122nd ASEE Annual Conference & Exposition
June 14 - 17, 2015
Seattle, WA
Paper ID #12194

Accessibility, Usability, and Universal Design in Online Engineering Education

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Abstract

Accessibility and usability have been fundamental concerns for instructional designs in online engineering education. With the prevalence of online professional development and course management systems (CMS), the delivery of accessible and user-friendly course materials become crucial to a successful online program. Government entities, including public universities like UW-Madison, are legally bounded by the regulations of Section 508 of the Rehabilitation Act requiring all web content is within reach of all users. Universal design principles go beyond accessibility requirements and advocate that designing online education for a diversity of user needs and circumstances enhances learning for everyone. In this paper, we explore key accessibility, usability, and universal design issues to see how user experiences in distance education have been optimized to benefit all users. We discuss current trends and potential best practices of effective distance teaching and learning in continuing education under recommended frameworks from Web Content Accessibility Guidelines (WCAG) 2.0. We will share practical tips and lessons learned from our experiences developing online Engineering Master Degree Programs

Keywords

Accessibility, Instructional Design, Universal Design, Online Engineering Education

Background

Online enrollments in higher education courses continue to increase at a steady rate. In the fall of 2012, 33.5% of all higher education students were taking at least one online course, up from 10% a decade ago[ii]. Meanwhile, postsecondary populations are also seeing an increased number of students with disabilities (Sevo, 2012), and according to the National Science Foundation (NSF) Committee on Equal Opportunities in Science and Engineering (CEOSE)[iii], as many as 11% of undergraduate students in science and engineering fields have one or more disabilities. These disabilities may include limitations in vision, speech, hearing, or mobility; or students may be affected by "invisible" disabilities such as learning or attention deficits, autism spectrum disorders, or psychiatric conditions.

In 2009 National Science Foundation concluded that the inclusion of students with disabilities in science and engineering is a national goal (CEOSE, 2009). To best meet the educational needs of all students in STEM and other online programs, course designers and instructors should consider the accessibility and usability of their course materials and take proactive steps to prepare and deliver instructional materials with the widest possible audience in mind.

Students with disabilities are protected by the Americans with Disabilities Act of 1990 (ADA), as amended in 2008 (ADAAA)[iv], and Sections 504 and 508 of the Rehabilitation Act of 1973[v]. The ADA prohibits discrimination against individual with disabilities in all areas of public life. Section 504 of the Rehabilitation Act protects individuals from

discrimination based on disability status and applies to organizations receiving federal funds. States receiving funds through the Assistive Technology Act of 1998[vi] are required to comply with Section 508 of the Rehabilitation Act and ensure that electronic and information technology is accessible to individuals with disabilities. Since all states receive this funding, state entities like public universities must comply with the law[vii].

These laws engendered several guidelines and standards for institutions to follow in order to ensure accessibility of their course materials. The Web Content Accessibility Guidelines (WCAG) are part of a series of web accessibility guidelines published by the Web Accessibility Initiative (WAI) of the World Wide Web Consortium (W3C), the main international standard organization for the World Wide Web. They consist of a set of guidelines for making content accessible and inform most institutions' accessibility policies. Some academic institutions also subscribe to the Quality Matters peer-review process to certify the quality of online and blended courses. The Quality Matters Rubric[viii] is a set of 8 general standards and 41 specific standards used to evaluate the design of online and blended courses. Quality Matters Accessibility Elements – Standard 8 describes the guidelines for creating the face-to-face and online course components that are accessible to all students.

While accessibility requirements are often about making accommodations for materials that are inaccessible, the concept of Universal Design advocates proactively designing from the start for the widest possible audience. With its origins in the field of architecture[ix], Universal Design in instruction goes beyond simply making course materials accessible to students with disabilities and provides a framework for meeting the diverse needs of as many students as possible. Universal Design has wide-ranging applications in online educational environments; from the way learning objectives are described and communicated, to the development and presentation of instructional materials, to methods of teaching and assessment[x].

Objectives

This paper has several objectives. The first is to present accessibility and Universal Design principles as they relate to online learning. This includes a review of current models and a description of best practices. Second, we will describe strategies used to implement a Universal Design process in the development of online courses within a distance degree Masters program. While a comprehensive application of Universal Design principles within an online program is arguably the ultimate goal, the scope of this paper focuses on the first phase of incorporating accessibility and Universal Design best practices into the design and delivery of online instructional materials, specifically course documents and videos. Using the Universal Instructional Design principles (UID) for Distance Education (Elias, 2010) and WCAG 2.0 accessibility guidelines, we will assess the current state of our online instructional materials and discuss challenges and opportunities for further UID implementations within our programs. Next, we will consider implications for students utilizing certain assistive technologies, and outline areas for further study.

