

XSLT: Effective E-learning Solutions for Section 508 and Mobile Devices

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ABSTRACT

Designing information technology accessible to all learners and/or available on mobile devices has sometimes posed a dilemma for instructional designers and managers alike. In the case of compliance with accessibility regulations—spelled out in Section 508 of the Rehabilitation Act (29 U.S.C. 794d)—designers have sometimes abandoned innovative instructional strategies in favor of those that will support accessibility, specifically for vision-impaired learners who often need to use assistive technologies like screen readers. Similarly daunting are the format challenges for training that will work in both full-screen and smaller mobile device formats. A solution now exists for both these situations.

A recent research and development project took the position that instructional designers should have the freedom to design multimedia training as creatively and effectively as they wish, regardless of the audience and/or format constraints, and enlist *technology* to adapt or enhance the final product to meet the needs of *all* learners. This capability is found in the XML-based language known as Extensible Stylesheet Language Transformation (XSLT).

XSLT is used to generate alternative document formats (HTML, for example) from an existing XML document. This transformation is accomplished dynamically and the new format is populated with the original content. The result is a second *accessible* version (screen readers, mobile devices, etc.) of the training created “on the fly” with no impact on the original multimedia version.

Development efficiencies and cost reductions are intrinsic to this solution, if the training is built from a library of instructional interaction templates. Once an XSL Transformation has been developed for a standard instructional interaction, any training developed with that same template will generate an accessible version for the vision-impaired which is also formatted for display on a mobile device. The authors reference a recent project for illustration and present lessons learned and recommendations for implementation.

ABOUT THE AUTHORS

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Craig Clark is an award winning web interaction developer who is constantly pursuing new and innovative ways of using Flash for online learning. He has experience in multifarious industries ranging from the airline industry to the Japanese factory automation industry. He is a certified Adobe Flash Designer and a certified Adobe Flash Developer. Currently he is working as a Senior Instructional Developer in the Bremerton, WA office of Concurrent Technologies Corporation (CTC).

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THE GOAL—QUALITY ACCESSIBLE TRAINING DEVELOPED EFFICIENTLY

Designing and developing quality e-learning efficiently and cost-effectively that is accessible to all learners, including those using mobile devices, is a challenge for instructional designers, developers, and managers.

The goal of a recent research and development project was to develop high quality multimedia e-learning and, with almost no additional effort or cost, deploy three additional course variants making the training as accessible as possible for: 1) Section 508 Interactive/Low Bandwidth; 2) Mobile/PDA; and 3) Text Reference.

THE NEEDS

E-learning (specifically, self-paced online training) has become a critical aspect of education and training within corporations and the Federal Government, including the Department of Defense (DoD). There are significant challenges and opportunities inherent to both bandwidth and accessibility requirements. Designers

and developers are engaging with emerging technologies to create solutions that answer a range of training needs.

Innovative Multimedia Training

New technologies appearing on a regular basis allow designers to “push the envelope” of interactive multimedia training in order to simulate devices, create virtual environments, or incorporate game-like experiences.

Instructional designers need to continue developing innovative and interactive e-learning using any technology or instructional approach in support of end-user needs, instructional goals, and training content.

Figure 1 illustrates a simple, visually-oriented game-style interaction created to give the learner an opportunity to drill their understanding of basic Roman numeral conversions. The interaction allows for three different speed settings and integrates a running tally of correct responses. It is presented here to help illustrate the dynamic courseware transformation solution.



Figure 1. Visually-oriented Game-style Interaction

Section 508-Compliant Interactive E-learning

In 1998, the US Congress amended Section 508 of the Rehabilitation Act (29 U.S.C. 794d), to require Federal agencies to make their information technology accessible to people with disabilities (www.section508.gov). The amended Section 508 was intended to eliminate barriers in information technology, to make available new opportunities for people with disabilities, and to encourage development of technologies that will help achieve these goals. To comply with Section 508, agencies must give disabled employees and members of the public access to information that is comparable to the access available to others. Typically, this means simplifying the display of information, adding keyboard shortcuts, and making alternative text-based information available.

