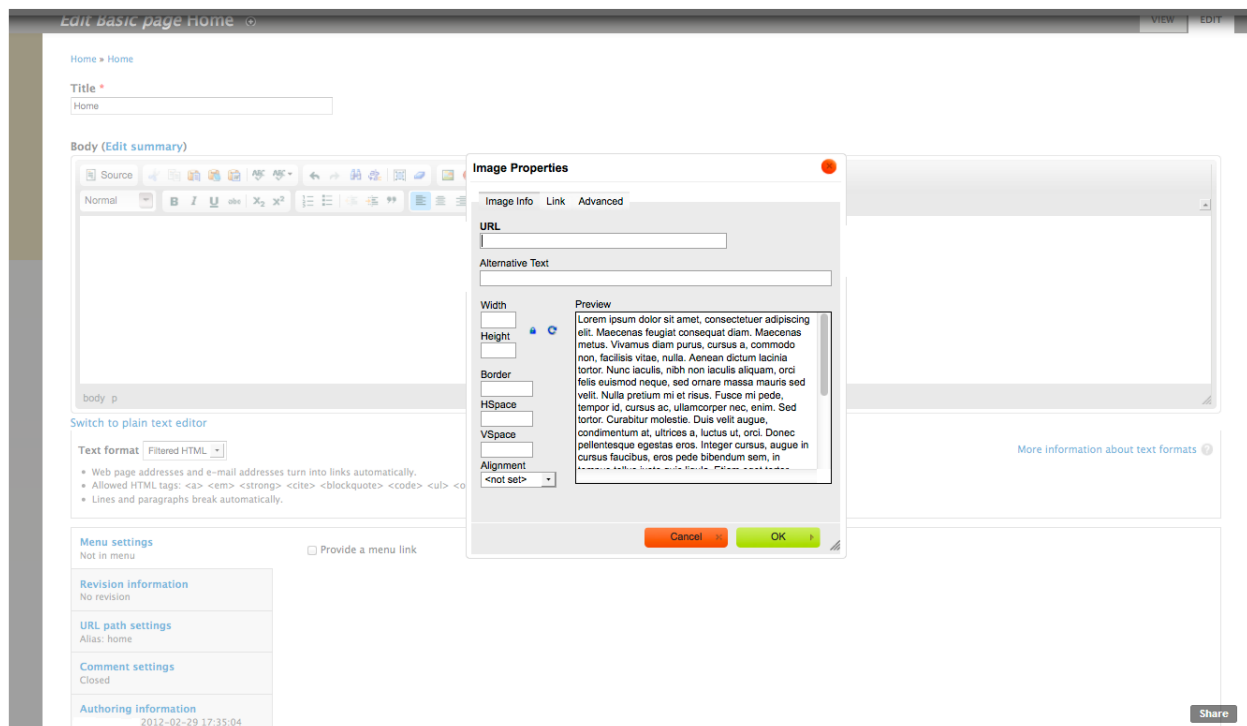


Figure 8. Drupal template Andy was using to build the new site.

More recently the concept of responsive design has been integrated into templates. Responsive designs scale across a variety of devices with screen sizes scaling from large desktop screens down to small phone screens. In addition to screen size, responsive designs are compatible with mouse and touch interfaces. Andy indicated that Drupal was selected as the CMS for the project in part because it is responsive and helps ensure that a site that may be primarily accessed from a desktop system will also work well on phones.

Andy reached out to colleagues with similar roles in other departments to learn from redesign projects that they had completed. Andy obtained a color-coded timeline illustrating milestones in the redesign process which he and Ann use every day in reference to their project. Andy said that this has saved him and Ann a lot of time already. Andy commented that the university should facilitate more networking among people in web development roles as there is not a strong top-down influence; the university tends to be decentralized with regards to how information technologies are planned and built.

## Planning the college site

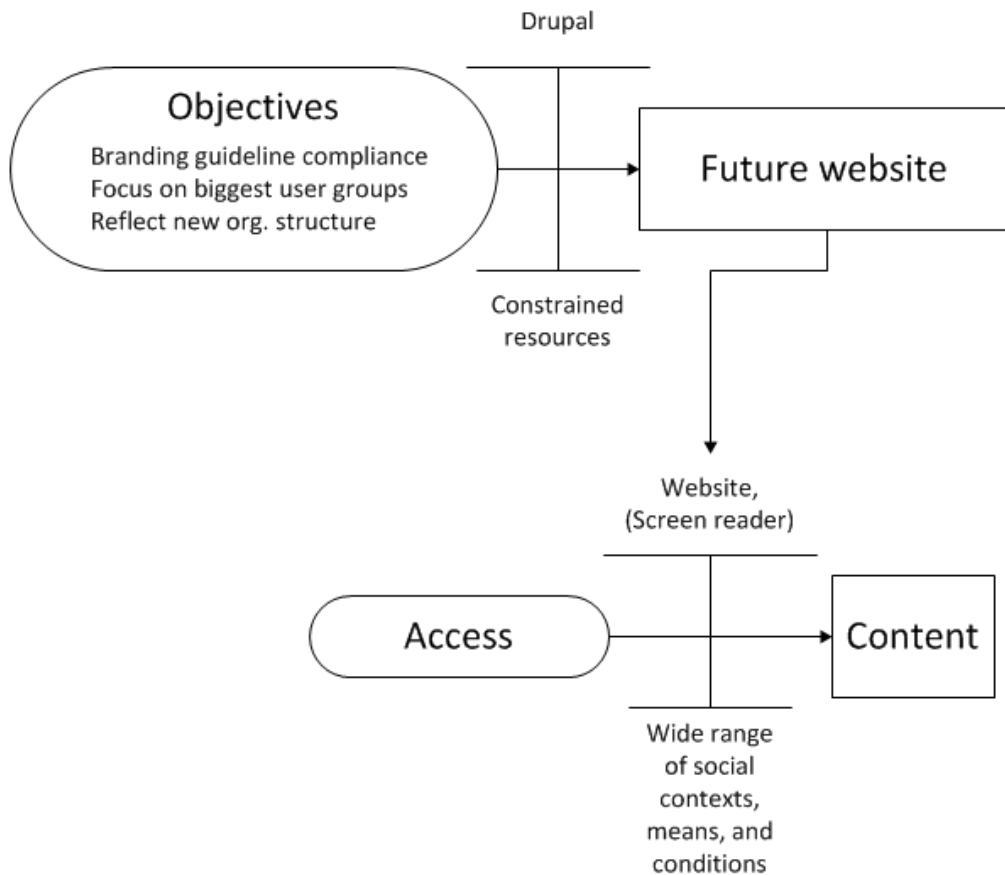


Figure 9. Planning the college site.

### *Accessibility of the future site*

As the future site was in the early stage of design during the interviews it was not possible to clearly assess how accessibility would be addressed; however, from interviews and

observations it was possible to explore how some elements relating to accessibility were being factored into the design plans.

The following data illustrates how Andy expects accessibility to be built into the templates within the CMS he has chosen. Andy mentioned the technique of adding “skip navigation” links which he referred to as “skip links”. Skip navigation is a link at the top of each page in a site that targets the main content area of the page to make it quicker and easier for someone using a screen reader to skip over the navigation elements that are typically at the top of a webpage. Andy spontaneously brought up this technique during our interview and was curious to verify if it was actually in the template he was using. During his discussion of skip links Andy stated, "They have, from what I understand, pretty strong accessibility built in. I trust the systems I decide to deploy are systems that are pretested for that <accessibility>." After opening the template he was using and finding the link he commented, "I don't have to pay attention to that <skip links>. See, I know it's there."

Andy also shared a dialog box within the CMS that would specifically determine the accessibility of images. This dialog box would be used by the content experts and would appear right after an image had been selected and uploaded. When sharing this screen Andy commented, “<There> probably is a way that it would be mandated that somebody fills in alt text before they can actually complete this task. I haven’t investigated it as something I could do.” Andy indicated that he planned to include information in a training manual on how to use

this dialog box that would include information on alternative text. He didn't have any further details or a draft yet for this manual.

### *Contradictions within the college system*

There was evidence of two significant contradictions within the collective activity of maintaining the college site. The first contradiction was between the new and old organizational structures of the college. The second was the contradiction between the heavy workload and the capacity for getting the work done, particularly for Andy. Constrained resources motivated the objective for distributing the work of posting content among others in the college. The change in organizational structure motivated the objective to update the website to better reflect this change.

Accessibility issues were identified in the site; however, there was no evidence that they were creating tension within the system that would result in prioritizing or improving accessibility. The misalignment between Andy's stated approach to writing alternative text and the actual alternative text he had posted provides an example of this absence of tension. Andy stated that he hoped alternative text would serve two purposes. He hoped that it would be legible and help SEO. While it is generally possible to achieve both of these goals with good alternative text, the evaluation of the current site found that this goal was not met because of missing alternative text as well as text that was abbreviated in a way that would not provide meaning to either a search engine or an individual using a screen reader. Accessibility was being

considered to some degree as the new site was being developed. However, there was no evidence of it becoming more of a priority in the new site than in the current site.

*Case 2: Planning and maintaining a department website*

The second activity system explored in this project was in a department with approximately 60 faculty members within a large college. This department had a small number of staff at the departmental level including Bill, the director of computing services. Most of the staff in this department were distributed into one of 12 academic areas. Each of the 12 academic areas had a staff position with a job title of associate program director or similar. Part of the responsibility of each of these staff members was to maintain the contents of the academic area's website. Student interns were also found to be playing a role in the department's website under the direction of the associate program directors. Contextual interviews were conducted with four respondents from this department.

Bill – Director of computing services

Ben – Associate program director

Bea – Student intern (working for Ben)

Beth – Outreach coordinator (Parallel to Ben's role, but in a different academic area)

The department's website contained information for current and prospective students as well as newsletters and materials targeting users outside the university. The information for students included admissions and academic advising procedures. The newsletters and

additional materials were designed by most of the 12 academic areas within the department to support k-14 curriculum development in their respective substantive areas.

As the sole person in the department with a role relating specifically to technology, developing the website was a part of Bill's job, but not his primary focus. In his own words, "I'm a computer guy. I'm not a web designer. I'm not a web developer. I'm none of that. I'm a systems administrator. . . I'm good at HTML. I'm a good programmer and all of that stuff, but I'm not a designer, and so this means that any time I try to come up with a content design it's just going to suck and so I want somebody else to do that." Part of Bill's role was to build and maintain the department's CMS driven website. Bill's desk was in a shared office in the wing with other department level staff.

Ben and Beth were staff at the associate director level and represented two of the 12 academic areas within the department. In relation to the website, they were responsible for the creating the newsletters and materials on their areas websites and for the distribution of these contents. They had their own offices in a small wing that also had a shared reception area with two desks. Ben and Beth each had student interns who used the desks in this shared space. Bea was a student intern working for Ben. Her role relating to the website was primarily to post new content on the site given to her by Ben.

In addition to being the associate director of his area, Ben was the chair of a committee aiming to improve the department's online presence and visibility. That was motivated by the fact that the department was partially funded through grants which required that the materials

produced in several of the academic areas be made available nationally. Ben didn't see the current website as an effective tool in meeting this need to distribute materials. Ben believed that they should be leveraging social media tools and incorporating dynamic content and that the current site didn't support these functions.

Decisions about the design of the department's website didn't appear to be as strongly influenced by the university or college as they were by the department. Here is how Bill described this balance of power: "Well the university itself has a branding guideline. In theory they require all of the departments to follow that guideline. In practice they don't because it's impossible. It's herding cats. You can't do it. And the theory is they have a branding guide with the different color pallets you're supposed to use and the elements that are supposed to appear things like that." Bill described the influence of the college on his specific department as "pretty wide in terms of influence over our websites. They basically don't have any, effectively, and then the university is sort of on top of that and they even have less."

Key actors and activities contributing to the department website

Maintaining the current site	Bill	Bill was responsible for the administration of the CMS which was used by the department to build and maintain the current website.
	Ben & Bea	Ben wrote and posted newsletters to the section of the site for his academic area with the assistance of Bea, his student intern. They used Bill's CMS accomplish these tasks.
	Beth	Beth wrote a newsletter for her academic area. She saved this in PDF format and gave it to her student intern to post to her academic area's section of the site.
Planning the future site	Ben & Beth	As the chair of a committee focused online presence and visibility Ben identified limits within the existing site that challenged the outreach goals of this committee. Ben saw an opportunity for improving the department's site to better achieve its outreach goals in a separate website that Beth had recently launched. They believed that social media and dynamic content should be leveraged in the site they were planning.
	Bill	Bill was in the early stage of exploring how features Ben was promoting could be implemented.

Table 7. Key actors and activities contributing to the department website.

*Maintaining the current website*

Collectively Bill, Beth, Ben, Bea, additional associate program directors and additional student interns maintained the department's website. The workflow diagram from the Contextual Design method is used to illustrate individual actors and the flow of artifacts through this activity system. Bill had created the CMS which was used by the department's academic areas to store their content. Ben and Bea used the CMS directly as they maintained the website. Text and images were posted and edited within the CMS. Beth was responsible for her respective area of the site; however, she did not use the CMS herself. She assigned the task to her intern. The newsletter in Beth's area was not posted as text and images through the CMS. It was uploaded as a single PDF file. The CMS was used to create an image link on the site that targeted this PDF.

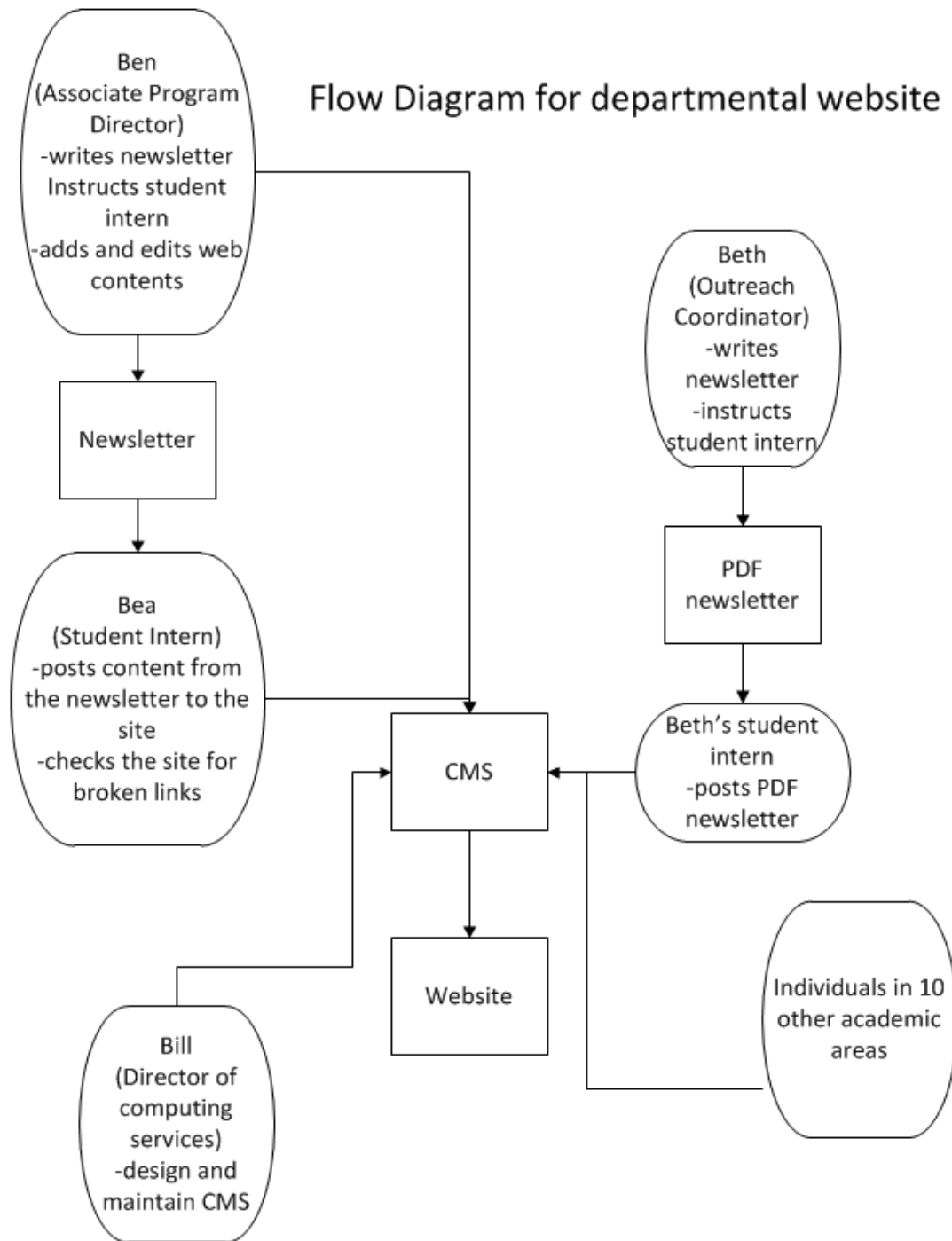


Figure 10. Flow diagram for departmental website.