Accessibility

In the context of arguing for the term "neurodiversity", Griffin and Pollack (2009) argue that focusing on "difference rather than difficulty" is more empowering as it "rejects a deficit approach to supporting students in higher education". The term "disabled student(s)" is used to refer to any student who has a sensory, cognitive, physical, or psychological impairment. These students may benefit from using technological tools and related services to support and promote access to equitable educational experiences and outcomes.

Many disabled students can only access learning resources and experiences if they have assistive technologies (Banes & Seale, 2002; Scherer, 2004). However, all students would benefit from using the same technology tools and related services. Assistive technology has been broadly defined as a "broad range of devices, services, strategies, and practices that are conceived and applied to ameliorate the problems faced by individuals who have disabilities" (Cook & Hussey, 1995, p.5), and the Assistive Technology Act (United States Congress, 2004) defined assistive technology as "any item, piece of equipment or product system, whether acquired commercially, modified, or customized, that is used to increase, maintain, or improve functional capabilities of individuals with disabilities" (Section 3, para. 4)[xi]. Similar to what assistive technologies can do, the goal of universal design, or inclusive design, is broadly defined as to produce buildings, products, and environments that are inherently accessible to older people, people without disability, and people with disabilities.

Universal Design in Instruction

In 1997, the Center for Universal Design (CUD) at North Carolina State University established seven principles of Universal Design (UD) to provide guidance in the design of products and environments (Connell, et. al., 1997).

1. Equitable use
2. Flexibility in use
3. Simple and intuitive use
4. Perceptible information
5. Tolerance for error
6. Low physical effort
7. Size and space for approach and use

CUD's guiding philosophy was that designing for individuals with disabilities ultimately makes products and environments more accessible and user-friendly for everyone. Curb cuts not only benefit individuals with wheelchairs; they are also of great use and benefit to anyone pushing a stroller or a shopping cart. Captions not only make video content accessible for the hearing impaired; they also serve anyone unable or unwilling to use audio such as travelers in noisy airports or individuals watching videos in areas where sound would be unwelcome.

In more recent years, researchers and practitioners have adapted and applied UD principles to the field of instruction. (Scott, et. al, 2003; Burgstahler, 2007 and 2009). The Center for Applied Special Technology (CAST)[xii] applied UD concepts to education,

coining the term **Universal Design for Learning (UDL)**. The principles of UDL focus on creating barrier-free instructional materials, methods, and activities to make them accessible to as many students as possible, across all levels of education, regardless of disability status.

The notion of universal design specifically to higher education settings was introduced by Silver, Bourke, and Strehorn (1998). They advocated a model where universal design and accessibility issues are in "integral component of all instructional planning" (p.47). Goff and Higbee's (2008) **Universal Instructional Design (UID)** framework is based on Chickering and Gamson's (1987) principles for good practices in undergraduate education but modified to include elements of universal design. Burgstahler's **Universal Design of Instruction (UDI)** model provides eight guiding principles intended to be applied to the design of instruction, the physical environment of the class, delivery methods, feedback, assessment, and technology. Burgstahler defines UDI as "the design" of instruction of products and environments to be usable by all students, to the greatest extend possible, without the need for adaption or specialized design" (Burgstahler, 2012, p.2).

Universal Design Educational Models	
UID: Universal Instructional Design (Goff & Higbee, 2008)	a. Creating welcoming classrooms b. Determining essential components of a course c. Communicating clear expectations d. Providing timely and constructive feedback e. Exploring use of natural supports for learning, including technology f. Designing teaching methods that consider diverse learning styles, abilities, ways of knowing, and previous experience and background knowledge g. Creating multiple ways for students to demonstrate their knowledge h. Promoting interaction among and between faculty and students
UDL: Universal Design for Learning (National Center on Universal Design for Learning, 2010)	Principle I. Provide Multiple Means of Representation Principle II. Provide Multiple Means of Action and Expression Principle III. Provide Multiple Means of Engagement
UDI: Universal Design of Instruction (Burgstahler, 2009)	1. Class climate 2. Interaction 3. Physical environments and products 4. Delivery methods 5. Information resources and technology 6. Feedback 7. Assessment 8. Accommodation

Table 1: Universal Design Models. Source: Rao & Tanners (2011)

As online teaching and learning has become more prevalent, frameworks for applying Universal Design considerations to online instruction have appeared in the literature. Rao and Tanners (2011) examined how Universal Design approaches could be considered during the instructional design process and applied in an online course. They considered implications for technology and pedagogy and also evaluated what UD elements students appreciated the most. Features of the course designed with UD principles were rated very favorably by students and were highly beneficial to those needing additional supports due to their disabilities (Rao & Tanners, 2011, p.225).