While accessible training is a critical need, designing information technology available to all learners has sometimes created challenges for instructional designers. In order to be in compliance with Section 508 accessibility regulations, designers have sometimes abandoned innovative instructional strategies in favor of those that will support accessibility, specifically for vision-impaired learners. These learners often need to use assistive technologies like screen readers.

Instructional designers have recognized that for some training interactions, it is essentially impossible to design for accessibility and therefore avoided the interactions altogether (a simple “drag and drop” exercise for example). Section 508 compliant e-learning

is often “lightweight” text-based content with simple HTML-based interactions and essential visual media coupled with alternative tags. The tags are descriptions of graphics that can be “read” by screen readers. On occasion, interactive training is abandoned altogether in favor of a simplistic, but compliant “page turner” form of e-learning.

Low Bandwidth Support

The DoD implements a significant amount of e-learning in support of military and civilian activities abroad. Even though DoD personnel may have up-to-date laptops or desktop computers, they do not always have access to high bandwidth networks and may attempt to access critical training in less than optimal field conditions. In response to this, e-learning courseware is being developed to include a low bandwidth version for this target audience.

The goal of low bandwidth e-learning is still interactive training requiring the same cognitive process, but it includes only text-based content, essential visual media, and simple interactions such as multiple-choice.

The technical solution described in this paper for Section 508 compliance can also be applied to serve the needs of learners in low bandwidth environments.

Figure 2 illustrates the difference between the original multimedia drill presentation and an alternative Section 508 compliant/low bandwidth version.

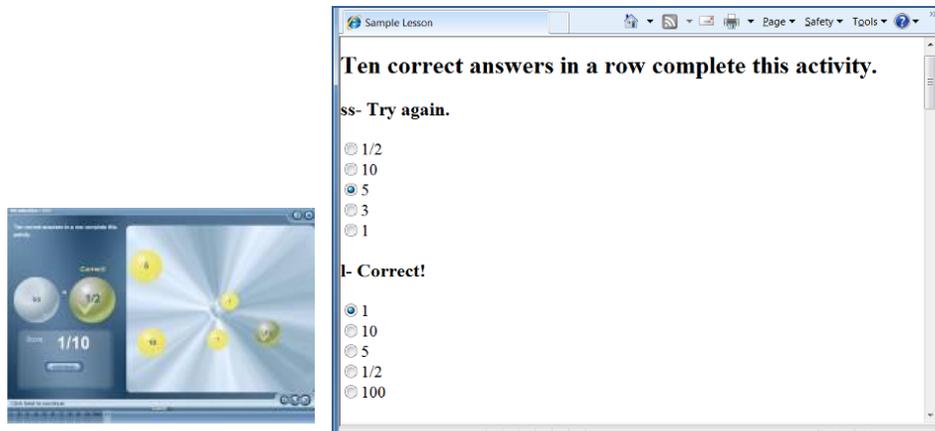


Figure 2. Alternate Section 508/Low Bandwidth Version

Access to E-learning via Mobile Devices

With fairly sophisticated mobile devices becoming ubiquitous, learners are demanding access to critical information, including training, via their mobile

devices. Examples of mobile implementation scenarios include the following:

- Training on the road – learners temporarily away from their desks desire to continue accessing time-

sensitive e-learning, such as mandatory organizational training.

- Just-in-time training – learners may need to access compliance or certification training in the field in order to complete critical tasking and be in compliance with regulations.
- Pre/Post training – traditional instructor-led training may have e-learning components that

precede the training or support follow-up activities including assessments. Access to these components via mobile devices while on travel may be beneficial.

Figure 3 illustrates the difference between the original multimedia drill presentation and the version formatted for display on a mobile device.