Bill had considered using a commercially available CMS when he developed the current site 6 years ago. However, he chose to build his own system by combining components into a home-grown system. He described his reason for this decision for a home-grown system was the complex nature of access permissions and the variety of templates that were necessary to support the individual groups within the department. Each group may have several users and be using different templates with customized colors and styles. Bill commented that CMSs also force the use of a database to contain the data. His current system simply stores text files in directories which he states is “easier from an administrative point of view”.

When asked if there was semantic markup in the site Bill replied: “Very little. Like I said this was not designed with that in mind but it was made at least so it's not completely broke. And the truth is we just don't have the resources for that. We don't have a web designer. We don't have the money for that right now. That's all we can do.”

From these comments from Bill it is evident that the bar for quality in general is questionable. Lacking funding for a web designer resulted in compromises in what could be addressed and how much effort could be put into the website. The following segments also point to lack of attention to the website from Bill's perspective.

Kyle: “I've seen the user view of the image upload form where you add content. Have you been working on that?”

Bill: “Not even a little bit. That's way down the road. That's mostly because when I first built it it was one of those things...oh this is temporary until I can figure out how to do it right

and nothing is permanent as temporary things go it's still there. I still hope to get it fixed.”

Note that Bill had mentioned that the site was originally set up 6 years earlier and had been functioning during that time in the “temporary” state. These comments from Bill reinforced that the website was not his primary focus. His approach was to bring it to a minimally viable level and then move on to higher priorities.

Ben was currently maintaining this content through the CMS that Bill had developed. Ben expressed concern over the limitations that he saw within this CMS, as it restricted him from editing parts of the site that he wanted more control over. Ben had been in his current role for the past 10 years and estimates that he has written and posted over half of the content that is on the site in his academic area. While his role within the department did not require him to learn technical skills relating to web design, he had taken on learning HTML several years ago as a hobby.

Ben’s involvement in maintaining the site for his academic area consisted of adding and updating content and posting events to a calendar that was shared by all of the areas in the department. Ben found that emailing a newsletter was more effective than the website, based on tracking the open-rates on the email messages that are sent and comparing these to measurements he had taken of web traffic. Because of this, his primary focus is on generating content for the newsletter to be emailed. The same content from the newsletter is then posted to the website.

Ben shared how he uses the CMS to make updates to his area's site. The CMS is designed to restrict users from having too much control over styles and formatting; however, there is a tab that enables the HTML to be edited directly. Ben demonstrated how he is able to use this feature to have more control over the design of the main content area of the site with an example of using tables to position images and text. When he wanted to control the formatting Ben posted some content himself, and other content he gave to Bea, his student intern, to post to the site.

Bea shared how she takes the content that Ben gives to her and uses the CMS to make additions and updates to the site. While she had the same tools within the CMS to add and update pages, her use of the tool was different from Ben's. She did not have background or interest in web technology that Ben had as a hobby, nor did she use the feature within the CMS to view and edit the HTML directly. Instead, she showed me how she copied and pasted text from the newsletter and how she uploaded images to the site. She only used the parts of the CMS that were required for her to accomplish her task. She didn't explore optional features within the CMS. Together, Ben and Bea kept the site contents for their academic area up to date.

While Beth's role was parallel to Ben's role she didn't use the same approach in her area of the site. In contrast to Ben, Beth had her student intern use the CMS to maintain all content for her area. Beth reported that she did not use the CMS directly herself. Beth wrote a quarterly

newsletter which she saved as a PDF file. Her student intern posted this PDF to the main content area of the home page of her academic area.

Ben indicated that other staff in parallel roles to him and Beth had similar methods of maintaining their sites, either directly, or through student interns. Bill also indicated that this was the case. However, these other staff members and student interns were not directly observed or interviewed as respondents in this study.

## Maintaining the departmental site

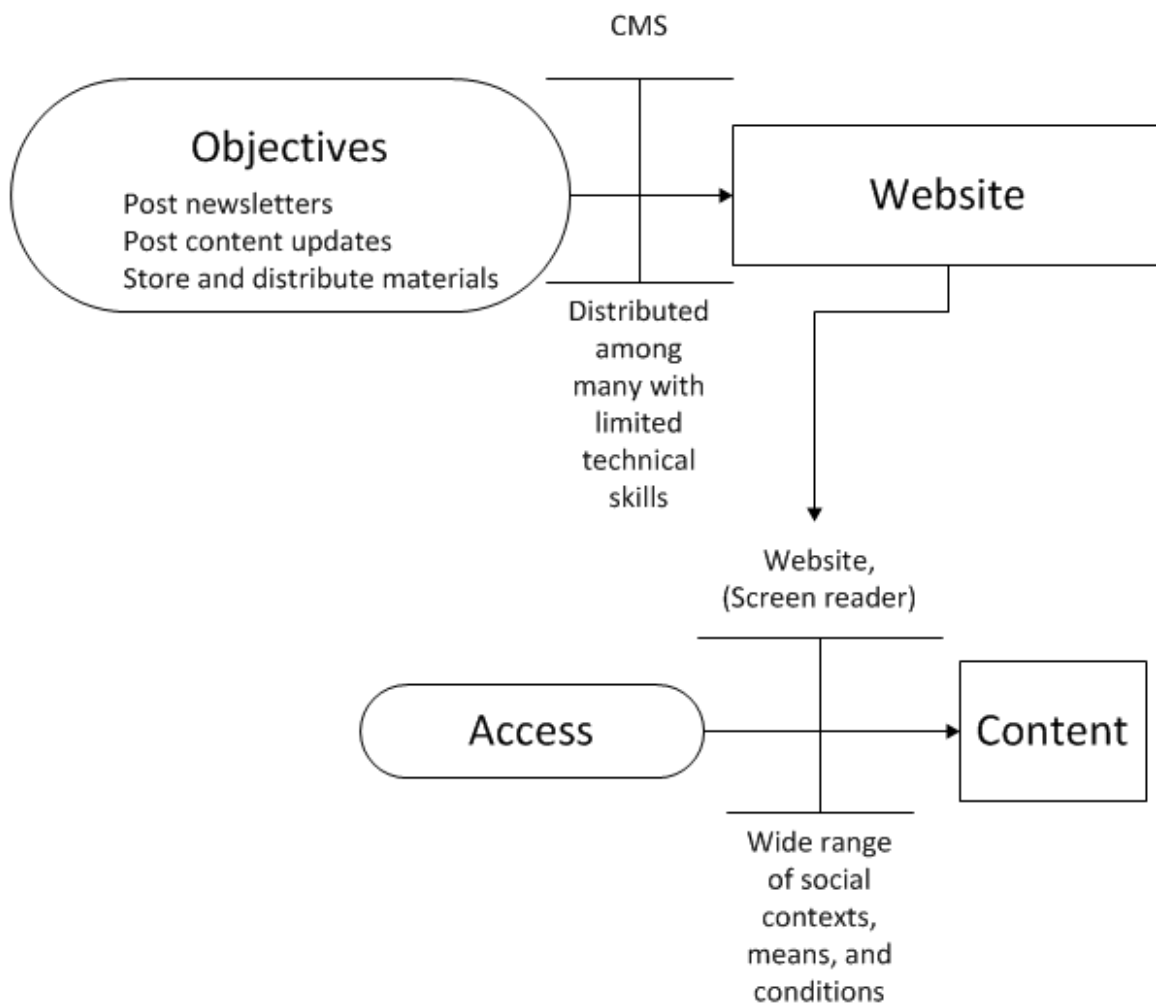


Figure 11. Maintaining the departmental site.

### *How accessibility is accounted for while maintaining the current site*

Each of the respondents in this activity system had a sense of the meaning of accessibility and all, except for Bea the student intern, had prior awareness of how this concept might apply to information technology. Bea was aware of the concept of accessibility in general,

but had never thought of how it might apply to the internet. Beth had recently been introduced to the topic of web accessibility but had not taken any action to apply what she had learned. Ben recalled learning about accessibility several years ago and remembers addressing some issues within his area of the website at that time. From his comments on how he addressed some accessibility issues when he first joined the department Bill had a deeper knowledge of the concept of web accessibility than the others. However, accessibility had not been given an ongoing priority in his work.

Regarding accessibility awareness, Ben stated, “In terms of accessibility, several years ago I think that somewhere on the <university> website there’s kind of a guide to accessibility and I read through it and I tried to implement most of the things that they said help, like the descriptions on photos and options for changing the font size and making sure that things like text are actually text and not images, you know, stuff like that, so it’s pretty basic stuff. Not much beyond that. . . and that will be an interesting thing if I do manage to implement this new site because I don’t know how to do any kind of those things.” Ben had not come across any further information on the topic of accessibility since that time.

Ben shared the example of using tables to position text and images when showing me how he used the feature within the CMS to directly edit the HTML. From this, it was clear that Ben was not aware that using tables for this purpose is not the current HTML standard (tables are now recommended only for tabular data, not for positioning). Using tables in this way degrades accessibility. Ben had some awareness of accessibility of information technology,

however, his knowledge and technical skills in this area were outdated and limited. He had awareness of the fact that he was limited in this area evidenced by his comment “I don’t know how to do any kind of those things.”

In addition to limited detailed awareness of what web accessibility is and how to address it, Ben also made a comment indicating that accessibility was not a high enough priority within his department to be considered. “I really think that accessibility is one that would have to be injected by someone. I don’t think it would be one of the first things to be considered.” This comment suggests that Ben does not believe that the objective to address web accessibility would likely be prioritized. Overall, he and Bea had limited awareness of what accessibility means as it applies to the web and limited knowledge of how their work could address accessibility.

Beth, who worked in another academic area within the department in a role parallel to Ben’s, had been recently introduced to the concept of accessibility as it applies to information technologies by a web designer from outside the university. In addition to her role in the university, Beth was the director of a non-profit organization and had contracted this web designer to build a Wordpress site for the non-profit. Now that the site was completed, Beth was responsible for maintaining and updating it. The designer had conversations with Beth which included instructions on how to maintain the site. These conversations referenced accessibility. Beth didn’t recall being introduced to web accessibility before she the designer brought it up. Beth stated, “I really didn’t know about creating photo descriptions and things

like that so that I think is for people who are visually impaired so that they can read the description of what the photo is of and is on my to-do list.”

Beth mentioned that the designer of her site also gave her a 5-page “cheat sheet” with tips on how to maintain and update the site which she thought mentioned something about accessibility. Beth looked through her email to locate and look through this job aid. As she started looking through the document for the accessibility reference she commented “Let’s see what she said, SEO?” I replied, “okay, that’s Search Engine Optimization. Beth said, “No, no, it wasn’t that.” She then read the sentences that touched on accessibility. “After uploading enter an alternate title for each image. This provides text for disabled viewers and is good for SEO searches, etc.”

From this exchange I gathered that Beth was not aware of what SEO meant, but as it was in the sentence with information about accessibility, she thought it had something to do with accessibility. She did understand what creating alternative text meant and told me that this was something she planned to add to a list of things to do on the site in the future.

Bea had awareness of the general concept of accessibility in, however, she had not considered accessibility in relation to websites or information technology. When asked accessibility was a term she had heard of, Bea replied, “I have, but to be honest I haven’t thought about it much. . . You know that’s the part I hadn’t really thought about. That’s what I meant. I’ve thought about accessibility in general but I’ve never thought about accessibility on the internet.”

Bea had not considered the accessibility of information technology, yet her role had a direct effect on the accessibility of the content of the information posted to the department's website. While walking me through the process of posting content from the newsletter to the website Bea showed me the screen where she uploaded images. I observed that she skipped the alternative text field so I asked her if this was something she was familiar with or used. She replied that she did not know what it was and didn't fill out the optional fields in the form she was showing me. She motioned to the screen, indicating the area where alternative text was listed with a group of options that she didn't understand or use. Bea didn't have previous exposure to the concept of accessibility of information technology, and the CMS she was using didn't require or encourage her to enter alternative text. Because of these factors she skipped over the field to enter alternative text, which resulted in missing alternative text on the website. The Human-Artifact Model is used to detail the specific what, how and why aspects of the interaction of Bea as the end user with the image properties dialog box which is sketched below.

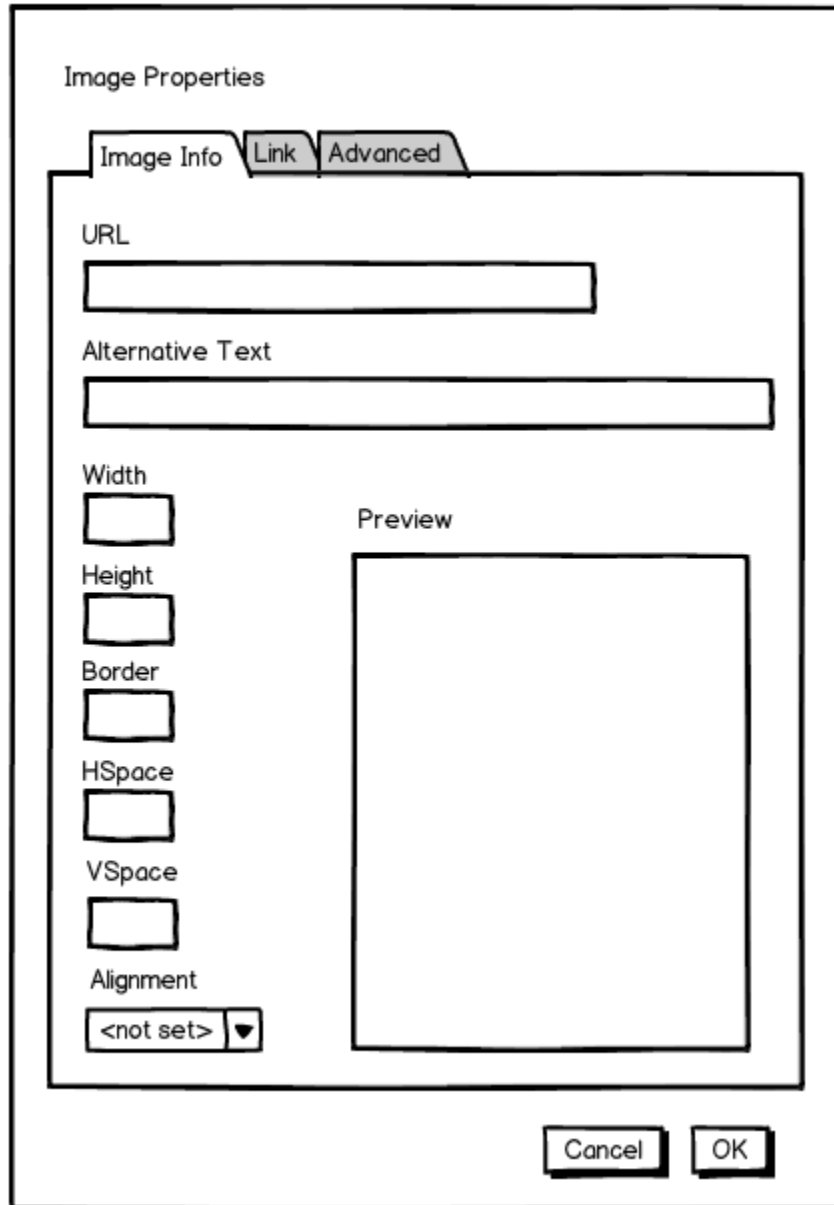


Figure 12. Sketch of Bea's "Image Properties" dialog box.