WCAG 2.0

Web Content Accessibility Guidelines (WCAG) 2.0[xiii], on the other hand, covers a wide range of recommendations for making web content more accessible. Content editors and managers are encouraged to follow these guidelines to make content accessible to a wider range of people with disabilities, including blindness and low vision, deafness and hearing loss, learning disabilities, cognitive limitations, limited movement, speech disabilities, photosensitivity and combinations of these.

Web accessibility, as the document indicates, depends not only on accessible content but also on accessible web browsers and other user agents. Authoring tools also have an important role in web accessibility. Therefore, there are overviews of how these components of web development and interaction working together: 1) Essential Components of Web Accessibility; 2) User Agent Accessibility Guidelines (UAAG) Overview; and 3) Authoring Tools Accessibility Guidelines (ATAG) Overview.

WCAG Principles and Guidelines	
Principle 1: Perceivable – Information and user interface components must be presentable to users in ways they can perceive	Guideline 1.1: Text Alternatives – Provide text alternatives for any non-text content Guideline 1.2: Time-based media – Provide alternatives for time-based media Guideline 1.3: Adaptable – Create content that can be presented in different ways Guideline 1.4: Distinguishable – Make it easier for users to see and hear content
Principle 2: Operable – User interface components and navigation must be operable	Guideline 2.1: Keyboard Accessible – Make all functionality available from a keyboard Guideline 2.2: Enough Time – Provide users enough time to read and use content Guideline 2.3: Seizures – Do not design content in a way that is known to cause seizures Guideline 2.4: Navigable – Provide ways to help users navigate, find content, and determine where they are
Principle 3: Understandable – Information and the operation of user interface must be	Guideline 3.1: Readable – Make text content readable and understandable

understandable	Guideline 3.2: Predictable – Make web pages appear and operate in predictable ways Guideline 3.3: Input Assistance – Help users avoid and correct mistakes
Principle 4: Robust – Content must be robust enough that it can be interpreted reliably by a wide variety of user agents, including assistive technologies	Guideline 4.1: Compatible – Maximize compatibility with current and future user agents, including assistive technologies

Table 2: Web Content Accessibility Guidelines (WCAG) 2.0

As we know, the Web has changed dramatically during the development of WCAG 2.0, and shows every promise of continuing to evolve at a rapid pace. WCAG 2.0 consists of technology-neutral principles, guidelines, and success criteria that reflect properties of web content that make it accessible to people with varying disabilities and combinations of disabilities. However, as the Web evolves, the guidelines should keep on evolving as well to continue assisting technology developers and authors in ensuring people with disabilities can share in the benefits of the World Wide Web (Reid & Snow-Weaver, 2008).

Universal Design (UD) in Online Learning Environments

Elias' (2010) specifies connections between Distance Education (DE) environments and Universal Design. For online education learners, students are diverse geographically, which means they are isolated from instructor(s), university facilities, and other students. There are diversities in schedules, timelines, work and family commitments, and technical skills. Moreover, students may be diverse in their online connectivity levels and availability.

UD as applied to date in EPD is based on principles from several models: 1) Accessible templates for course materials; 2) Consistent LMS structure; and 3) Couse designs that promote interaction among and between faculty and students. In the Case Study section, we will take the production and delivery of: a) Accessible PDFs; b) Lecture videos; along with c) Learning management systems (LMS); and d) Web conferencing tools; as essential online course components to verify levels of usability and accessibility through the lens of universal design and accessibility principles.

Analytical Frameworks

To set up a new course or modify an existing course in EPD, at first Program Directors (PD) identify course instructor whose expertise matches competencies and then Learning Design & Technologies (LDT) unit sends instructors welcome email to include schedules for kick-off meeting, needs for course evaluation survey with Qualtrics, and course design guidelines. In the kick-off meeting, instructors share timeline, course syllabus, lesson files, and tentative recorded presentations with LDT. LDT offers templates from previous courses, concepts of basic course setup, and perhaps some necessary setup trainings. If needed, LDT also provides consultation and follow-up tech training meetings on authoring and delivery tools.