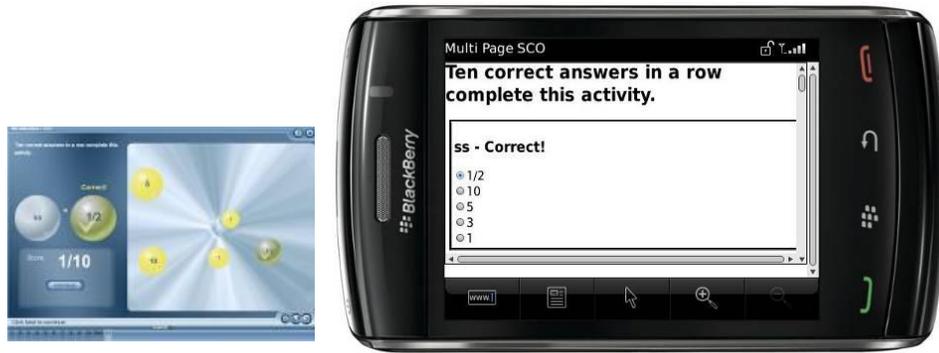


Figure 3. Alternate Mobile Device Version

Just-in-time Text Reference Materials

Interactive training may not always be the answer, but access to data and information associated with critical training content may be. Whether it is in order to remain knowledgeable in a job, perform a task to a particular specification, or review for re-certification, accommodating the needs of learners will support job performance. This is particularly the case for learners needing critical information in the field. Mobile devices are increasingly being used to access specifications,

procedural steps, and vital data with a just-in-time urgency. If the critical information is embedded in courseware containing prerequisite lessons and assessments, and is not available within a click or two, time is wasted just getting to the target content. Reference material should be readily accessible.

Figure 4 illustrates the very basic transformation of the original multimedia drill presentation to a simple listing of critical content.

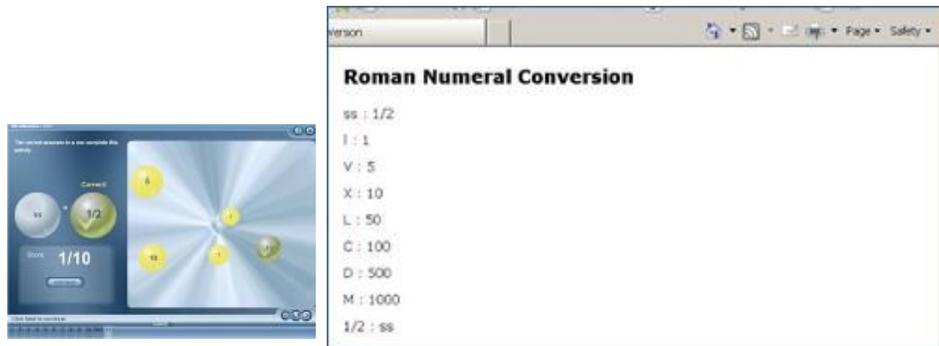


Figure 4. Alternate Text Reference Version

THE SOLUTIONS

The research and development team made one major assumption as they began looking for ways to meet the needs described above. They took the position that the designers should have the freedom to design multimedia training as creatively as they wish, regardless of the

audience and/or format constraints, and *enlist technology* to adapt or enhance the final product to meet the needs of *all* learners. This capability is found in Extensible Stylesheet Language Transformation (XSLT), based on Extensible Markup Language (XML).

XSL Transformations

XSLT is used to generate alternative document formats (HTML, for example) from an existing XML document. This transformation is typically accomplished at the click of a button and an alternate document is populated with the original content. The result is a second, *accessible* version of the training created “on the fly” with no impact on the original version.

XSLT was developed by the World Wide Web Consortium (W3C). The most recent version is XSLT 2.0, which reached W3C recommendation status on 23 January 2007.

The XSLT processing model involves:

- One or more XML source documents
- One or more XSLT stylesheet modules
- The XSLT template processing engine (the processor)
- One or more result documents.

The XSLT processor ordinarily takes two input documents—an XML source document and an XSLT stylesheet—and produces an output document. The XSLT stylesheet contains a collection of template rules: instructions and other directives that guide the processor in the production of the output document.

Figure 5 illustrates the basic elements and process flow of XSLTs.

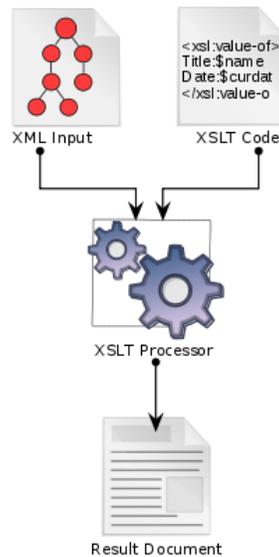


Figure 5. Basic Elements and Process Flow of Extensible Stylesheet Language Transformations

Separating Content from Presentation

The power and elegance of the XSLT stems from its ability to transform XML documents into other output formats like HTML, fulfilling one of the original promises of XML: separating content from presentation.