The Human Artifact Model: Bea’s use of “Image Properties”

	Artifact	Human (Bea)
Why?	<ul style="list-style-type: none"> <li>• Enable images to be placed with optional attributes defined</li> </ul>	<ul style="list-style-type: none"> <li>• Using images to visually and pleasantly communicate information to the end user</li> </ul>
What?	<ul style="list-style-type: none"> <li>• Accepting user input to place an image on a webpage</li> </ul>	<ul style="list-style-type: none"> <li>• Uploading an image</li> <li>• Verifying that the correct image has been selected (facilitated by the preview)</li> <li>• Verifying that the image displays properly on the page which is being worked on</li> </ul>
How? (operational aspects)	<ul style="list-style-type: none"> <li>• Accepting input for the following functions                             <ul style="list-style-type: none"> <li>○ Locating the images by URL</li> <li>○ Alternative Text                                     <ul style="list-style-type: none"> <li>▪ (Potentially a mandatory field)</li> </ul> </li> <li>○ Width</li> <li>○ Height</li> <li>○ Border</li> <li>○ HSpace</li> <li>○ VSpace</li> <li>○ Alignment</li> <li>○ Link (tab to make the image a link)</li> <li>○ Advanced (more options)</li> </ul> </li> <li>• Providing an image preview</li> </ul>	<ul style="list-style-type: none"> <li>• Bea was not a technical expert and did not understand operational aspects of the artifact (technical labels)                             <ul style="list-style-type: none"> <li>○ Fields that were not understood and don’t appear to be required were skipped</li> <li>○ The field for alternative text was skipped as were all of the subsequent options to control the display of the image</li> </ul> </li> </ul>
How? (adaptive aspects)	<ul style="list-style-type: none"> <li>• This dialog box is geared toward someone who has enough technical background or training to understand the effects of the form functions</li> </ul>	<ul style="list-style-type: none"> <li>• Users expect the dialog box to adapt to them in offering functions that they understand in a language that they understand</li> </ul>

Table 8. The Human Artifact Model: Bea’s use of “Image Properties”.

In contrast to Bea, Bill had awareness of both the concept of web accessibility and enough knowledge of the technical aspect to know that there were some areas of accessibility that had been addressed in the department's site and other areas that were not being addressed. Bill's first comments during our interview shed light on his perspective on accessibility and how it has been addressed in his work:

Bill: So do you have specific questions or did you want me to talk about it in general terms?

Kyle: I would love it if you could start by talking about it in general terms.

Bill: So the website itself is not specifically designed for vision impaired or things like that but it was taken in mind during the design and so one of the approaches we took was to make sure that there was no graphics-only information that couldn't be duplicated in text. One of the issues when I came here was the interface itself. A lot of it was in flash. And so the flash interface is not at all friendly to any of these accessibility issues. So we pulled all that out and we turned that into HTML only interface menus. So that was the first step in trying to make it a little more friendly.

From this exchange it was clear that Bill did not see accessibility as a primary objective, however, it is something that he does factor into his work. He went on to describe how the menus were written in Flash and that this created problems not only for accessibility, but for maintenance. People from the various areas within the department were editing and breaking the menus which he then had to fix. To address this, he converted the menus to HTML and also

built a system for managing the department's content.

Part of what Bill had compiled in his system for managing web content was the image upload form that Bea was observed using. Here are Bills comments when specifically directing his attention toward the alternative text field.

Bill: This is something that most people don't use. I think it is possible to enforce it in the

WYSIWYG <what you see is what you get> but I never did, and that's just part of the accessibility issue that we never looked at. It was basically like, theoretically these images <can be> annotated. So if you can't see the image you should at least know what it is. But it's not being done."

Bill's thought to consider "enforcing" alternative text was in the same line of thinking that Andy had. While Andy positioned this thought as something he might consider Bill's thoughts immediately turned to the idea that although alternative text could be "enforced" in the dialog box; his system does enable users to edit the source directly and so it would be still be possible to have images without alternative text. He then went on to explain why he discourages editing the source directly. The main reason is that students who have web development skills create something "really nice, really slick," but then they graduate and no one knows how to maintain their code on the site.

Bill's comments regarding the image upload dialog box contrast sharply with Bea's comments and experience on the page. Here is Bill's description of how he sees the dialog box supporting end users, "These <images> are all sitting on the server here or you can upload

them from your local machine. So if you uploaded something from a local machine you can then find it on this list, select it, add it and it's done. You have quite a bit of control of what you can do like wrap-arounds. You can do all the standard stuff you can do with images. You can turn it into a link if you want. You can do anything you need to.”

When Bill looked at the image upload form he saw “quite a bit of control. . . you can do anything you need to” in contrast to Bea, who used the function to upload the image to the page, but did not understand, pay attention to or use the additional options on the form. When asked about her general familiarity with web technology, Bea said that she maintained a personal blog, but did not edit any code directly. The image upload form was clear to the developer, however, it was not clear to the end user. Because of this lack of clarity and/or enforcement, alternative text was not entered resulting in images with missing alternative text on the department’s website.

Bea’s lack of accessibility awareness combined with her ignoring the optional fields of the image properties box can be thought of as an active choice that she made as an individual to ignore accessibility and also a collective action as Bill was aware that alternative text was not being entered. The passive approach she was taking to the form can be explained by the fact that she was intimidated by the technical language on the form and found it easy to skip over the fields as they were not required, however, her approach to the form is better framed as an intentional collective action to ignore the unknown than an unintentional absence of action.

This perspective frames her interaction as a tangible issue that can be addressed through changes to the tool and/or her training.

*Accessibility evaluation of the current site*

The home pages of the areas of the site that Ben and Beth were responsible for were evaluated for accessibility through a screen reader. The evaluator found that the home link, which is expected to be listed first, was after the navigational links. This issue was parallel to the experience of a sighted user, as the home tab was located on the top right area of the screen after other top level navigational tabs. The evaluator also found a link in this top level of navigation that was not labeled so he was not sure where it would take him. He found a second home link in an unexpected location. In the area Ben was responsible for he found the use of a level-one heading attached to the title of the first article, which is helpful for accessibility as it enables him to easily jump to that section. The primary content featured on the homepage was not the article that the evaluator could access, but a video that he could not detect even existed through his screen reader. The article that the evaluator was able to access from the homepage was in a side bar, rather than the main content area on the page. This article appeared to the evaluator to be the main content for the page since the content which was given visual prominence to him was invisible. Several images had empty alternative text when they should have had image descriptions. One image on the page did have meaningful alternative text.

In Beth's area of the website the top level navigation was shared across the department so it was the same as Ben's area. However, the main content area of the homepage in Beth's area was organized differently. It consisted only a large image linked to a PDF newsletter. The evaluator was able to access this document with his screen reader, however, his evaluation within the document revealed that the PDF was untagged. A table of contents provided quick navigation through the newsletter for a sighted user; however, through a screen reader, because there was no semantic structure applied through tagging the document was a 20-page string of text with no reliable way to choose an article and navigate to it.

#### *Planning the future site*

Ben's role on the department's outreach board tasked him with ensuring materials were nationally distributed. Several years ago the materials were printed and physically mailed in the form of newsletters, however, this had been replaced by email and posting content to the department's website. Ben saw the current site has being limited in that it didn't take advantage of newer delivery methods and lacked dynamic content. When asked for examples of what Ben meant by dynamic content, he referred to a video of a lecture which was posted online and to the Wordpress website that Beth had launched for her non-profit organization. Ben saw an opportunity through a website redesign to broaden the reach for the department's materials. He believed that if the site were more dynamic and leveraged social media channels it would be more effective.

Beth, the outreach coordinator for her area within the school, shared her experience with me and focused on her view of the potential redesigned site for the school. Beth's vision for the future site for the department was similar to Ben's. She explained that the site could do more to "reach out to the world" rather than just be an "internal tool for students, faculty, and staff." Beth was eager to discuss and share the Wordpress website that Ben had mentioned. While Ben and Beth were both focused on improving the distribution of information, neither of them evidenced that they saw or acted on the connection between accessibility and improving the reach of the materials they were producing and distributing.

While Ben was hopeful for the redesign from the time of our initial contextual interview, the decision to move ahead with these plans was made near the end of the time that data were collected for this dissertation. With this decision, ownership for the project (from Ben's perspective) transitioned from Ben to Bill. Early mockups that Bill shared of his work on the redesign largely consisted of content from the current site with the addition of image links to social media tools. He was planning for these links to be at both the level of the department as a whole and at the level of the 12 or so different areas within the department. Bill shared that they were planning on hiring someone to do the web design work but the scope of what would be within this role was still unclear as was the scope of the redesign project as a whole in his view.

*Contradictions within the departmental system*

The contradiction driving the planned redesign in this system was between the perceived effectiveness of the current site and the perceived opportunity in a new site. The expectation was that social media and more dynamic web content would improve the effectiveness and reach of the site. The decision to move forward with the redesign appeared to be resulting in further tension emerging among the roles and skills of the individuals in the system and the objectives for the redesigns. Ben's tone of voice was quite eager to hand off the project to Bill, however, Bill was equally eager to clarify that the website was not his primary focus and that his design skills were inadequate.

There was no evidence in data collected in this system that pointed to enough tension relating to the accessibility of the site to motivate a change in how it is addressed. Ben stated that accessibility likely "would have to be injected by someone" to be considered. As there was no evidence that anyone was "injecting" this objective, there was no a contradiction or tension regarding the systems status quo regarding how web accessibility was being addressed. Bea's actions when skipping the field to enter alternative text for images clearly created issues for potential users accessing the site. However, her actions did not result in any tension within her activity system that appeared likely to motivate change.

*Case 3: A group promoting and evaluating accessibility*

The vision of the university where this research was conducted indicates that the university aims to educate a diverse student body. Educational and research activities at the university are facilitated through information technologies used by all students, faculty and staff. In order to achieve the vision of educating a diverse group of individuals it follows that these technologies are accessible and usable for the diverse group of people within the university. Offices and programs within the university system support students with disabilities by providing accommodations to students, assistive technology consultations, and support to faculty and staff as they in turn support the university's diverse student body. Part of this support is provided through information on IT accessibility which is posted on the university's website.

New roles and initiatives relating to accessibility were emerging during the time I was interviewing and observing activities for this dissertation. A new role was created to look after compliance with the ADA. A task force was formed to focus on improving the accessibility of existing systems and ensuring accessibility is addressed as a part of the vetting process for procurement. A new role was also created to check university sites for accessibility issues and track down those responsible to provide feedback and assistance.

To understand the activities in this system I interviewed Debbie who was the newly hired individual tasked with checking university sites for accessibility issues and conducted a group interview with Derrick and Denney, two accessibility specialists, and Dave the webmaster

covered in case 4. While this group was in the early stages of a web project of their own for a site providing assistance on making accessible websites, this redesign was in an early planning phase. Several distinct activities were identified in this activity system. The following table summarizes the key activities of the respondents in this group. The upcoming sections provide more details describing these activities.

Key actors and activities in the group promoting and evaluating accessibility

Derrick, Technology Accessibility Specialist	Derrick’s role included promoting IT accessibility through developing educational materials and through lectures and workshops.
Denny, Access Technology Consultant	Denny provided consultation to students, faculty and staff on a wide range of assistive technologies. He reported spending a disproportionate amount of his time on issues created by inaccessible PDF documents.
Debbie, Web Accessibility specialist	Debbie evaluated university websites for accessibility. She was in a new role and the details and scope of how her feedback would be provided to those responsible for the sites she was evaluating was still being sorted out.

Table 9. Key actors and activities in the group promoting and evaluating accessibility.

*Promoting accessibility with research and education*

Derrick was involved with promoting IT accessibility through conducting research on accessibility in the context of higher education. He gave presentations on the topic at several conferences and has served as a consultant in both public and private sectors. He has conducted workshops for faculty at the university. He is fluent in both the high level topics such as accessibility policy and low level technical details including how to produce accessible PDF documents.

*Establishing a collective voice to advocate for accessible technology*

Derrick also shared his involvement with ATHEN which is the Access Technology Higher Education Network. ATHEN is an organization that aims to use the collective leverage of its members as it defines and disseminates best practices. <http://www.athenpro.org/> In banding together universities can have a stronger voice than they have on their own when working with vendors. Their collective voice is more likely to be heard and puts pressure on vendors to meet the expectations of their customers.

*Ensuring current students can access content in PDF documents*

Denny relayed that he spends a lot of his time providing services to students who need assistance accessing PDF documents. The scope of his role is technically much larger, to provide consultation services on a wide range of assistive technologies that support students, faculty, and staff, yet a large portion of his time is spent on the specific issues created by inaccessible PDFs. The least accessible form of PDF is created by scanning full documents and rendering

entire pages of content as images. Screen readers can't read scanned images of text, however, there is a process that can provide access. In this process optical character recognition (OCR) software translates the image of text back into characters which screen readers can access. This is not a flawless process as OCR software can make mistakes in "reading" the document which are then misspoken by the screen-reader.

PDFs containing actual text rather than scanned text still often pose barriers. Screen readers depend on headings to navigate efficiently through a document. Unless PDFs are specifically created with accessibility features enabled from original documents that use headings or styles properly, the result is difficult to navigate. The user will not be able to preview headings as one might do in a table of contents and jump to the desired section of text. While not fully inaccessible, this process is arduous and time consuming for the user. PDF documents of this type can sometimes be retrofitted for accessibility by defining the headings within the document, however, this is also arduous and time consuming.

#### *Checking university websites for accessibility*

Debbie was recently hired to provide a service for the university's web developers in checking sites for accessibility, providing recommendations, and assisting in triaging and resolving issues. Her background is in web development with experience in developing sites which focus specifically on individuals with disabilities. Debbie uses several tools to check for accessibility including screen readers, Firebug, WCAG contrast analyzer, and simply reviewing the source code. Debbie shared some code that she had been reviewing on a key page for the

university and pointed out an example of empty alternative text. She went on to show me ascii art in the source code of the home page of the university pointing to the irony that there was effort put into this in contrast to the apparent lack of effort put into accessibility. Ascii art is using plain text to create pictures. The art on this university's homepage was a large letter symbolizing the university. The following much smaller example illustrates the concept:

```
  A
 A A
  A  A
 AAAAAA
 A      A
 A      A
```

Figure 13. Example illustrating Ascii art.

At the time of the interview the team was still working out the details of how the service that Debbie was hired to provide would be positioned. They were working out how to position her work so that it would be perceived as a helpful service, rather than as a critical watchdog.

#### *Learning from past attempts*

Approaching the topic of accessibility head-on can be problematic. Learning opportunities have been offered in the past, however, low attendance was an issue, particularly when offering a course more than once. The idea of connecting accessibility to other objectives was suggested, such as connecting accessibility to the broader concept of web quality.

*Case 4: An individual promoting and evaluating accessibility*

Dave worked closely with the group within the university responsible for providing accessibility related services; however, his official position was as a senior webmaster in the university’s IT department. Dave’s motivation for promoting web accessibility was not a result of his role within the university hierarchy but was from his personal interest in promoting an inclusive culture. Dave was passionate about the topic and has been actively promoting web accessibility for several years. His case illustrates that while often motives for how work is performed can be traced through organizational hierarchies, there are exceptions to this pattern. Dave is not working in an organization that puts a high priority on inclusive web design practices, yet he is a committed proponent of accessible web design practices.

Dave’s key activities, promoting and evaluating accessibility

<p>Dave, Senior Webmaster</p>	<p>Dave organized a monthly meeting open to anyone associated with the university and interested in learning about IT accessibility to build a community of practice. Dave moderated an email group with the open membership and purpose. Dave and the others from the group of accessibility specialists (Case 3) were evaluating the existing resources posted to the university website that provide information and instructions on IT accessibility. Dave was also evaluating the accessibility of technology that that university was potentially procuring.</p>
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Table 10. Dave’s key activities promoting and evaluating accessibility.

*Building a community of practice for accessible web design*

For the past several years an effort has been underway building a community of practice for those involved with web design at the university to share and collaborate. Dave has monitored a list-serve with varying degrees of activity where typically new and interesting resources or news about accessibility is circulated for the past 10 years. The forum also occasionally addresses technical questions about accessibility which are posed by people from through the university in web development roles. This group meets monthly in person for presentations and discussions about web accessibility at the university. A small proportion of those who are in web development roles at the university attend these meetings. The meetings and list-serve are a resource that is available, however, there is no top-down requirement for web developers or managers to attend.

*Developing resources for web accessibility*

Dave and the accessibility specialists were in the early phase of a web redesign project for a site that aims to promote accessibility and provide resources on how to incorporate accessibility into web design. Dave pointed to the existing resource and noted how it is not well targeted to the needs of the universities web developers. He saw the need for more practical and concise technical help being more prominent and less prominence given to historical information on accessibility.

Dave conducted a needs-assessment survey of web developers to help define who the audience is for the resources that are being developed and clarify their expectations for the

resources he and the group were developing. Part of what Dave and the team have learned is that there is a segment of users who have multiple roles in addition to web-development. They are identifying these individuals as the “do-it-all type”. The people who were in web development roles in the first two activity systems that I explored both could be described this way. Particularly Bill, who does explicitly does not describe himself as a web developer, and yet is doing this work in addition to all other computing service related work in his department. Ben also fits this type to a degree as he is covering all of the technical aspects of a large redesign project. Understanding these constraints will help guide Dave and the team that he is working on to be sure that the resources that they develop are used.