LDT provides technical trainings in the following Learning Management Systems (LMS): Moodle, or Desire to Learn. We use Microsoft Word and Adobe Acrobat to create accessible PDFs as course overview and lesson plans, and Box for cloud storage and most of the video streaming. Instructors and students have access to web conferencing tools like Blackboard Collaborate, Adobe Connect, and Google Hangout. We have Kaltura on D2L for video streaming, and Camtasia, ScreenFlow, and Quicktime Player for screencasts and lecture video production.

We are in a process of continuous improvement regarding all of our processes and workflow, particularly how they relate to Universal Design.

To demonstrate our current practices with universal design principles on course material preparation and delivery, we review the necessary components of our instructional technologies and standard procedures with Elias' (2010) recommendations on how to apply UID & WCAG principles to distance education. Specifically we looked at the four major tools of online course delivery within our Master of Engineering Management (MEM) and Master of Engineering in Engine Systems (MEES) programs: **lesson files (Acrobat)**, **assignments (Moodle)**, **recorded lectures/discussions (Box)**, and **web conferences (Blackboard Collaborate)**.

UID & WCAG Principles	Categories of online course material accessibility
Perceivable use: Equitable	1) All content online 2) Accessible Anywhere Anytime 3) Text alternatives for non-text content 4) Alternatives for time-based media 5) Make it easier to see and hear content
Adaptable use: Flexible	6) Choice of study topics/assignments 7) Real-time conferencing function 8) Video/audio presentation function 9) Create content to be presented in multimodal ways
Operable use: Simple and intuitive	10) Searchable content 11) Easy-to-navigate menus & simple interface 12) Mobile interface 13) Offline resources 14) Text-only interface
Understandable use: Perceptible Information	15) Screen preferences, font, size, masking, colors 16) Screen/document readers or text-to-speech 17) Screen/cursor magnifiers 18) Video transcription/captions
Enough time: Tolerance for user error	19) Confirmation before sending comments or uploading assignments 20) Warnings when leaving the program
Compatible use: Technical and physical effort	21) Embedded multimedia/assistive technologies 22) Word prediction

	23) Voice recognition
Collaborative use: Learner community and support	24) Links to support services 25) Study group 26) Involvement in discussion forums 27) Availability for weekly web conferences 28) Availability for one-on-one consultation

Table 3: UID & WCAG principles for online course materials/tools (Modified from Elias, 2010)

On Online Engineering Education Tools

The analysis provides an overall impression of the types online course preparation and delivery technologies currently used in EPD and their corresponding features as suggested by UID & WCAG design principles. In order to illustrate the potential for improving accessibility and usability in online course platforms, we revisited our tools and environments to identify a series of standard product features and possible improvement.

Perceivable use: Equitable

Course design should facilitate equitable use by people with diverse abilities and locations.

Perceivable use: Equitable Use	Moodle	Acrobat	Box	Blackboard Collaborate
All content online	Y	Y	Y	Y
Accessible Anywhere Anytime	Y	Y	Y	Y
Text alternatives for non-text content	Y	Y	N/A	Y/N
Alternatives for time-based media	Y	N/A	Y	Y
Make it easier to see and hear content	Y	Y	Y	Y

Table 4: Equitable Use Evaluation Rubrics

Discussions

- All the content and lecture videos should be put online and downloadable for offline use. PDF files should be accessible by screen readers or text-to-speech programs, and videos should come with closed captions. Our course overview and lesson plan templates are made with accessible PDFs, and our LDT research unit is experimenting with effective ways to add closed captions to lecture videos.
- Recordings of lectures and group discussions are alternatives for real-time, face-to-face interactions.

Adaptable use: Flexible

Course design should accommodate a wide range of individual abilities, preferences, schedules, levels of connectivity, and choices in methods of use.