Since the early days of the Web (Hoskinson, 1999), developers, designers, and content providers have grappled with the problem of separating presentation

and design from content and functionality. A best practice when developing e-learning is to design in a modular manner, keeping presentation components separate from both content and business logic.

Figure 6 illustrates this point with examples of the same content, relating to lighting conservation tips, presented in four very different formats: high bandwidth interactive multimedia, Section 508/low bandwidth, mobile/PDA, and text reference.

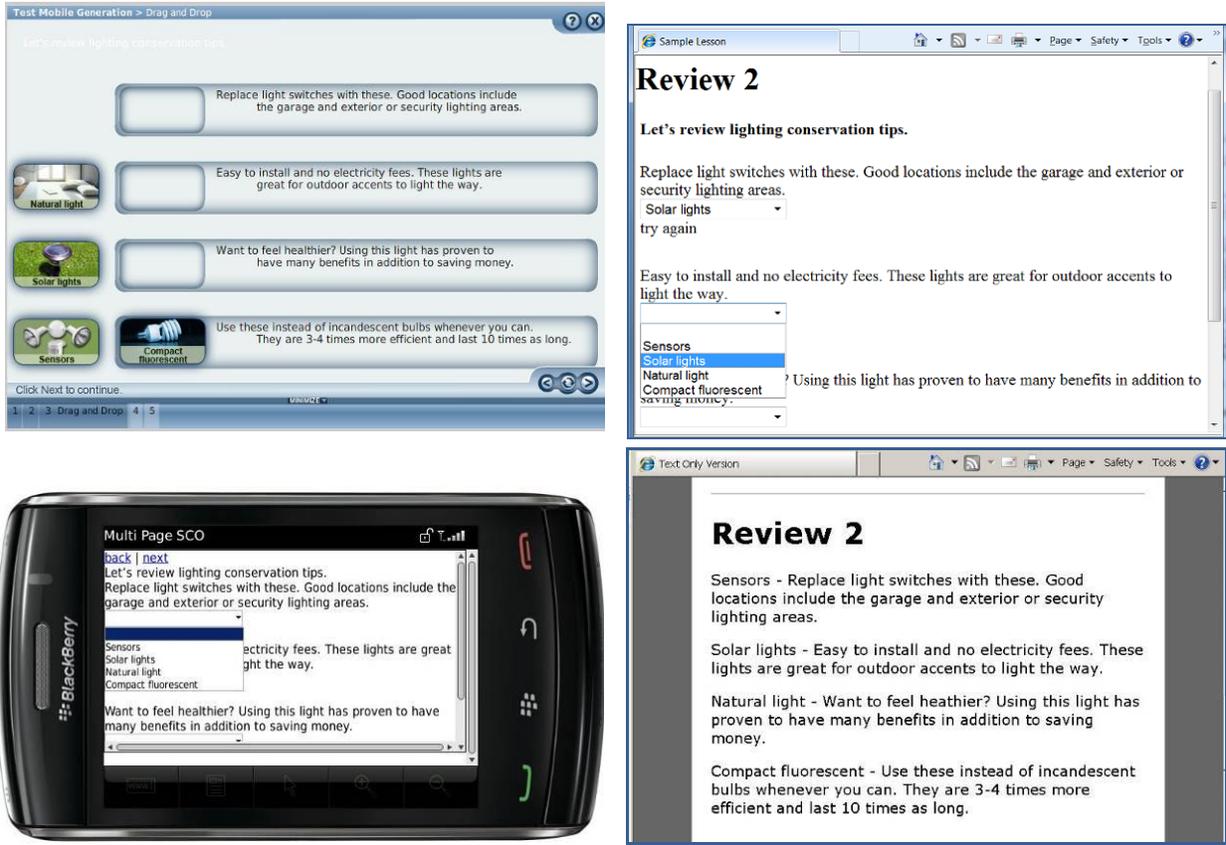


Figure 6. Variant Presentations of Identical Content

XML-based E-learning

XML-based information is the foundation for separating e-learning content from presentation. The single-source XML document can be formatted for display in a web browser, reformatted for delivery to mobile devices or converted into a PDF file suitable for printing. Parts of an XML document, such as paragraphs that supply critical training information, can be reused in other

documents. XSLT makes this possible and bridges the gap between content and presentation by providing a means of specifying how a content-based XML document is transformed into a presentation-oriented document.