*Ensuring that the university procures accessible technologies*

Dave was participating in a committee that was evaluating new technologies that the university was considering for procurement management. His objective in this role was primarily to evaluate the accessibility of the options, however, he also found that this was an opportunity to communicate with the vendors so they could be aware of issues in their products and potentially address them. This strategy can be effective in addressing accessibility issues as the financial motives of the vendors to sell their products can give leverage to the buyer’s requests. Dave shared that one product claimed to be accessible, however, the main marketing page for the product had significant accessibility barriers. Dave commented:

“One of the products that was looked at recently it looked good but turned out to be ineligible for other reasons. They asserted strongly that they fully complied with

508 and WCAG and so I go to their user facing page and virtually everything on the page was graphics with no Alt texts. As you moved around trying to explore the page all you hear was link, link, link”

*Ensuring that technology is accessible using Penn State materials*

As the discussion of motivating accessibility improvement efforts continued the approach of ATHEN was contrasted with the approach of litigation. A federal complaint was filed against Penn State in 2010 for discrimination which has ultimately resulted in an expensive clean-up project for the university to retrofit many of their tools and services for accessibility. They have also created resources that Dave is using and adapting. These resources help triage accessibility to prioritize the issues and also provide clear instructions for addressing issues. These resources can be found on <http://accessibility.psu.edu/>.

Dave is using these Penn State resources in two distinct ways. First, he is using them as an evaluation tool as he assesses the accessibility of technology systems that the university is considering for procurement. Second, he uses them as a tool to check existing technology at the university. The value in using the Penn State resources is because they are tightly prioritized to facilitate a triage process. They provide a prioritized checklist that is based on guideline violations that result in the most frequent and severe barriers. This helps to address the question that Bill asked regarding how much attention to accessibility is enough.

Another difference between the Penn State resources and guidelines is that they not only describe how to ensure accessibility, but discourage the use of products that are difficult

to make accessible. PDF is a notable example of this. One of the accessibility specialists noted that there is a long manual on how to make PDFs accessible. The Penn State resources describe PDFs as challenging to make accessible and suggest providing alternative formats when PDFs are used.

*Contradictions connecting to cases 3 and 4*

The tension identified through the interviews of individuals within these systems pointed primarily to tension among systems, rather than within this system. The absence of a top-down leadership style and formal accessibility policy to enforce and communicate the need for addressing web accessibility appeared to be part of what was triggering the grass roots approach which was observed. Dave appeared more focused on how to pull developers in to consider and address accessibility than on pushing the objective head on. Dave described the university as a place where decisions are made democratically. Teams work together to solve problems by consensus rather than through an autocratic management hierarchy. Within this context Dave's approach to the website redesign project was on clearly defining the needs of the target audience of the site and ensuring that the new site gave prominence to content that directly addressed the needs and expectations of the audience. Rather than overwhelm users with content, his intention was to entice them with quick and helpful answers to their questions. The following segment illustrates some of his perspective on this topic.

“. . . and is there any motivation for them to learn this technology in any depth?

And do they have the support of their managers to think about it. And like I don't know

about you but my days are full and I don't necessarily want to sit and watch a video about someone trying to navigate a web page with a voice prompter. Although that might be a very effective way to be able to demonstrate. Anyway so that's the realization we're coming to. It's not a question of us guessing the right way to do the site so that it suddenly works. We actually have to begin an engagement process over time and develop this step by step as we go along so that it really is something immediately useful to people."

#### *Summary of results*

Key activities observed in this project were maintaining sites, redesigning sites with CMSs, and advocating for accessible information technologies. Observations and interviews found that the individuals collectively planning and maintaining sites for one college and two academic areas within a department of another college within the university were not prioritizing efforts to ensure that accessibility considerations were factored into the sites they were responsible for. Evaluations of these two sites by an individual who is blind were conducted with a screen reader to identify accessibility issues and determine how they connect back to the activities observed during the contextual interviews. The evaluations identified several accessibility issues which were consistent with top issues referenced in related literature (Fichten et al., 2009; Lazar et al., 2007; Thompson et al., 2013).

Little evidence pointed to tension *within* the college or departmental systems relating to accessibility. However, when considering the relationships *among* the three systems clear

differences were found between the objectives of actors in the college and departmental systems compared to the objectives of actors in the system that specifically promotes accessibility. Specifically, web accessibility was not given a high priority for those in the departmental and college systems, in contrast to those in the system who were specifically aiming to promote accessibility. In isolation, this claim is bloodless, unsurprising and nearly true by definition. However, focusing on the articulation of linkages and tensions among competing objectives can bring clarity to why a given action or activity is occurring. Clarity of the details of how and why accessibility is addressed can point to potential and emerging transformative changes to the activities that influence web accessibility.

#### *Awareness of accessibility as an objective*

A key result of this study was in examining the influence of both awareness and perceived importance of accessibility on the activities of those in the college and departmental systems who were implementing CMSs and managing content. While awareness of accessibility among those designing and maintaining websites is a starting point, it alone is not sufficient to ensure that accessibility is addressed in all cases. Each individual in the activity systems in this dissertation had a different degree of knowledge as well as nuanced perspectives of accessibility and its implications for web technologies. Bea and Ann had not considered accessibility as it relates to the web prior to discussing the topic in the context of this research project. Beth had recently become aware of a relationship between accessibility and technology; however, she had not acted on this knowledge in either of her two websites. Bill,

Ben and Andy each had prior knowledge of accessibility, and had taken some level of action to address accessibility within their respective sites. A need can become a motivating objective of activity, but a need can also be unmet. Andy was aware of the need but placed it “a bit low” on his “triage ladder”. Ben was aware but stated that someone would have to “inject” this as a priority for it to be considered.

While there were differences in the degrees of awareness and how accessibility was considered in each of the systems, in both systems accessibility was collectively not seen as a primary concern. Ben recalled an effort he made several years ago to go through his site and integrate recommendations he found on a university website that provided instructions on how to make websites accessible. Andy had a more current and ongoing experience relating to accessibility as he demonstrated awareness of some specific techniques and mentioned Dave’s role at the university’s web council meetings.

Bea and Ann had not considered IT accessibility very much if at all before my introduction of the topic to them. Despite having had some past exposure to the topic and having each taken action on what they had learned, Bill, Andy and Ben did not perceive a strong top-down mandate regarding how their websites were designed, or how accessibility was addressed. In the first system Andy and Ann made the decision in a meeting with the Dean to be consistent with university branding; however, it appeared to be their option to adopt this as a requirement. It was not pushed upon them. In the second system, decision making power regarding the website resided largely within the department. Decisions about the site were

made by resolving the needs of the individual academic areas with the needs of the department as a whole.

Bill and Andy had differing approaches to using networking as a means of influencing how the websites were redesigned. Andy attended web council meetings and claimed that these had influenced his awareness of accessibility, which resulted in his considering accessibility for the website he was building and maintaining. He specifically named Dave as the individual who had raised his awareness of accessibility. Andy also found value in reaching out to other departments to learn from their redesign projects. When I asked Bill about the web council or making a connection to others regarding his redesign, he said he did not attend them and clarified that his role is broader than website. As Andy was a web developer he reached out others in this role for ideas on how to facilitate the redesign he was working on. This resulted in increasing Andy's awareness of web accessibility. In contrast, Bill did not see himself primarily as a web developer, did not reach out to others for ideas regarding his redesign project.

The need for addressing accessibility is recognized by the leadership of the university, as evidenced by the vision and values statements and a video on the university website featuring the university president and leaders from other institutions, including IT leaders, discussing the importance of addressing IT accessibility. Considered with the above demonstration that accessibility is not being addressed consistently, there is a contradiction between the university's objectives and respondent's objectives in building and maintaining university websites. The above collection of reasons why web accessibility was not consistently addressed

forms a contradiction, a tension between the objectives of the university's vision and the objectives of the respondents in the study who were building and maintaining university websites.

*Connections between accessibility and the image upload form*

The human artifact model was used to illustrate the difference between Bea's perception and use of the CMS and Bill's perception of the image upload tool. It did not appear that this difference was creating much tension within their system. However, it did provide evidence that explains a cause of missing alternative text. Bea, Andy, and Bill were all observed interacting with the same image upload form. Dave confirmed that this same image upload form is common in many CMSs. This component, CKEditor ([www.ckeditor.com](http://www.ckeditor.com)), includes a WYSIWYG editor for web content that includes a function for uploading images.

### Analysis

The methods section outlined the analytic strategy of tying theoretical assumptions back to the core question of research: How is accessibility understood and accounted for (question 1) through the lens of activity theory (question 2) with specific focus on authoring tools (question 3)? Here in the analysis section the remaining areas of the analytic process were fleshed out by tying the theoretical assumptions to the results discussion and conclusion of the study.

#### *Analytic framing of the results*

This approach of connecting the results of the study to the theoretical assumptions had the effect of distilling the results down to the following core set of findings.

Analytic framework: Results

<b>Theoretical Assumptions</b>	<b>How theoretical assumptions focused results</b>
Cultural tools are the <i>products</i> of social/political negotiation	Negotiations were focused on improving the reach to targeted audiences in all cases; however, accessibility was low on the triage ladder (case 1) or not being considered (case 2) in contrast to cases 3 and 4. The websites and PDFs in cases 1 and 2 had several typical accessibility barriers.
Cultural tools both afford and constrain practice	The CMS tool observed in case 2 and in the planning stage in case 1 made it possible, but unlikely for alternative text to be included. The WYSIWYG editor made it likely that semantic structure would be properly applied to headings within the documents produced. Accessible themes and templates being adapted in case 1 for the planned site have accessibility features built in. Tools used to produce PDFs in case 2 make it difficult to address accessibility.
How tools are used is affected by subjects' motivations, and a variety of social/contextual factors (e.g., policy, community/institution values, division of labor)	Case 1 included one web developer with a large set of responsibilities. In case 2 there was no one dedicated to the department's website. It was only a part of a computing service director's role. Respondents exhibited a low range of awareness and value regarding accessibility; and, none of the actors in cases 1 and 2 were strongly motivated to prioritize accessibility. While the tools they were using generally could have made accessible design possible, the tools did not make it easy or probable given the lack of motivation, awareness or priority given to accessibility.
Contradictions emerge as structural tensions within or among activity systems	Case 1's primary tension was created by the amount of work one web developer was responsible for completing. Case 2's primary tension was between the perceived ineffectiveness of the current site to distribute materials and the possibilities offered by more dynamic content and social media channels. While there was evidence of contradictions emerging in cases 1 and 2, these tensions did not relate to accessibility. The tension between accessibility was clear between the motives of the group and individual focused on promoting accessibility (cases 3 & 4) and the lack of consideration for accessibility of found in cases 1 & 2.

Table 11. Analytic framework: Results.

Analytic framework: Summary table of methods and results

<b>Theoretical Assumptions</b>	<b>Methods</b>	<b>Results</b>	<b>Discussion</b>	<b>Conclusion</b>
Cultural tools are the <i>products</i> of social/political negotiation	How is work, specifically consideration for accessibility, prioritized?	Accessibility was given low or no priority in cases 1 and 2.		
Cultural tools both afford and constrain practice	How do authoring tools help and hinder addressing accessibility?	Tools made it difficult to produce accessible sites/PDFs.		
How tools are used is affected by subjects' motivations, and a variety of social/contextual factors (e.g., policy, community/institution values, division of labor)	How do social and contextual factors affect how tools are used, specifically in relation to accessibility considerations?	Tools are used by non-experts who sometimes have more work to do than they can manage. Given these conditions, accessibility was given low priority or not addressed at all.		
Contradictions emerge as structural tensions within or among activity systems	What contradictions exist that specifically relate to accessibility?	There was a contradiction between the barriers in the sites produced in cases 1 and 2 and the desire for good accessibility promoted by cases 3 + 4.		

Table 12. Analytic framework: Summary table of methods and results

*Analytic framing of the discussion*

In contrast to the framing of results which narrowed the focus of mass of data from the study, the analytic frame of discussion broadens the focus as it interprets the findings.

Theoretical assumptions were used in two ways to interpret the findings of this study. The first was to explain why things are as they are. The second is was explore possibilities for change.

The following table poses interpretive questions which are addressed in the discussion section.

Analytic framework: Discussion

<b>Theoretical Assumptions</b>	<b>How theoretical assumptions explain findings and point to potentials for change</b>
Cultural tools are the <i>products</i> of social/political negotiation	Why were accessibility considerations largely absent in the social/political negotiation processes in cases 1 and 2? As this need was generally <i>not</i> considered, what <i>was</i> being considered? What changes could occur to bring accessibility into the negotiation process?
Cultural tools both afford and constrain practice	How can the artifact side of the human-artifact model be used as an analytic tool to examine how tools can afford and constrain activities that affect accessibility? How can the model be used to explore possibilities for changes that aim to improve affordances and remove constraints?
How tools are used is affected by subjects' motivations, and a variety of social/contextual factors (e.g., policy, community/institution values, division of labor)	How does division of labor connect to how tools are used? How do policies and guidelines affect motives and how tools are used? Why individuals in were cases 1 and 2 either unaware of or not giving priority to accessibility considerations? What contextual factors could change to influence how tools are used respect to accessibility?
Contradictions emerge as structural tensions within or among activity systems	Why was there a lack of tension within systems, regarding accessibility, but a clear evidence of a strong contradiction between systems? What opportunities might emerge to resolve this tension?

Table 13. Analytic framework: Discussion

Analytic framework: Summary table of methods, results and discussion

<b>Theoretical Assumptions</b>	<b>Methods</b>	<b>Results</b>	<b>Discussion</b>	<b>Conclusion</b>
Cultural tools are the <i>products</i> of social/political negotiation	How is work, specifically consideration for accessibility, prioritized?	Accessibility was given low or no priority.	What changes could occur to bring accessibility into the negotiation process?	
Cultural tools both afford and constrain practice	How do authoring tools help and hinder addressing accessibility?	Tools made it difficult to produce accessible sites/PDFs.	How can the Human-artifact model be used to explore possibilities for changes that aim to improve affordances and remove constraints?	
How tools are used is affected by subjects' motivations, and a variety of social/contextual factors (e.g., policy, community/institution values, division of labor)	How do social and contextual factors affect how tools are used, specifically in relation to accessibility considerations?	Tools are used by non-experts who sometimes have more work to do than they can manage. Given these conditions, accessibility was given low priority or not addressed at all.	What contextual factors could change to influence how tools are used respect to accessibility?	

<p>Contradictions emerge as structural tensions within or among activity systems</p>	<p>What contradictions exist that specifically relate to accessibility?</p>	<p>There was a contradiction between the barriers in the sites produced in cases 1 + 2 and the desire for good accessibility promoted by cases 3 and 4.</p>	<p>What opportunities might emerge to resolve the tension among activity systems created by the lack of addressing accessibility?</p>	
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Table 14. Analytic framework: Summary table of methods, results and discussion

*Analytic framing of the conclusion*

The analytic framing of the conclusion highlighted key connections to the previous chapters. It specifically covered what happens when accessibility is and is not addressed.

Analytic framework: Conclusion

<b>Theoretical Assumptions</b>	<b>How theoretical assumptions explain what happens when accessibility is and is not addressed.</b>
Cultural tools are the products of social/political negotiation	Addressing accessibility in the websites and other information technologies supports the university’s vision to educate a diverse student body When it is not addressed a part of this student body is systematically excluded.
Cultural tools both afford and constrain practice	The specific example of modifying the image upload form illustrates how affordances can be designed into tools. This specific example could be applied as a general approach. Without this approach, individuals with low awareness of accessibility are unlikely to build accessible websites.
How tools are used is affected by subjects’ motivations, and a variety of social/contextual factors (e.g., policy, community/institution values, division of labor)	Formal accessibility policies can be used by advocates to highlight the importance of accessibility when producing information technologies. The goal for improving accessibility in this institution was disadvantaged by the absence of such a policy. Information technology was being built in a resource constrained environment by individuals covering many roles. Often developing information technology was ancillary to their core job functions. These are among the factors resulting in low priority of accessibility as authoring tools (CMSs) were being developed and subsequently used to produce websites.
Contradictions emerge as structural tensions within or among activity systems	The poor accessibility in the websites and PDFs embodies the lack of priority and attention in how it was collectively addressed. The institution’s inclusive vision was out of sync with the low level of effort put into accessibility resulting in tension between importance expressed in the inclusive vision of the university and the websites which represent the institution.