Adaptable use: Flexible	Moodle	Acrobat	Box	Blackboard Collaborate
Choice of topics/assignments	Y	N/A	N/A	N/A
Real-time conferencing function	Y/N	N/A	Y/N	Y
Video/Audio presentation function	Y	N/A	Y	Y
Create content to be presented in multimodal ways	Y	Y/N	Y	Y

Table 5: Flexible Use Evaluation Rubrics

Discussions

- Make both synchronous and asynchronous sessions available. Asynchronous delivery, such as watching lecture videos or recorded web conferences, is important for students with different work and family responsibilities. Our courses use a combo of synchronous/asynchronous settings to allow for flexible schedules. Synchronous sessions are hosted and recorded with Blackboard Collaborate.
- Consider diverse options for presenting content, and allowing assignments on different topics or in multiple formats. By providing students with greater flexibility and choices, the enhancement aims at unlocking the full potential of students, and providing more opportunities for them to pursue activities that match their interests. Most of EPD courses used project-based learning, which allows students to choose the topics for many of their assignments. Even though many instructors offer choices for topics of studies and projects so students can meet course requirements in a way that is best suitable for their individual needs, it is equally important to provide clear instructions for assignment submission.
- Diversified choices of assignments allow all students in the class to look for specific solutions that best suit their strengths and weaknesses for completing the tasks. Meanwhile, instructors have to clarify grading rubrics in advance.

Operable use: Simple and Intuitive

Course design should be simple and intuitive. Unnecessary complexity should be eliminated.

Operable use: Simple and intuitive	Moodle	Acrobat	Box	Blackboard Collaborate
Searchable content	Y	Y	Y	N
Easy-to-navigate menus & simple interface	Y	Y	Y	Y
Mobile interface	Y	Y	Y	Y/N
Offline resources	Y	Y	Y	Y
Text-only interface	Y	Y/N	N	N

Table 6: Simple and Intuitive Use Evaluation Rubrics

Discussions

- Offer simple, text-only interface, and easy-to-navigate menus. Simple interface and easy-to-navigate menus are fundamental requirements for better usability. Text-only

interface as an option is extremely important for visually impaired students because it is difficult for screen readers or text-to-speech programs to follow graphical or nonlinear setups. Text-only interface, however, also benefits learners struggling with low Internet connectivity.

- Offline format of course materials are downloadable from course website so learners can still access the content without Internet connectivity.
- Search box for course content and online discussions are convenient for users to retrieve the information they desire.
- With the prevalence of smart phones, tablets, Wi-Fi and 3G/4G networks, mobile options are the emerging features for usability improvement. For example, Blackboard Collaborate has mobile interface to connect to a webinar, but with limited functionalities. Participants are able to join in their weekly sessions but unable to upload slides for presentation from their mobile devices.

Understandable use: Perceptible Information

Course design should communicate necessary information effectively to the user, regardless of ambient conditions or the student's sensory abilities. Add captions, descriptors, and transcriptions. Incorporate assistive technologies.

Understandable use: Perceptible Information	Moodle	Acrobat	Box	Blackboard Collaborate
Screen preferences, font, size, masking, and colors	Y	Y	Y	Y
Screen/document readers or text-to-speech programs	Y/N	Y	N	Y
Screen/cursor magnifiers	Y/N	Y	Y	N
Video transcription/captions	N/A	N/A	N	N

Table 7: Perceptible Information Evaluation Rubrics

Discussions

- Accessibility concerns: allow screen reader compatibility. For screen reader users on PC or Mac, they need to download and install Java Accessibility Bridge to have access to Blackboard Collaborate v12.5.[xiv] The Java Access Bridge is a technology that allows assistive technologies, such as screen readers, magnifiers, etc., to access Java applications and applets, including Blackboard Collaborate products. In order to use Blackboard 11 with the JAWS (Job Access With Speech) screen reader, users must install Java Access Bridge v.2.0.1. For Moodle users there is a potential screen reader and magnification software Supernova[xv] that provides independent screen access for users with visual impairment. But the basic packet for a single user costs around USD$1,000.00. There are also a variety of options on free & open source or commercial screen readers.[xvi]
- For LMSs like Moodle, or D2L, learners cannot set screen preferences or change font or colors, but font size is adjustable in most browsers by pressing "Ctrl/Cmd" and "+/-" simultaneously on the keyboard.
- Have lecture videos closed captioned. As we mentioned earlier, captions not only make video content accessible for the hearing impaired; they also serve anyone

unable or unwilling to use audio, such as travelers in noisy airports or individuals watching videos in areas where sound would be unwelcome. The term "closed" means that the captions are not visible until viewers activate them. In EPD we are not yet captioning or transcribing videos, but we are piloting workflows and video delivery systems to allow for the better integration of transcripts and closed-captioning in our instructional videos.