Figure 7 shows a portion of an XML content source file. Figure 8 shows a portion of an XSLT associated with the content source file.

```

1  <!--<?xml version="1.0" encoding="UTF-8"?>
2  <?mso-infoPathSolution solutionVersion="1.0.0.27" productVersion="12.0.0" F
   href="http://ctcportal.ctc.com/project/PTTP/XML%20Development/Base_XML_
   name="urn:schemas-microsoft-com:office:infopath:Base-XML-Form:" ?>
3  <?mso-application progid="InfoPath.Document" versionProgid="InfoPath.Docu
4  <page gid="" template="drill" course="Pharm Measurement Systems" lesson=
   Numerals" topic="Drill " subtopic="Roman Numeral Conversion" pcheck="true"
   Drill">
5  <setup>
6  <text id="setup" x="" y="" z="" clip="">
7  <src>Click Start to begin. Then click the amount in the box to the right
   amount in the blue ball below. Ten correct answers in a row complete this acti
8  </text>
9  <criteriaValue>Criteria Value</criteriaValue>
10 <criteria>10</criteria>
11 </setup>

```

Figure 7. Content Source File in XML

```

1 <?xml version="1.0" encoding="utf-8"?>
2 <xsl:stylesheet version="1.0" xmlns:xsl="http://www.w3.org/1999/XSL/Transform"
3
4 <xsl:template match="/">
5 <html>
6 <head>
7 <title><xsl:value-of select="page/@lesson" /> - <xsl:value-of select="pag
8 <xsl:value-of select="page/@subtopic" /></title>
9 <link id="style" rel="stylesheet" type="text/css" href="../style/508.style.css"
10 <xsl:text disable-output-escaping="yes">
11 <![CDATA[
12 <script type="text/javascript">
13   function checkAnswer(selObj, fb)
14   {
15     if (selObj.value == "correct")
16     {

```

Figure 8. XSLT of Content Source File

Cascading Stylesheets

XSLT has a related standard - Cascading Stylesheets (CSS). CSS can be used to add additional formatting to XML documents for display. Using CSS to complement XSLT is a powerful strategy for developing e-learning content. CSS provides a way to make wholesale design changes to any content without having to change the formatting code in every HTML document, such as the layout, colors, and fonts. CSS is extremely useful when formatting e-learning content for mobile devices, allowing the content to be “chunked” into small but logical sections for display on the mobile screen.

EFFICIENT E-LEARNING DEVELOPMENT

Many organizations develop courseware using COTS or custom-built e-learning development tools with a foundation of XML-based interaction templates. The authors summarized best practices associated with one custom e-learning development platform they use, which employs Adobe Flash-based templates. For more information, see IITSEC 2009 paper, *Reducing E-learning Development Costs Using a Streamlined XML-based Approach* (Bandrowski et al, 2009). Since the XML-based template library is key to development efficiencies, a summary of development goals and tools is presented here for context.

Interaction Library-based Development

Development efficiencies are intrinsic to this solution if the training is built from a library of instructional interaction templates. Once an XSLT and a CSS have been designed and applied to a standard XML-based instructional interaction, *any* training developed with that same template will generate a Section 508-compliant accessible version, a version formatted for

display on a mobile device, and also a text reference version.

E-learning Development

An integrated suite of XML-ready commercial-off-the-shelf tools creates a “platform” supporting a content development process that is nearly seamless from storyboard to final courseware.

During run-time, a Flash-based e-learning engine combines single-source XML-based content available from form-based storyboards with a library of reusable interaction templates. Additionally, the e-learning engine provides support for functionality such as navigation, assessments, etc.