Table 15. Analytic framework: Conclusion

Analytic framework: Summary table of methods, results, discussion and conclusion

<b>Theoretical Assumptions</b>	<b>Methods</b>	<b>Results</b>	<b>Discussion</b>	<b>Conclusion</b>
Cultural tools are the <i>products</i> of social/political negotiation	How is work, specifically consideration for accessibility, prioritized?	Accessibility was given low or no priority.	What changes could occur to bring accessibility into the negotiation process?	When accessibility is not addressed a part of the student body is systematically excluded.
Cultural tools both afford and constrain practice	How do authoring tools help and hinder addressing accessibility?	Tools made it difficult to produce accessible sites/PDFs.	How can the Human-artifact model be used to explore possibilities for changes that aim to improve affordances and remove constraints?	The example of modifying the image upload form could serve as a model for other components of authoring tools.
How tools are used is affected by subjects' motivations, and a variety of social/contextual factors (e.g., policy, community/institution values, division of labor)	How do social and contextual factors affect how tools are used, specifically in relation to accessibility considerations?	Tools are used by non-experts who sometimes have more work to do than they can manage. Given these conditions, accessibility was given low priority or not addressed at all.	What contextual factors could change to influence how tools are used respect to accessibility?	Formal accessibility policies can be used by advocates to highlight the importance of accessibility and influence how tools are used to address it..

<p>Contradictions emerge as structural tensions within or among activity systems</p>	<p>What contradictions exist that specifically relate to accessibility?</p>	<p>A core contradiction was found between the accessibility barriers in the sites produced in cases 1 and 2 and the desire for good accessibility promoted from cases 3 and 4.</p>	<p>What opportunities might emerge to resolve the tension among activity systems created by the lack of addressing accessibility?</p>	<p>The poor accessibility in the websites and PDFs embodies the lack of priority in how it was collectively addressed.</p>
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Table 16. Analytic framework: Summary table of methods, results, discussion and conclusion

*The ecosystem of web design activities influence upon accessibility*

Connections among multiple activity systems can be viewed as an ecosystem of activities. Key activities are summarized in the following diagram, as defined by their objectives and objects, both directly observed and uncovered in the interviews and accessibility evaluations within this project. The diagram reflects the current orchestration of activity relating to web accessibility in systems using CMSs. The diagram illustrates how objectives relating to accessibility can flow through the activities of downstream actors in related activity systems. It illustrates that objectives can be embedded into artifacts such as CMSs or websites. This flow is in alignment with the earlier notions of activity theory and tool mediate action upon physical objects. It also shows that objectives can be actualized into non-physical concepts such

as accessibility awareness. Both physical tools and non-physical concepts can mediate activities that ultimately influence the accessibility of information technologies.

## Key activities relating to accessibility and web design

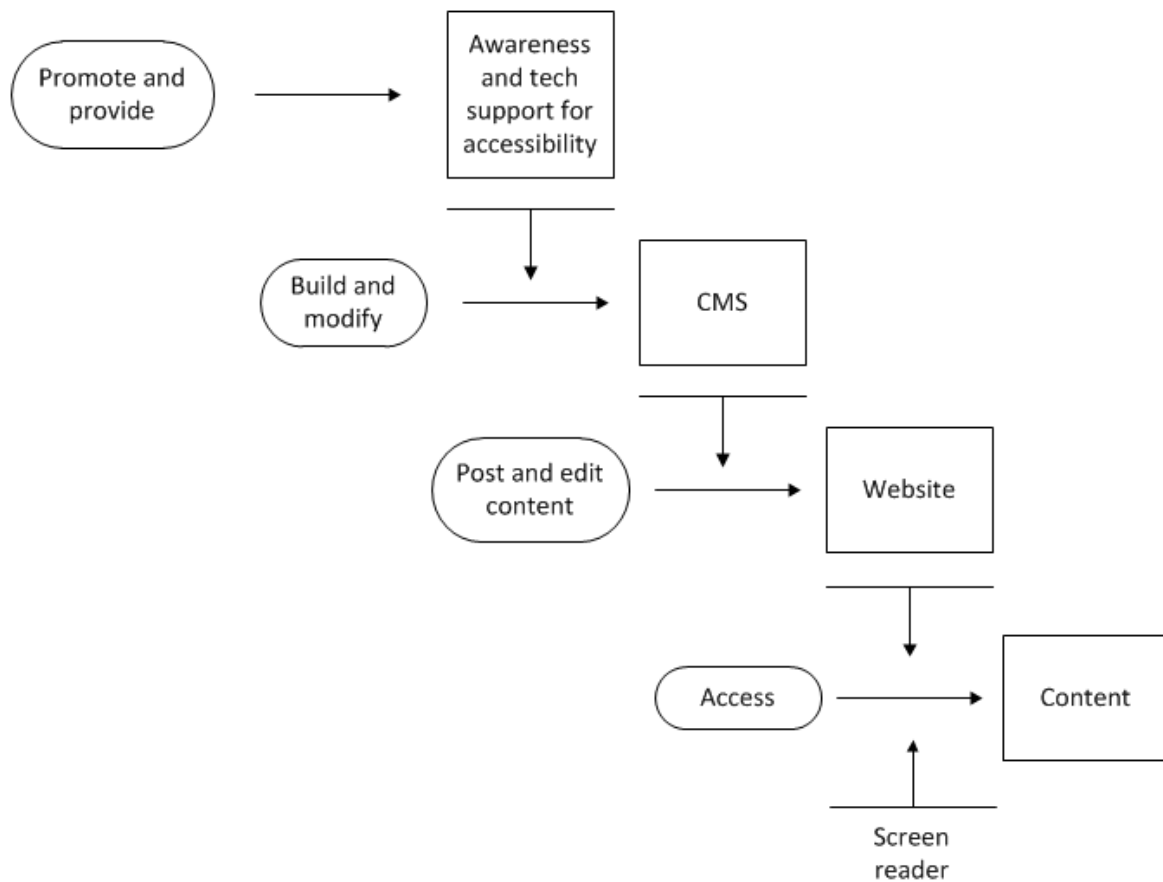


Figure 14. Key activities relating to accessibility and web design.

The frame of activity theory points to two distinct but related methods whereby accessibility was addressed in the observations and interviews of this project: directly and indirectly. The first method was directly addressed accessibility, where the designer became aware of the means and conditions of the end users and then acted on this awareness. For example, Bill, Ben, Andy and Beth all had some degree of awareness of what alternative text is used for and why it is important. Bill, Ben and Andy had all acted on this awareness in their work by writing alternative text.

## Accessibility is directly addressed

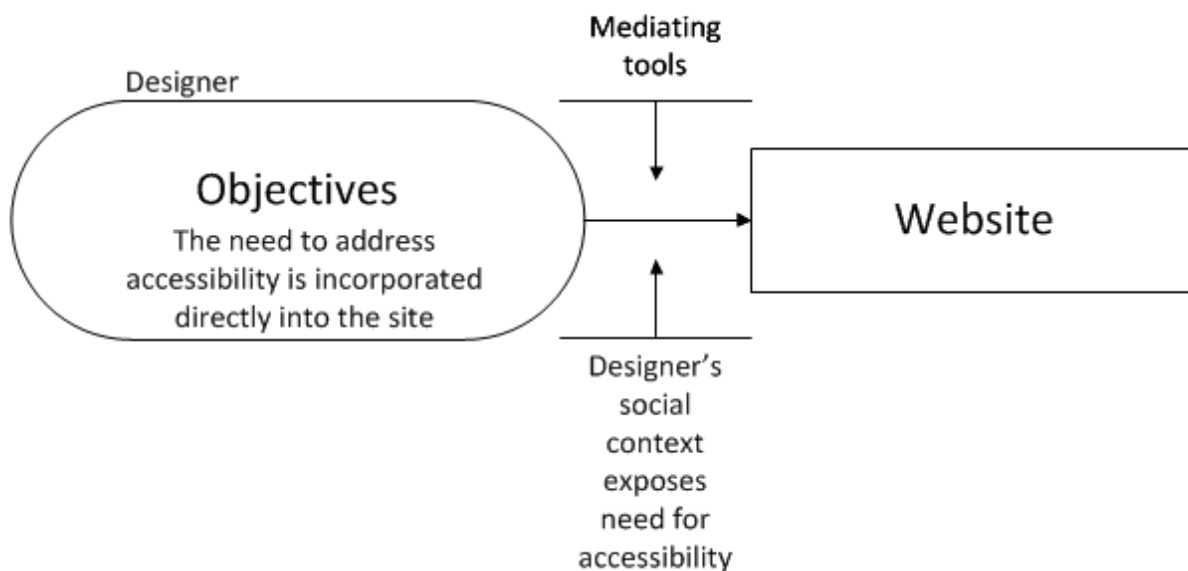


Figure 15. Accessibility is directly addressed.

The second method, indirectly addressed accessibility, was a two-step process through the tools that mediated the activity of the designers. In the first step, the person building or modifying the CMS made a conscious choice to incorporate components that have certain accessibility features built into them. Once this choice is made, further conscious consideration for certain aspects of accessibility is not needed. For example, navigational elements are included in templates, and the semantic structure for content can be facilitated through heading styles within the CMS. Andy had chosen a Drupal theme he believed to be pretested for accessibility, and verified that the skip navigation feature was included. Once this had been validated, content managers using the CMS would not need to be aware of these features as they manage content. Some aspects of accessibility can be indirectly addressed; the CMS implementer can incorporate the feature into the CMS so that pages created by a content manager automatically factor in certain aspects of accessibility.

# Accessibility is indirectly addressed

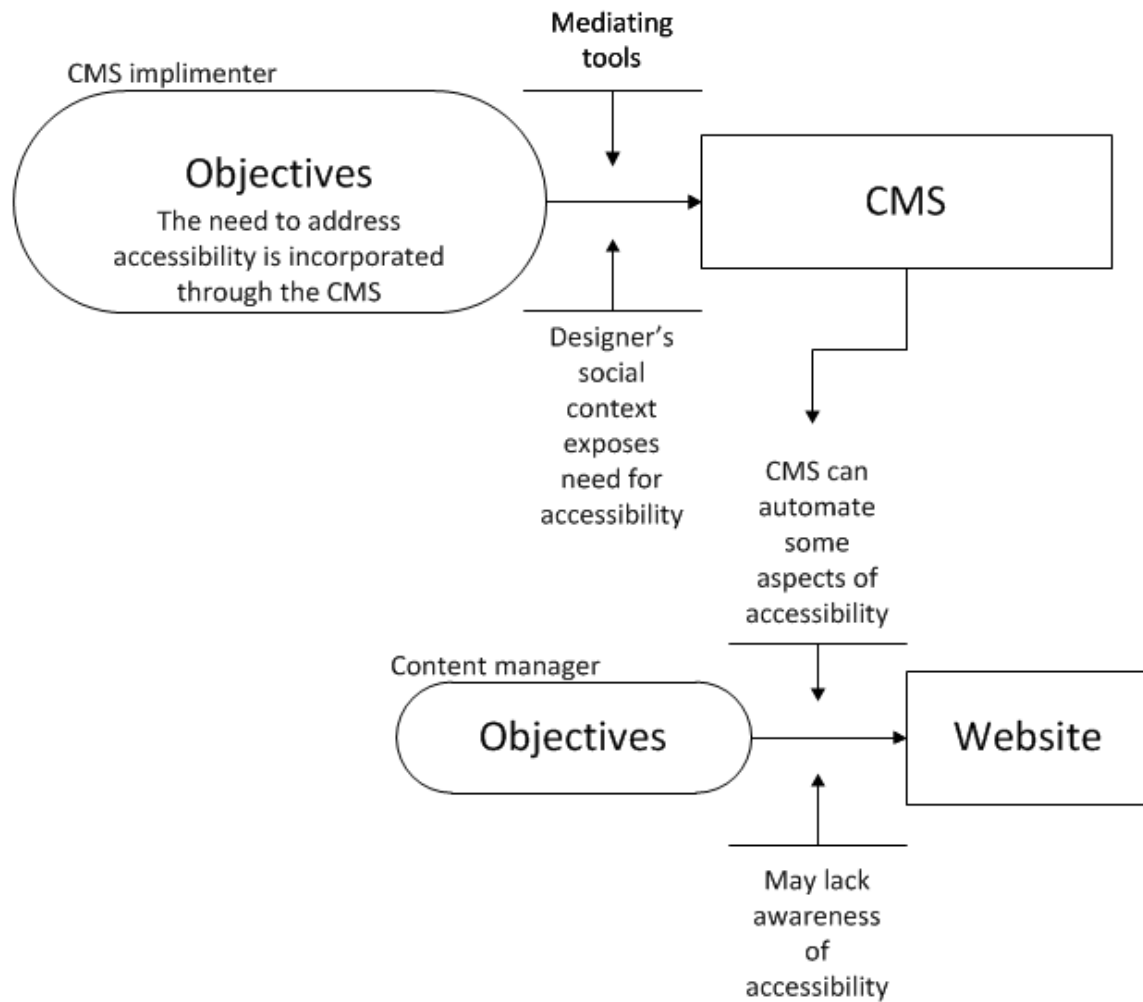


Figure 16. Accessibility is indirectly addressed.

## Discussion

Designing tools for others to use is a deceptively complex activity (Redish, 2007). Design can be facilitated by improving designer awareness of the means and conditions, social context and objectives of the end users of the tool being designed. There are many techniques that have evolved to facilitate this complex activity, such as usability tests and contextual interviews. The human artifact model is an analytic technique designed to both evaluate existing artifacts and facilitate the design of new artifacts.

Accessibility barriers identified from the site evaluations, conducted as a part of this project, included issues with alternative text, headings, PDF tagging, and link wording. These issues were consistent with top issues reported in literature and also with the fixes spelled out on the Penn State site (<http://accessibility.psu.edu/>). PDF tagging and missing and misused headings are core requirements to support accessibility as both of these features expose the semantic hierarchy of information that screen readers use to enable efficient navigation. Questions of why and how the tools that are used in creating websites and PDF documents can influence the probability that sites and documents will include semantic markup are discussed in the following sections.

Missing and unclear alternative text was historically the first major barrier and remains a top factor blocking accessibility. The importance and persistence of this issue suggests that it should be given specific attention. The human-artifact model brings focus to how and why alternative text is, and is not, entered. It can also be used to identify possible adjustments to

the image upload form that may improve both the frequency and quality of alternative text entered. The model brings this into focus by examining both the human and artifact sides of interaction. The following section begins by describing changes to who is posting content and then moves on to propose changes in the form to better support user interaction.

*Reorchestration of voices in web design activities*

The division of labor is changing over time for activities of designing and building websites and other information technologies, as briefly described in the literature review. These activities have become much more distributed, with some aspects being addressed by individuals who do not have technical expertise in web development. The second system was typical of this reorchestration with a technical expert responsible for building and maintaining the CMS and several domain experts and student interns responsible for posting content. An example of this shift was also evidenced in the plans within the first system to shift the responsibility of posting content from the web manager to others in the college who were described as often in being in secretarial roles.

Content posters, CMS implementers and accessibility advocates have different degrees of awareness of accessibility because of their roles and background. Content posters, such as Bea, may have some awareness of accessibility, but may not have considered accessibility in relation to information technologies. CMS implementers, such as Andy and Bill, have more awareness of web accessibility, particularly some of the technical aspects. HTML tags for alternative text are often covered in tutorials and training materials for web developers.

Accessibility experts, such as Dave and Debbie, had awareness of a broader range of technical aspects as well as a more complete picture of the range of means and conditions and tools used by students and staff at the university as they access information technologies. The following table illustrates the levels of awareness of the actors in these roles.

Levels of IT accessibility awareness

Role	Level of awareness of accessibility
Accessibility expert (promoting accessibility and providing accommodation services)	Web technology expert. Deep awareness of technical and applied aspects of accessibility.
CMS implementer, Web developer (building websites)	Web technology expert. Has some awareness of technical aspects of accessibility.
CMS user (posting and maintaining content)	Secretary, student intern, or domain expert. May have low awareness of web accessibility.

Table 17. Levels of IT accessibility awareness.

*Possibilities for the image upload form*

CMS users with low awareness of web accessibility are posting content to university websites. The Human-Artifact Model was used to describe how this creates web accessibility issues. The next section uses the Human-Artifact model to explore design options that may help

resolve the issue created by the form. The following questions were generated directly from the model and focus on the alternative text field on the image properties dialog box:

1. What is alternative text and why is the field on this form? The form does not explain what alternative text is or why it is on the form.
  - a. CMS implementers likely have some technical awareness of what it is and why it is on the form.
  - b. CMS users likely do not have technical or practical awareness of what alternative text is or why it is on the form.
2. How does the form facilitate entering alternative text? The text box makes it clear where to enter text, however, the form can be submitted without entering text in the field.
  - a. CMS implementers would likely know how to use the form to enter alternative text.
  - b. CMS users would know that it is a text field; however, as the field is not required and the form does not communicate what or why alternative text is it is unlikely to be used correctly. It is likely either to be skipped or unhelpful text may be entered.
  - c. Any user may likely skip optional fields, particularly if there is not a perception that the fields are important.