Enough time: Tolerance for User Error

Course design should minimize hazards and adverse consequences of accidental or unintended actions.

Enough time: Tolerance for user error	Moodle	Acrobat	Box	Blackboard Collaborate
Confirmation before sending comments or uploading assignments	Y/N	N/A	N	N
Warnings when leaving the program	N	N	N	N

Table 8: Tolerance for User Error Evaluation Rubrics

Discussions

- Balance between rules and tolerance. Students have to be responsible for their posts, but consequences of accidents should be avoided. For instance, in Moodle students get a notice after posting, and have 30 minutes after that to decide to edit or remove the message before it is permanent.
- Confirmation when submitting quiz answers or assignments. It is essential to allow students enough response time in assessments. Allow learners to correct technical mistakes as it also helps learners build up their own confidence in using the technology.

Compatible use: Technical and Physical Effort

Course design should require low level of technical and physical effort compared to face-to-face instruction.

Technical and physical effort	Moodle	Acrobat	Box	Blackboard Collaborate
Embedded multimedia/assistive technologies	Y	Y	Y	N
Voice recognition	N	N/A	N/A	Y/N
Word prediction	Y/N	Y/N	Y/N	N

Table 9: Technical and Physical Effort Evaluation Rubrics

Discussions

- Incorporate multimedia and assistive technologies. As Elias' (2010) suggests, instructional designers need to integrate available Moodle modules to enable the use of sound and video and other assistive technologies to help reduce the "physical and

mental fatigue" of our students online (p.120). Assistive technologies like voice recognition or word prediction will meet the diverse needs of all students.

- Recruit a robust tech support team. Campus technologies grow rapidly in the online education field, and it is important to receive new updates and explore emerging issues and solutions associated with tools for online education.
- Online course materials are designed so they can be downloaded easily in an accessible format. Students should have the option to work offline as face-to-face instruction, without extra technical frustrations in the learning process.

Collaborative use: Learner Community and Support

The learning environment should promote interaction and communication among students and between students, faculty and administrative services.

Collaborative use: Learner community and support	Moodle	Acrobat	Box	Blackboard Collaborate
Links to support services	Y	Y	Y	Y/N
Study group	Y	N/A	Y/N	Y/N
Involvement in discussion forums	Y	N/A	N/A	N/A
Availability for weekly web conferences	Y	N/A	N/A	Y
Availability for one-on-one consultation	Y	N/A	N/A	Y

Table 10: Learner Community and Support Evaluation Rubrics

Discussions

- All the campus technologies should incorporate the Help part to assist their users with problem-solving. The option of online chat with technical support team provides users quick solutions to issues they are facing. In a broader sense, EPD credit programs offer easy-to-find links to a variety of support services. Direct links to the library, administration, cloud storage, online discussion rooms, and alumni communities can be found on most course pages. The support services not only promote connections between and among faculty and students but also offer the ability for students to work together as study groups and to learn from each other.
- This UID principle concerns impact of the instructor delivering a course. Our faculty is highly engaged in discussion forums in Moodle, weekly web conferences with Blackboard Collaborate, and email contact with students. Some instructors have participated in Teach Online, a professional development workshop for UW-Madison faculty and staff who are involved in online course preparation and delivery. Meanwhile, it is the instructors' responsibility to make sure that expectations of students' course performance are clearly stated in the syllabus/Course overview in terms of assignments, participation, and feedback.

Authoring Tools for Video Captions and Accessible PDFs

Authoring tools are software and services that "authors" (web developers, designers, writers, etc.) use to produce web content (static web pages, dynamic web applications, etc.). The Authoring Tool Accessibility Guidelines (ATAG)[xvii] explain how to: a) Make

the authoring tools themselves accessible, so that people with disabilities can create web content; and b) Help authors create more accessible web content, specifically on supporting and promoting the production of content that conforms to Web Content Accessibility Guidelines (WCAG).

The screenshot below demonstrates one of LDT's efforts on the exploration of potential authoring tools and third-party companies for adding video transcripts/captions.

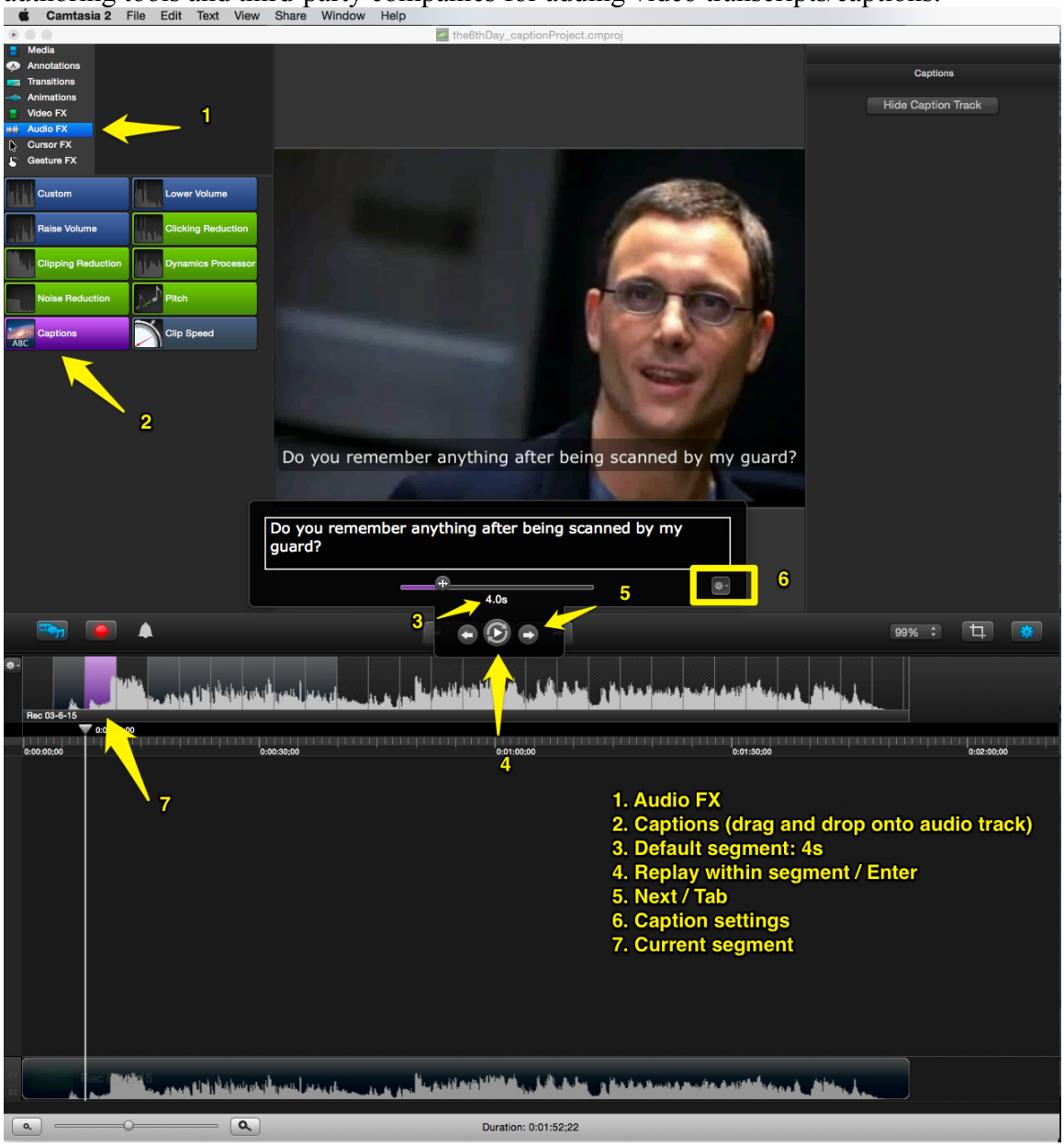

Illustration 1: Closed captions with Camtasia 2

Authoring tools like Youtube Video Editor, Camtasia, ScreenFlow, and Quicktime Player are tested for video captioning, as Word and Acrobat are for accessible PDFs. However, as EPD constantly sponsors extensive explorations on emerging and existing instructional technologies and authoring tools to build up our own Standardized Operating Procedures

(SOP) on the production and delivery of accessible online course contents, we found that there is still ample room for improvement on making the authoring tools themselves more accessible, by applying more textual and less graphical user interfaces (UI).

Challenges and Conclusions

Usability is the ease of use of a human-made object. The object of use can be a software application, website, tool, machine, or anything a human interact with. When we revisit the concepts of Universal Design (UD) and web accessibility, there are three common major concerns to consider in course development and tool choices: 1) The systems are designed to be used by Anyone, Anywhere; 2) By *Anyone* it means known issues for specific populations (e.g. kids, seniors, tech-savvy users, less-tech-savvy users, users with disabilities, users without disabilities, etc.) need to be taken into consideration; and 3) By *Anywhere* it indicates there could be, and should be cultural differences among people and designs from diverse geographical regions (Carroll, 2010).