Bea's case shows that form design can cause poor or missing alternative text, however, it is less clear how much the claim can or should be generalized. Dave indicated that the CKEditor tool is a commonly used component in CMSs suggesting how the claim could be generalized from the artifact angle. Generalizing from the human angle is arguably more complex. The degree to which Bea's means, conditions and social context are typical of CMS users is a key question. If her approach was typical it is likely that others would use the form in a way similar. Given that CMS tools were created to distribute work that once was technical in nature to individuals without technical skills it follows that other CMS users would not know the HTML tags which are exposed in the form. Given that CMS tools are often used by individuals who are not experts in web accessibility it follows that these users may have limited awareness of accessibility. Given these factors the general prevalence of missing and unhelpful alternative text, it seems quite likely that Bea's interaction with the form was typical. This assertion could be further validated through contextual interviews with a sample of CMS users.

The Human-Artifact Model offers a second approach for framing these concepts and data by shifting the questions derived from the model from the existing interaction issues to possible improvements. The following sketch on the left illustrates a slightly modified design that aims to clarify the what, why, and how of alternative text to users who have neither a background in web technologies nor web accessibility. Current (left) and proposed modification

to the Image Properties dialog box.

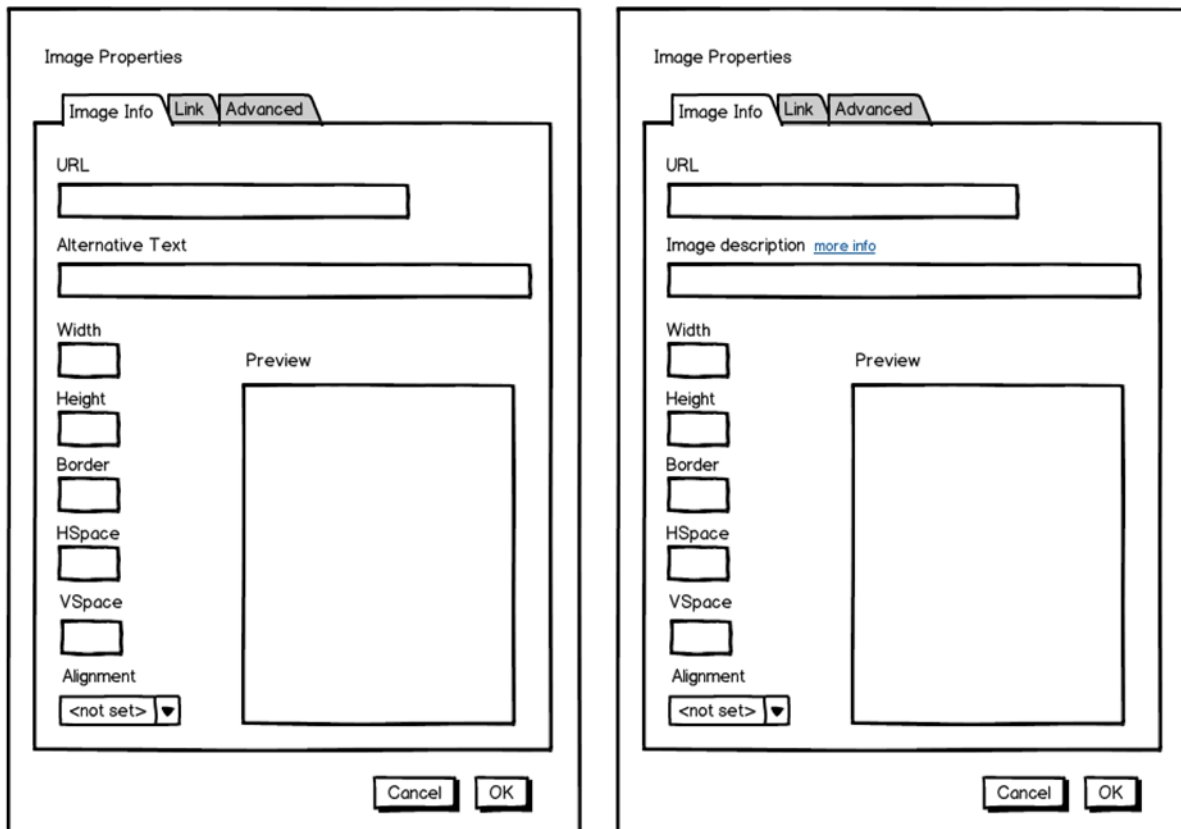


Figure 17. Current (left) and proposed modification to Image Properties

While the term alternative text is crystal clear to a web accessibility expert and understandable to a web developer, it is potentially unclear to people without the typical background knowledge associated with these roles. Image description would likely be more readily understood by users with a broader range of backgrounds. The link for “more info” could provide further explanation for the purpose of the field, tips on how to write good

alternative text, what to do in the case of images that don't communicate salient meaning that can be written as text, and what to do in the case of images that communicate something that takes more than a few words to describe. The idea that Andy first suggested to make the field required could also enforce the field and help ensure that alternative text was included. For this to work there would need to be an error message that provided instructions on how to write alternative text that could be similar to the contents of "more info".

*The shift from possible to probable – Alternative text*

The human-artifact model shifts the focus from the possibility for an action to occur to the probability that it will occur. If there is a poor fit between a human and an artifact regarding what and why a given activity or action is to be taken, that activity is unlikely to occur. This poor fit can be illustrated with another example of how the alternative text field has been labeled. This example was taken from the Google sites image upload form.

Google sites image upload form

Add an Image ×

**Uploaded images**    Upload an image     No file chosen

[Web address \(URL\)](#)

Alt text (optional):

Figure 18. Google sites image upload form.

In this example the alternative text field is labeled “Alt text (optional):” This label is both technically accurate and precise, but does not communicate what the field is or why it is on the form to someone who does not have prior awareness. Specifically indicating that the field is optional suggests that it may not be important: if the user is not aware of what it is, there should be no problem to leave it blank and submit the form. Questions derived from the Human-Artifact model suggest that this form has qualities that would decrease the probability that the field would be used.

Missing and unhelpful alternative text has been and continues to be a longstanding issue of accessibility for information technologies. If the design pattern inspired by the Human-Artifact Model has the desired effect of improving the quantity and quality of alternative text

entered, it could have important practical significance if it were broadly applied in a device and application agnostic manner.

*Possibilities for semantic tagging on headings*

Semantic tagging is a key requirement for “accessibility supported” designs. Semantic markup attaches meaning to the information on the page as opposed to just defining the presentation of the information. For example, using levels of headings in a document can create a virtual table of contents that a screen reader can access, making it accessibility supported. This enables someone using a screen reader to scan through headings and drill into the desired section. It is possible to create a document without using the headings function within a CMS or other tool. It is possible to enlarge and/or change the color of the text so that it looks the same as the text created with the heading function. However, in this case where the text is formatted to look like a heading, but actually isn’t a heading a screen reader would not be able to detect the hierarchical structure of the document.

The CKEditor tool being implemented by Andy and Bill and used by others in the departmental system makes it not only possible to apply semantic tagging to headings, but also probable. The control to mark up text as a heading is quite prominent in the design of the editor; and the ability to change font size and color is not exposed in the toolbar by default. The CMS both requires extra steps to format text without using the heading feature and it requires the user to know the HTML tags for formatting text. This design of the tool encourages the production of code that supports accessibility and discourages code that does not support

accessibility. The screenshots below were taken from the demonstration site of the CKE editor tool. Comparing these flows illustrates why flow A is more likely than flow B for a user who does not have technical skills.

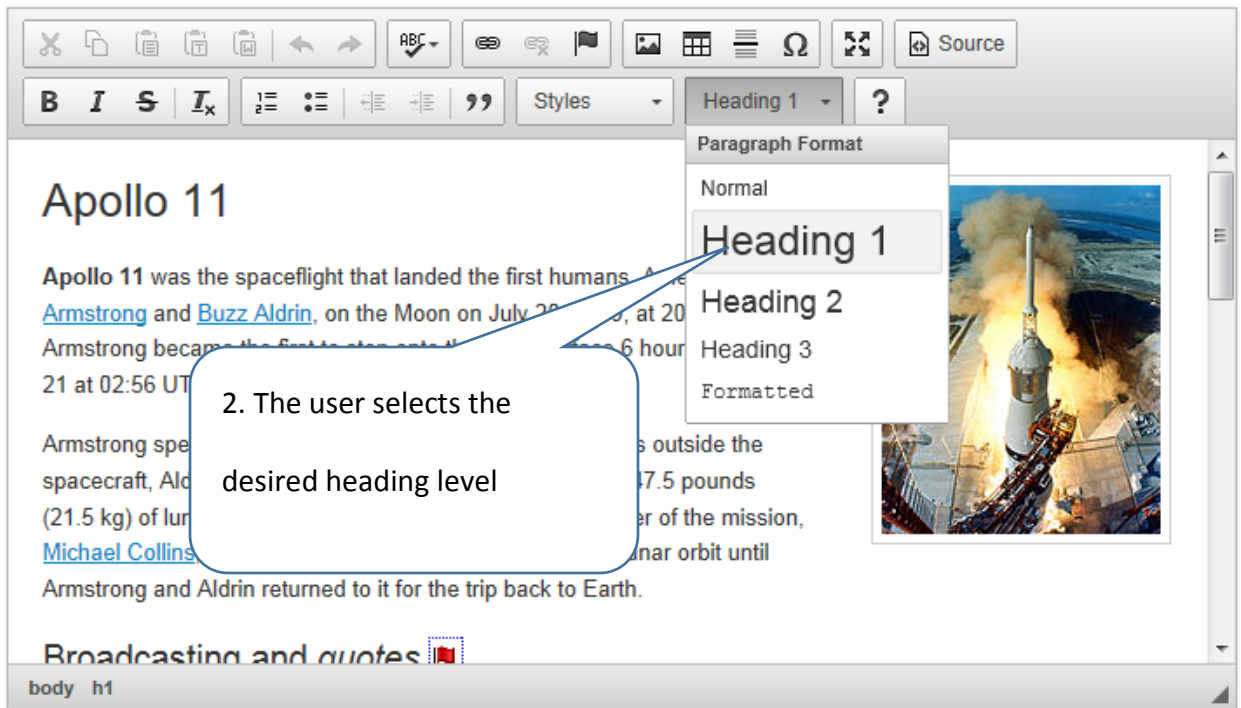
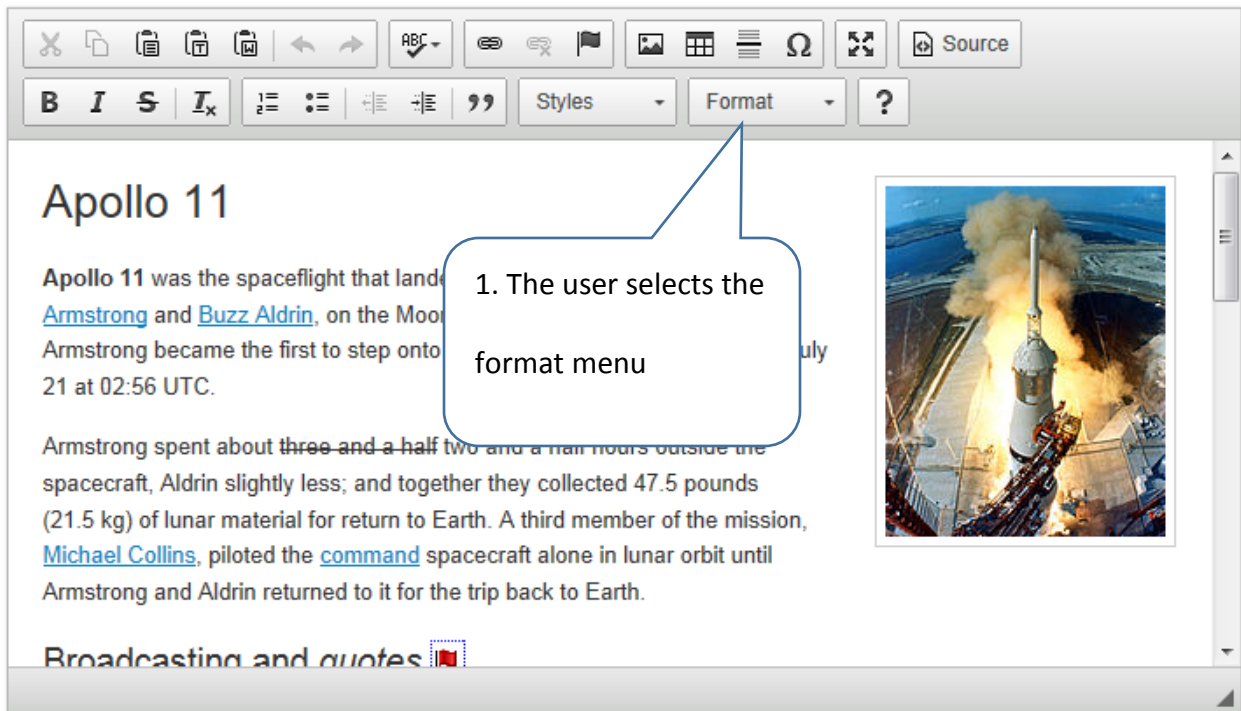


Figure 19. Flow A illustrates the probable workflow.

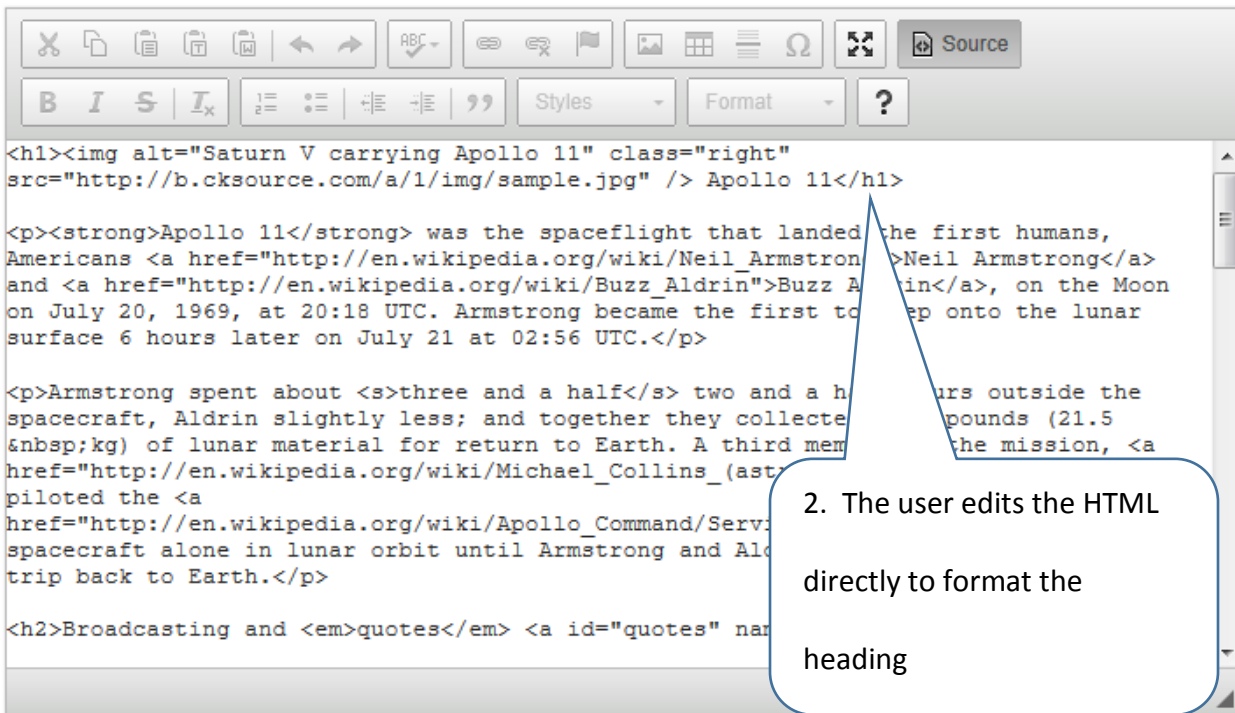
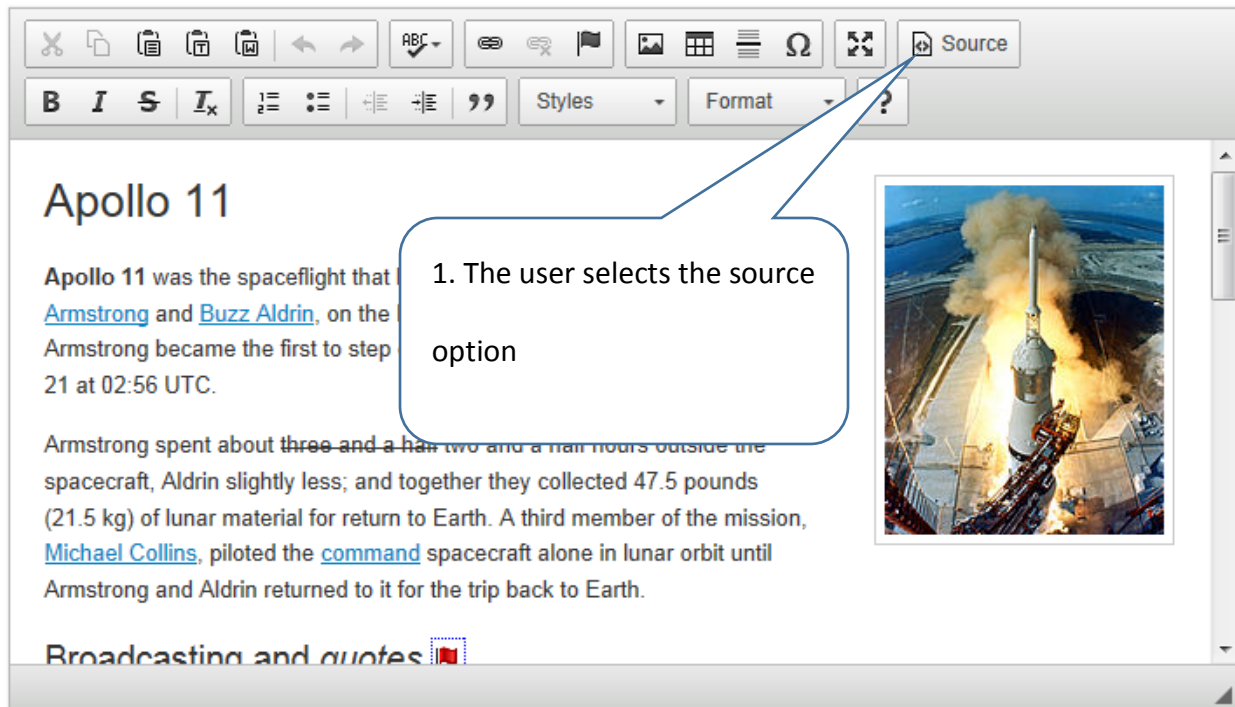


Figure 20. Flow B illustrates the unlikely workflow.