Our initial efforts for applying Universal Design principles to online engineering education in course preparation and delivery have focused on evaluating our currently available tools, creating universally designed course documents and videos, doing research on UD-related applications, and reaching out to our faculty and staff for more UD implementation.

One of the challenges we faced was the time and resources needed for adding closed captions to all lecture videos. However, it is a necessary step towards accessible and user-friendly web contents. The primary purpose of closed captions is to help the hearing impaired audience. With closed captions created, Youtube has a translation feature that will automatically render captions into over 60 different languages, and viewers in foreign countries will at least get the general ideas of the videos. With another powerful Interactive Script function, video transcripts serve as searchable indicators so viewers can skip ahead or backwards according to the keywords they put in the search box. Moreover, captioned videos can be indexed more efficiently because Google and Youtube will understand the exact content of the video. However, with all these benefits, the whole captioning process is still very time-consuming, and requiring transcribers to manually work back and forth on the recordings, and the collaboration with experienced third-party companies for these services seems to be a must.

Another challenge for us was to promote Universal Design and WCAG accessibility guidelines to continue the steady adoption and implementation of more accessible course materials. LDT have developed customized templates in accessible PDF formats for syllabi, lesson files, assignment files. Our short-term goal is to implement these templates more widely across our program over time. We are currently working to encourage the adoption by more EPD faculty/programs.

The development and delivery of course materials with a Universal Design mindset meets accessibility requirements and meets the needs of all potential users. As Rao (2013) suggests, “Universal design (UD) educational models provide useful frameworks to consider when creating courses for the diverse and non-traditional students served by

online engineering programs". The intention to integrate UD-based strategies requires additional forethought, planning, and resources on an instructor's part during the instructional design phase. That is, if instructors want to make this process manageable, they may try to add a new UD-based strategy each time they teach a course and assess what works best for their students.

Building and refining a learning environment that meets most UID principles is our long-term goal. There are several sets of guiding principles for universal design in online courses (Burgstahler, 2012; Elias, 2011; Connell, et al., 2007; Scott, McGuire, & Shaw, 2003), and many instructional design practitioners caution against becoming overwhelmed with trying to meet all guidelines at once. Starting with one or two modifications to the design of course materials is a more realistic goal and that moves the course in the right direction towards incorporating more universal design and accessible approaches to the program.

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[i] Many thanks to Lisa Linfield for her expert input and encouragement throughout this project, as well as to Mark Millard and Paul Miller for their review, comments, and suggestions.

[ii] Alfred P. Sloan Foundation: http://onlinelearningconsortium.org/survey_report/changing-course-ten-years-tracking-online-education-united-states/

[iii] CEOSE, NSF: http://www.nsf.gov/od/iia/activities/ceose/index.jsp

[iv] For more information about the ADA and ADAAA, see www.ada.gov

[v] For more information about sections 504 and 508 of the Rehabilitation Act of 1973, see http://webaim.org/articles/laws/usa/rehab

[vi] For more information about the Assistive Technology Act of 1998, see http://www.section508.gov/assistive-technology-act-1998

[vii] US laws on rehab: http://webaim.org/articles/laws/usa/rehab

[viii] For more information about the Quality Matters rubric, see https://www.qualitymatters.org/rubric.

[ix] Universal Design origin/architecture: http://architecture.about.com/cs/buildyourhouse/a/universaldesign.htm

[x] From Theory to Practice: UDL "Quick Tips": http://accessproject.colostate.edu/udl/documents/udl_quick_tips.pdf

[xi] Text of the Assistive Technology Act of 2004: https://www.govtrack.us/congress/bills/108/hr4278/text

[xii] For more information about CAST, see www.cast.org

[xiii] WCAG 2.0: http://www.w3.org/TR/WCAG20/

[xiv] Screen reader accessibility in Blackboard Collaborate v.12.5: http://www.adaconferences.org/Accessibility/

[xv] SuperNova Access Suite: http://visionaid.co.uk/product/supernova_access_suite/

[xvi] A list of contemporary screen readers: http://en.wikipedia.org/wiki/List_of_screen_readers

[xvii] ATAG overview: http://www.w3.org/WAI/intro/atag.php