*PDF accessibility*

PDF accessibility also highlights the distinction between possibility and probability. It is possible to produce a tagged PDF document (i.e., with semantic tagging); however, the newsletter that Beth had her intern post to their departmental site was not tagged. PDFs can be created in three general ways, resulting in a range of accessibility barriers that are briefly described below as a backdrop for discussing the possibilities and probabilities of PDF accessibility.

The least accessible PDFs are simply scanned documents where each page in the PDF is a scanned image. Bea showed me some scanned PDFs of old newsletters on the departmental site, which were created when the newsletters were primarily delivered by post as opposed as by email. To be accessed through a screen reader these PDFs are scanned and converted into text with OCR (optical character recognition) software. OCR software is dependent on the image quality, with poor images resulting in mistakes in the character recognition. That software is also dependent on the organization of the blocks of text. If the blocks were formatted like a newspaper with stories continued on different pages, the resulting text from the OCR would be out of order. In today's world, scanned PDFs are still created: for example, old media that does not have an electronic version is scanned into this format. The issues created by scanned PDF persist. However, as more and more information is created and stored in formats where text is stored as text, rather than as an image, the prevalence of scanned PDFs should decrease over time.

Beth's untagged PDF newsletter was in the middle of the range of accessibility. The text of the document could be accessed through a screen reader without needing OCR software. The document still posed a fairly significant accessibility barrier, however, as the lack of semantic structure prevented a screen reader accessing the function to jump to a specific article.

It is possible, but difficult to generate PDFs with the necessary tagging of semantic structure which enables good accessibility. Generating tagged PDFs requires several steps. These steps are spelled out in an 86-page document on Adobe's website located here: [http://www.adobe.com/enterprise/accessibility/pdfs/acro6\\_pg\\_ue.pdf](http://www.adobe.com/enterprise/accessibility/pdfs/acro6_pg_ue.pdf). However, concise sets of instructions can be found through web searches. In any case, the steps often require changing default settings in the applications used to build the document, and those changes can interact with other application settings.

While scanned PDFs are likely decreasing in prevalence, untagged PDFs remain an issue. A comprehensive study of PDFs on higher education institution websites found that only 33.8% of the PDFs were tagged (Thompson et al., 2013). Beth's untagged PDF is typical of the PDFs evaluated in this study. Beth's emerging awareness of accessibility did not cover specific techniques such as PDF tagging. Tagging PDFs is not a function of accessibility that can be easily addressed through the indirect method of automating the function within the tools used to mediate PDF creation. It would require two things of Beth. First, she would have to become aware of the need to create tagged PDFs, and second, this need would have to be acted on. In

this case, she would have to become aware of the steps necessary to ensure that her PDFs are tagged. Given Beth's means, conditions, social context and tools mediating her activity creating the newsletter for her academic area, it is unlikely that she will become aware of and act on the necessary steps for tagging her PDFs.

### *Implications*

Tools used in authoring information technologies can facilitate or challenge accessible web design. The CKeditor facilitates user actions that result in semantic markup; however, it challenges user actions that result in helpful alternative text. The tools used to generate PDF documents make it challenging to ensure that they are accessible. This study explored how authoring tools can help and hinder IT accessibility. This core assertion on why and how accessibility issues are inadvertently built into information technologies has two implications for research and development in IT accessibility. The first implication connects this assertion to the approach taken by authoring tool accessibility guidelines. The second implication is for more research to further explore and validate this assertion from various angles.

*Implications for authoring tool accessibility guidelines*

The results of this study point to an implication for the W3C Authoring Tool Accessibility Guidelines (ATAG), particularly in how they address alternative text (W3C, 2013). The ATAG guidelines also address semantic markup with a clear difference in how the success criteria connecting to alternative text is written from the success criteria relating to semantic markup. These two guidelines are included in appendix D along with some of the text that describes their success criteria. The full guidelines are available here: <http://www.w3.org/TR/2013/CR-ATAG20-20131107/>. (Note that I have opted for the 2.0 version of the guidelines which are not yet in the officially approved state, however the 1.0 guidelines are over 10 years old at this point.)

The guideline that addresses semantic markup, B.2.2, emphasizes the probability that the user will make choices that lead to better accessibility. It specifically indicates that “problematic options” should be “deemphasized”, and in doing this encourages designs that increase the probability of improved accessibility. The guideline and success criterion for alternative text, B.2.3, addresses the possibility of entering and modifying alternative text, but does not emphasize the probability of alternative text being entered. It is possible to meet the criterion and still make it difficult for the user to enter alternative text. The guideline does not intentionally discourage authoring tools from making the task easy, however, in contrast to guideline B.2.2, it does not specifically encourage the makers of authoring tools to make adding alternative text easy. The criterion can be met as long as authors “can add alternative content”.

My analysis of this dissertation suggest that the ATAGs would be more effective if they consistently used the approach taken in B.2.2 where problematic options are de-emphasized and better options are hard to avoid.

The success criteria for B.2.3 provides a hint as to why this guideline has a weaker requirement for conformance than B.2.2. The apparent reason is that WYSIWYGs by definition emphasize what is “seen” and hide elements that are not seen. As text alternatives are not part of what is typically seen, the guideline suggests that it is acceptable for a WYSIWIG to hide missing or poor alternative text issues from the default view as long as “another mechanism” is provided to add and modify the text. In an idealized activity it is possible that all CMS users are trained to be aware of IT accessibility and seek out this other mechanism for validating their work, however, the observations made in this study and the current IT accessibility issues on the web in general suggest that this is not probable.

ATAGs and other WAI guidelines include success criteria that correspond to three levels of conformance: A, AA, and AAA. This leveling opens an opportunity for systematically connecting the levels of conformance to the probability that conformance results in improved accessibility for end users. For example, level A conformance could be connected to the possibility for accessibility; and level AA conformance could be connected to the probability for accessibility. As they are currently written an authoring tool can conform at the highest, AAA, level for guideline B.2.3 yet make it quite improbable that accessibility would actually be addressed.

Perhaps the core thrust of this dissertation as it relates to authoring tools can be reframed as an application of universal design to authoring tools and ATAGs. Universal design aims for a single design that is flexible enough to accommodate users with a wide range of skills and abilities. ATAGs clearly cover the range of authoring tool user needs regarding visual disabilities; however, the results of this study indicate that the ATAGs are not flexible enough to effectively accommodate the user needs of web authors without visual disabilities.

#### *Implications for future research*

The following range of questions point toward projects with potential to extend the core assertion of this project.

1. How much influence would the specific design change suggested for the image upload form have on the quality and quantity of alternative text entered?
  - a. This could be explored with an experimental design research approach comparing the alternative text produced through the existing design with text produced through the proposed design.
2. This project only explored two aspects of IT accessibility, alternative text and semantic labeling of headings. While these are core, they are not the only aspects of IT accessibility. There are other types of semantic labeling and other problematic barriers which were not explored. The approach taken in this project could be replicated with a shift in focus to some of these other top issues such as labels for forms and tables, link wording, and video captioning.

3. How much influence does the specific CMS used to produce content have on the nature of accessibility issues?
  - a. This could be explored initially by evaluating the accessibility of content produced through the most commonly used CMS tools to see if there are correlations between specific CMSs and the types of issues identified.
4. What are trends are emerging in authoring tools used to produce websites used in higher education? Which tools are used most commonly? CMSs? Traditional authoring tools which are optimized for designers and developers?

*Reflexive considerations*

My background and experience have influenced this project. I have worked as a user experience research manager for the past 11 years for an established ecommerce website. This has influenced my sense of what is normal regarding web design and development processes. The division of labor observed in the systems in this study were notably different from what was found in my work experience. Activities focused on and building a single webpage on the ecommerce site were distributed among several large teams of individuals each with well delineated objectives. My contribution to these activities was limited to customer research focused on our designs. My colleagues had roles with equally narrow focuses. This background led me to believe that maniacal attention to detail on every tiny aspect of how sites are designed is normal. This contrasted sharply with the approach taken by the respondents in this study. In the first system there was only one person whose role primarily focused on the

website and there was no one in the second system. Dave's analysis of data from his needs assessment survey suggesting a "do-it-all" type of web developer highlighted this contrast.

The overarching objective of an ecommerce business to facilitate the sale of products contrasts with the overarching objective of a university to facilitate research and education. In ecommerce the website (evolving to include native applications, etc.) is the primary mediating tool that facilitates virtually all of the company's business. In the university setting departmental websites are important mediating tools, however, they are not as core to overarching function of a university as a website is for an ecommerce business. For this reason it should not have been surprising to find the "do-it-all" type of web developer in the university setting.

This difference in the overarching objective also connects to differences in how work is prioritized how roles are created and filled. In the private sector, work is prioritized largely based on the profit motive. Although web development work is divided among many professionals with narrowly focused roles, their work collectively focuses on building a product that better facilitates the business's financial goals. Roles are created and individuals are hired to fill these roles with clear focus on the contributing to the overarching objective of building a profitable business. This objective is embedded into the ecommerce site, the object of collective activity. Work is prioritized to maximize the return on investment with careful calculations estimating the costs and benefits of various investment options. Content management roles exist in the corporate world, however, they are filled by specialists, in

contrast to the university setting where the task was performed by secretaries, student interns and associate program directors as an ancillary task.

In the university setting the overarching focus is on research and education as opposed to website development. Because of this, the focus of the work is less on the profit motive and more on supporting research and education. The goals associated with the redesign projects in cases 1 and 2 reflect this focus.

As I reviewed research and literature on web accessibility I found multiple articles focused on the challenges faced by web developers as they consider accessibility. This led me to expect that I might find this challenge facing the respondents in this project. The first design persona listed on the WAI site was described as being unsure whether to follow the national guidelines (Section 508) or the WCAG guidelines. This led me to believe that participants in this project might have the same question.

These reflexive thoughts illustrate the contrast between the results of this study and my experience and review of the literature. As I gradually became aware of these contrasts, my interpretation of what I was observing evolved. Initially, I expected stronger implications for training materials and for clarification of accessibility guidelines. By the time the contextual interviews were complete, my focus shifted more to the influence of tools framed by the Human-Artifact Model and ATAGs.

*Why were accessibility considerations largely absent in cases 1 and 2?*

Accessibility was either low on the triage ladder, or not being factored into the negotiation processes or information technologies developed in the first two cases. While there is no single answer to why accessibility was ignored, connections to activity theory offer an explanation of the phenomenon. The structural tension in the interrelated activity systems was not sufficient to produce the disruptive change necessary to ensure that accessibility was considered and factored into the information technologies that were being developed.

The university's inclusive vision along with the accessibility proponents in cases 3 and 4 spoke to the need; however, there was a disconnect between the need and the activities occurring in cases 1 and 2. From Ben's perspective there was no one "injecting" the need to address accessibility into the website and content he was responsible for planning and maintaining. In addition to lacking perception of the need to address accessibility, the hiring practices constrained what could be achieved. In a resource constrained environment the work to build and maintain CMSs was reactive and resulted in tools that were intended to be temporary fixes being used for 6 years. While accessibility was not considered, improving the reach of communications was considered in the first two cases. The combination of lack of awareness and priority given to accessibility with tools built and maintained in a resource constrained environment accounted for poor accessibility of the websites in cases 1 and 2.

*Forces of stability and change*

Opportunities for change exist within the policies and social/political cultural of the university. However several competing forces were observed, some of which maintain the status quo and some which challenge it. Some forces were from within the institution and some from the outside.

The institution's vision statement articulated the motive for an inclusive learning environment, however, the university lacked a formal accessibility policy. A formal policy could be used to aid in the negotiation process. This could ultimately "inject" awareness of accessibility needs into Ben's system, bring it up a few levels on Andy's "triage ladder" and generally improve consideration for accessibility throughout the university. Hiring practices could ensure that human resources are adequate to meet the evolving needs to create high quality, accessible information. Yet activity patterns remain stable until disruptive forces challenge them. Hiring practices, familiar objectives and how tools are used to achieve objectives are all characterized by stable, patterned activities until sufficient tension in the system builds to force change. Unless Bea is challenged, she will continue to disregard form fields that are critical to accessible design. Unless Beth becomes aware that her PDFs are inaccessible and is motivated enough to change her approach, she will continue to follow the path of least resistance within the tools she uses to produce PDFs.

The image upload form has provides an example of how tools can be changed to improve accessibility. This single example illustrates a strategy for change that could be applied

more generally to cover other top blocking accessibility issues as suggested above in connection to the ATAGs. However, demonstrating that a strategy for improving accessibility is possible is not sufficient to ensure that it will be followed. Again, the key is not what is possible, but what is probable as various competing motives and forces are negotiated.

The overarching objective in Case 3 is a force of change promoting accessibility. The formal roles within this group were created specifically to promote accessibility and provide related services. Dave, case 4, had also taken on the function of promoting accessibility even though his formal role didn't require this of him. He described the social context of the university and decision making process as being collaborative and democratic enabling him to take on this extra initiative in his work to promote accessibility.

The threat of costly legal ramifications is also a force that can motivate accessibility considerations. The costly lawsuit against Penn State creates pressure that challenges the status quo of poor accessibility. The fact that the university had recently created a position for an attorney within the risk management department to look after ADA compliance evidences this motivating force.

Opportunities for change exist; past and present forces motivating change and stability can be analyzed. However, it is difficult to predict the future. It is hard to know exactly how much tension needs to build before a disruptive change releases it. How much is the fear of litigation building up? Will this fear motivate a push for increasing awareness of the importance of accessibility? How effective will proponents of accessibility be, not only in providing training

materials and technical support, but also in spreading the word on why accessibility is important in the first place? Fear can motivate change, but humanitarian concern can also factor into the negotiation process to prioritize what will be addressed and what will be left undone. While predicting the future is a challenge, shaping the future is not only tractable but inevitable.

### Conclusion

This project examined the activities of web developers and content managers through the lens of activity theory. The results and discussion of this study suggest value in focusing both upstream and downstream while exploring the relationships among activity systems. This study found that most accessibility related contradictions were between systems as opposed to within a single activity system. The study also illustrated that the relationships among the systems could be represented with a waterfall diagram. While other methods of illustrating the ecosystem surrounding activity, such as a beehive, could be more accurate, the waterfall approach prevents complexity from detracting from the most salient relationships.

Activity diagrams can be used to differentiate actions that directly vs. indirectly influence accessibility. After making this distinction, the objective of accessible design becomes more tractable as it become clear who and what tools are in a better position to mediate the various actions and interactions the ultimately influence the accessibility of the resulting designs.

Design certainly is a complex activity. In the case of information technologies, individuals with an increasingly wide range of skills and abilities are using a wide range of tools to create information supporting a wide range of end users who are accessing content through an increasing number of devices. This study focused the activities of web developers and content managers that influenced the accessibility of the sites they were creating. Respondents in the first two systems were not prioritizing accessibility as they were building and maintaining

university websites. The tools that they were using did not facilitate the creation of accessible information technologies. This study explored how tools could be designed to ultimately result in improved accessibility, even to a degree in cases where authoring tool users have no prior awareness of IT accessibility, and how this approach could be incorporated into the WAI's ATAGs.

The university did not have a formal accessibility policy during the time of this research; however, forces were at work to change this. Proponents from within the university (case 3) were motivated by their roles which explicitly aligned with the need to improve how accessibility was addressed. Dave was a self-motivated individual who had latched on to the cause and been informally promoting accessibility across the university for years even though it was not required of his position as a web developer to reach out in this way. The new role within risk management to look after ADA compliance would undoubtedly have some influence on this effort as well. The absence of a formal policy challenged the efforts of those promoting accessibility. However, they were clearly focused on injecting the importance of accessibility and bringing it up a few rungs on the triage ladder of those building the university's websites.

While this study focused on activity systems within university departments, these activities were occurring within the larger context of technology development. In this larger context the pattern of major innovations followed by adjustments to promote universal access has persisted to the present. The cycle will move forward. Emerging technologies may replace the need for manually entering alternative text for images with automated descriptions.

Automation could also summarize and provide semantic structure for text. While these innovations could resolve some of today's core accessibility barriers, they will likely also result in new barriers.

On the surface, when accessibility is not adequately addressed in the activities of designers and developers individuals with disabilities are blocked from accessing information technologies. The lens of Cultural Historical Activity Theory provides a frame that provides a richer description and explanation of what is happening when accessibility is not addressed. Web sites, web authoring tools and PDF documents are all examples of cultural tools produced through a negotiation process. They embody components of the culture of those who create them. How inclusive is the culture at the university regarding individuals with disabilities? The answer to this question is reflected in the actions of the individuals that collectively make up the university. The answer is embedded in the cultural tools the university produces.

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Appendices

*Appendix A: recruitment email and eligibility script*

Recruitment email:

RE: Web accessibility research at the XXXXXXXXXXXX

Hi XXXX member,

I'm a graduate student seeking the opportunity to learn more about how web accessibility is considered when sites, such as departmental sites, are built or redesigned. I'm interested in finding groups, ideally including a developer, a content manager and person responsible for the pages being built who are willing to meet with me and share the processes that go into web projects. Participants will each receive a \$15 Starbucks card. If you or someone you know may be willing to assist me, please be in touch for details.

Thank you for considering this!

-Kyle Russell, M.S.

[XXXXXX@XXXXXX.edu](mailto:XXXXXX@XXXXXX.edu)

XXX-XXX-XXXX

Eligibility Script:

I am looking for teams comprised of the following three roles to participate in the project I'm working on. Are you in one of the following three roles?

Web Developer employed by the XXXXXXXXXXXXXXX in a role where web development of user interfaces is a present work task. Does all or part of your work include interaction design or display of information?

Web Content Manager employed by the XXXXXXXXXXXXXXX in a role where a web content management tool is being used on a present work task.

Web Business Owner employed by the XXXXXXXXXXXXXXX in a role responsible for either supervising web developers or content managers, or responsible for defining the requirements of the web pages being developed.

*Appendix B: Interview discussion guide*

1. What is your role as it relates to web design and development?
  - a. What specific tasks are you responsible for? I.e. collecting requirements, building wireframes, interaction design, visual design, user research, etc.? What processes do you follow when accomplishing these tasks?
2. What are your relationships with others who are involved with this process?
3. How is the work divided among you and others involved with the process?
4. What tools do you use to accomplish this work?
5. How do you personally evaluate the success of the work you perform?
6. How is your work evaluated by others in your organization?
7. How is your work evaluated by end users? What kinds of feedback exist from end users?
8. Are you familiar with the concept of web accessibility? If so:
  - a. Where did you learn about this?
  - b. What does accessibility mean to you?
  - c. What tools and guidelines do you use that relate to accessibility?
9. Show me an example of your work.
  - a. At this point the respondent was encourage to show work that they were currently doing on the their site

*Appendix C: Selected ATAG guidelines*

ATAG purpose:

“This standard provides guidelines for designing web content authoring tools that are both more accessible to authors with disabilities (Part A) and designed to enable, support, and promote the production of more accessible web content by all authors (Part B).”

“Guideline B.2.2: Guide authors to produce accessible content.”

“The intent of this success criterion is to help ensure that accessible authoring practices are part of the default workflow of authoring tools”

“De-emphasizing problematic options: A WYSIWYG editing-view emphasizes more accessible choices with a higher position in the menus and a position in user interface shortcuts, such as toolbars. Choices that always lead to less accessible web content are de-emphasized with lower menu positions.”

“Guideline B.2.3: Assist authors with managing alternative content for non-text content.”

“The intent of this success criterion is to ensure that authors can add alternative content for non-text content and modify that alternative content in the future.

If the type of alternative content (e.g. alternative text) is not typically displayed on screen by user agents, then WYSIWYG editing-views may not display it. This is acceptable as long as another mechanism is provided for modifying that alternative content (e.g. an "Image Properties" dialog).”

*Appendix D: Glossary*

1. ASCII art – A graphic design technique using the characters within a given font to create designs or emoticons.
2. CKeditor – CKeditor is an open sources WYSIWYG HTML editor and is a common component of CMS applications. <http://ckeditor.com/>
3. CMS – Content management systems are computer applications that facilitate building and maintaining information technologies such as websites. They enable the work of building and modifying these technologies to be distributed to individuals that don't have hand coding skills.
4. Design persona – Representation of a targeted user group for a given product used to give designers a concrete image of the end user's skills, goals, and context. Personas are often based on research data from a variety of sources.
5. Drupal – Drupal is a free, open source CMS. <https://drupal.org/>
6. Firebug – Firebug is a plugin for the web browser FireFox. It is a tool for developers to identify and fix bugs on web pages.
7. Flash – Flash is an adobe product with applications for building and viewing web animations.
8. IT accessibility – Information technology accessibility has essentially the same meaning as web accessibility except it is broader in scope. Because information

technologies have evolved to include more than simply websites, native applications on mobile devices for example, a term with a broader scope was necessary.

9. OCR – Optical character recognition. OCR converts scanned text (scanned from a physical book, for example) into digitized form. Once text is in digital form a screen reader can access and read it.
10. SEO – (Search Engine Optimization) Search engines use several types of information on websites to assist in determining how results are sorted. This information includes both visible elements, such as the text on the page, and elements which are not typically visible, such as the semantic markup, alternative text, etc. Search engine optimization aims to target this information to what search engines are factoring in to gain a better sort ranking.
11. W3C – (World Wide Web Consortium) The W3C is the main standards organization for the WWW.
12. WAI – (Web Accessibility Initiative) The WAI is the division of the W3C responsible for developing guidelines and technical reports relating to web accessibility.
13. Wordpress – Wordpress is a free, open source CMS. <http://wordpress.org/>

14. WYSIWYG (What you see is what you get) WYSIWYG provides the creator of a document or webpage with a view that is the same or very similar to the view of the end user of the document or webpage.

*Appendix E: Long descriptions for figures*

Figure 1. Contextual Design Flow Model. This model illustrates the flow of communication and artifacts between individuals and groups in a work system with arrows. These arrows can point in one direction or both directions. Individuals and groups are described in rounded boxes which include key activities that they perform. Individuals who are specifically interviewed are indicated by putting their job title under a pseudonym. Artifacts are described in rectangular boxes. Communications are summarized with text written on the arrows which connected the artifacts with the individuals and groups in the work systems.

Figure 2. Kaptelinin and Nardi's model of poly-motivated activity. This model illustrates how multiple, N, motives can map to a single object and activity. Need 1 feeds into Motive 1, Need 2 feeds into Motive 2 illustrated with arrows which converge on a single object of activity. It shows social context, and conditions and means as factors that mediate poly-motivated activity. These factors are represented as arrows that point to the converging motives.

Figure 3. The human-artifact model. This image is a picture of a table of concepts with the human/artifact on one axis and “Why?”, “What?”, and “How?” on the other axis. One small detail that is illustrated visually in the table is a separation between the operational and the adaptive aspects of “How?”, with the operational part focused on the handling aspects of the artifact and learned handling of the human and the adaptive part on the adaptive aspects of the artifact and adaptation of the human.

	Artifact	Human
Why?	Motivational aspects	Motivational orientation
What?	Instrumental aspects	Goal orientation
How?	Operational aspects	Operational orientation
	-Handling aspects	-Learned handling
	-Adaptive aspects	-Adaptation

Figure 4. Activity theory applied to design. This model connects the core concept of mediated activity to the activity of design. There are two activities illustrated, the activity of design and the activity of the end user. The Designer is the subject of the first activity where Objectives are fed into an Object with Mediating tools, Social context, and means and conditions influencing this activity. The designer’s objectives consist of multiple needs – motives and are acted upon by multiple actors – actions. The object of the designer activity becomes a mediating tool of the end user activity illustrated by an arrow pointing from the

object of the designer activity to the mediating tool of the end user. The human-artifact model is illustrated as text on this arrow. The activity of the end user is similar to the designer activity in that objectives are fed into an object with mediating tools (from the designer activity), social context, and means and conditions as mediators of the activity.

Figure 5. Flow diagram for Andy and Ann. Ann is represented in a rounded box with her job title, marketing manager, and key tasks: “Write feature articles” and “Interview individuals that the articles spotlight”. She is connected to her interviewees with a bidirectional arrow. A photographer photographs interviewees and gives this artifact to Ann. The feature articles that Ann builds are given to Andy. Andy is also represented in a rounded box with his job title, web manager, and key task, maintaining current website. In addition to receive artifacts from Ann, he also receives content updates (represented as an artifact box) from others in the college with many roles. Andy’s rounded box points to the current website as an artifact.

Figure 6. Accessibility of the college site. This illustration uses the model in Figure 4, activity theory applied to design to illustrate the design activities that related to accessibility. the designer objectives are “Accessibility is considered, but not given high priority”. Mediating tool is “Dreamweaver” the social context, conditions and means is “constrained resources”. The object is “site has multiple blocking accessibility issues”. The end user activity shows “Access” as the objective. The mediating tool is the “website” with an arrow pointing from the site as the object of the designer’s activity. A “screen reader” is also shown in parenthesis under “website”. The social context, means and conditions are “Wide range of social contexts, means,

and conditions”. The object of the end user activity is “content” so that the objective-object relationship is access-content.

Figure 7. Future flow of maintaining the college website. Three parallel streams of work all converge on Andy and Ann as content reviewers who approve and post content to the website which is illustrated as an artifact (box). The three parallel streams are associate deans who are responsible for content with arrows pointing to content experts who create and enter content in the CMS pointing to content updates entered in the CMS which all point to Andy and Ann.

Figure 8. Drupal template Andy was using to build the new site. This screenshot illustrates a page that Andy was working on for the new site. The image properties dialog box is shown in the foreground with the title and body sections of the work-in-progress page shown in the background.

Figure 9. Planning the college site. This illustration uses the model in Figure 4, activity theory applied to design to illustrate the planning of the college site. Objectives are “Branding guideline compliance, focus on biggest user groups, reflect new org. structure.” The mediating tool is “Drupal”. The mediating contextual factor is “Constrained resources”. The object of activity is the “Future website”. The end user activity shows “Access” as the objective. The mediating tool is the “website” with an arrow pointing from the site as the object of the designer’s activity. A “screen reader” is also shown in parenthesis under “website”. The social context, means and conditions are “Wide range of social contexts, means, and conditions”. The

object of the end user activity is “content” so that the objective-object relationship is access-content.

Figure 10. Flow diagram for departmental website. The CMS is central to this diagram as an artifact (box) with an arrow to the website as an artifact (box). Several streams feed into the CMS. Bill, director of computing, has the task to “design and maintain CMS.” Ben and Bea form a second stream. Ben, Associate program director, writes newsletter, instructs student intern, and adds and edits web contents. Ben both points to the CMS directly and also to Bea, student intern, in giving her the newsletter (box) to post content from the newsletter to the site and check for broken links. Beth, outreach coordinator, does not have a direct arrow to the CMS, but writes newsletters, and instructs her student intern. Beth’s arrow points to the PDF newsletter she gives to her student intern who posts the PDF newsletter to the CMS. Individuals in 10 other academic areas also point to the CMS.

Figure 11. Maintaining the departmental site. This illustration uses the model in Figure 4, activity theory applied to design to illustrate the maintaining of the departmental site. The objectives are to “post newsletters, post content updates and store and distribute materials”. The mediating tool is the CMS. The contextual factors are “Distributed among many with limited technical skills.” The Object of this activity is the website which is the mediating tool of end users. The end user activity shows “Access” as the objective. The mediating tool is the “website” with an arrow pointing from the site as the object of the designer’s activity. A “screen reader” is also shown in parenthesis under “website”. The social context, means and conditions

are “Wide range of social contexts, means, and conditions”. The object of the end user activity is “content” so that the objective-object relationship is access-content.

Figure 12. Sketch of Bea’s “Image Properties” dialog box. The title of the dialog box is “Image Properties”. The box has three tabs with the first tab, “Image Info”, selected. The other tabs are “Link” and “Advanced”. Next is an input textbox labeled “URL”. Next is an input text box labeled “Alternative text”. Next is a list of small input text boxes for “Width, Height, Border, HSpace, and VSpace. Next is a dropdown box labeled “Alignment” with “<no set>” as the defaulted selection. The dialog box contains an area labeled “Preview” where images can be previewed. The action buttons at the bottom of the dialog box are “Cancel” and “OK”.

Figure 13. Example illustrating Ascii art. This figure illustrates what ascii art looks like with a letter “A” as an example. The letter A is constructed from spaces and “A” characters to form a large letter A from these individual characters.

Figure 14. Key activities relating to accessibility and web design. This image shows that an object of activity can be either a physical object or an abstract objective. In both cases it shows the flow of the object(ive) in a waterfall diagram with consecutive activities where the object(ive) of the proceeding activity mediating the next activity. The flow begins with “Promote and provide – Awareness and tech support for accessibility” where “Awareness. . .” mediates the next activity, “Build and modify – CMS” where “CMS” mediates the next activity “Post and edit content – website” where “website” mediates the next activity “Access – content” which is mediated by a screen reader.

Figure 15. Accessibility is directly addressed. This illustration uses the designer component of the model in Figure 4, activity theory applied to design. The end user component is left out of this model. Designer objectives are “the need to address accessibility is incorporated directly into the site with the website being the object of the activity. The contextual factor is “Designer’s social context exposes need for accessibility”.

Figure 16. Accessibility is indirectly addressed. This illustration uses the model in Figure 4, activity theory applied to design, to illustrate how accessibility is indirectly addressed. The designer is a CMS implementer and the end user is a content manager in this illustration. The objectives of the CMS implementer is “the need to address accessibility is incorporated through the CMS”. “Mediating tools” and “Designer’s social context exposes need for accessibility” are the mediating factors. The CMS is the object of the CMS implementer and an arrow shows that this object becomes the mediating tool of the content manager who’s “objectives” are focused upon a “website”. The content manager’s contextual factor is “may lack awareness of accessibility”.

Figure 17. Current (left) and proposed modification to Image Properties. This figure shows a copy of figure 12 with a modified version of the same image. The modified version is identical except that the label “Alternative Text” is replaced by “Image description” with a link to the left of the label, “more info”.

Figure 18. Google sites image upload form. This figure is a screenshot from Google sites of a dialog box that is similar to “image properties” in its function. The part of the screen

relevant to this topic is the label for the alternative text input field. The label is “Alt text (optional):”

Figure 19. Flow A illustrates the probable workflow. This flow shows the CKeditor WYSIWYG with the “format” dropdown open to show that the user can choose “Normal, heading 1, heading 2” and “heading 3” as options to format text which would result in a site with good semantic markup that would result in better accessibility.

Figure 20. Flow B illustrates the unlikely workflow. This shows that as an alternative to the “format” dropdown in shown in figure 18 there is a “source” button that displays the HTML code in the main content area of the tool for direct editing. This is unlikely to be used by typical content managers as they are unlikely to know HTML and might be intimidated by seeing the code.