Overarching development goals associated with the platform include the following:

- Maximize instructional design investment through a well-designed, reusable instructional interaction library
- Minimize manual manipulation
- Maximize instructional interaction reuse by decoupling presentation elements from content
- Reduce life-cycle maintenance costs with single-source content.

The research team used this platform and associated Flash-based templates as a starting point for design and development. The XSLT solution for courseware variants was a direct extension of the original goals associated with the platform.

Designing Transformations for Section 508 and Low Bandwidth

Since Flash support is not as widely available as simple HTML, each Flash template needed to have a second “parallel” HTML version created by instructional system designers (ISD). ISDs reviewed the library of interaction templates and chose a subset with which to start. This subset of templates was chosen because they tend to be the most problematic and challenging when it comes to Section 508 accessibility—visual-based games, drag and drop exercises, etc. In addition, some templates were chosen because of challenges associated with mobile formatting.

ISDs spent time carefully thinking through the transformation design. Template transformation focused on ensuring that parallel versions supported a similar instructional goal though using a different instructional approach and presentation. For example: a visual-based drill and practice game was transformed into a series of multiple-choice questions; or a drag and drop check-on-learning was transformed into a series of drop-down combo boxes.

In some cases it was recognized that the current XML would need to be revised and augmented to function as a single-source document. The original Flash-based media and XML did not contain simple compressed JPG graphics and alt tags. Additional “lightweight” media needed to be made available in media folders and referenced in the XML, along with alt tags, in order for XSLT to generate the content and page layout for accessible and mobile versions.

Designing Transformations for Mobile

To support mobile devices, additional CSS formatting was designed and applied to the transformation. This formatting supported the “chunking” of content to accommodate viewing the e-learning within a limited screen size.

The developers also had to consider the fact that there is wide variation among mobile devices in terms of screen size and factors such as processing power, memory availability, and web support. In an attempt to benefit from industry lessons learned, the developers drew up a set of best practices. These were based on the W3C Mobile Web Initiative Best Practices (Rabin et al, 2008), as well as online resources available from individual mobile developers (Blackberry, 2010) and publications (Fling, 2009 and Firtman, 2010).

Variations in screen orientation and dimensions dictated that the layout of items, as well as their size, needed to be communicated in relative terms. For example, rather than specifying the number of pixels between a drop-down box and associated text, the XML contains an indicator that the box appears to the left of the text.

Restrictions on images and resource-intensive media were also an issue. When the source XML contains an image that would not transfer well to the mobile device environment (such as .swf or bitmap), alternative images in .png or .jpg, or simply a smaller file format, are included. The result is a reduced memory footprint and faster load times. Indicators were also added to the XML to differentiate between graphics that must be included as critical content and enhancement graphics that can be excluded from the mobile content.

The current environment of mobile devices is slightly reminiscent of the early days with the World Wide Web, when proprietary applications were the norm, and cross-platform compatibility remained elusive. However, establishing standards and adopting open-source protocols is now the norm, and the technology gap between potential and capability in mobile devices is closing rapidly.

Designing Transformations for Text Reference

Client-side processing by the web browser enables a text-based alternative version to be available via a simple link to a “Text Alternative Version.” Once the link is clicked, the XSL Transformation is applied to the source XML and generates the alternative pages of text. These pages, extracted from the original Flash-based e-learning, contain all critical content. The alternative page opens in a new window as a single scrollable HTML page. This simple transformation meets the requirements for critical reference information.

Additional Support Functions

A limitation that currently exists with mobile devices is that the mobile browser does not have enough processing power to support dynamic run-time (client-side) XSLTs. Consequently, a parallel version of the rich-media Flash-based training, one designed specifically for mobile, needs to be generated at “author-time” as opposed to run-time.

A text reference version can be a single scrollable page, but, for ease of viewing, both Section 508 and mobile versions need to display in multiple pages. Additional support elements were required for the transformation,

including support for navigation between pages and page sequencing functionality.

To answer this need, a Java-based utility was developed. The utility automates much of the entire transformation process for all three alternate versions—

text reference, Section 508/low bandwidth, and mobile—and provides access to learners via simple hyperlinks.

Figure 9 displays a menu in the Java-based utility used to select files for different transformations.

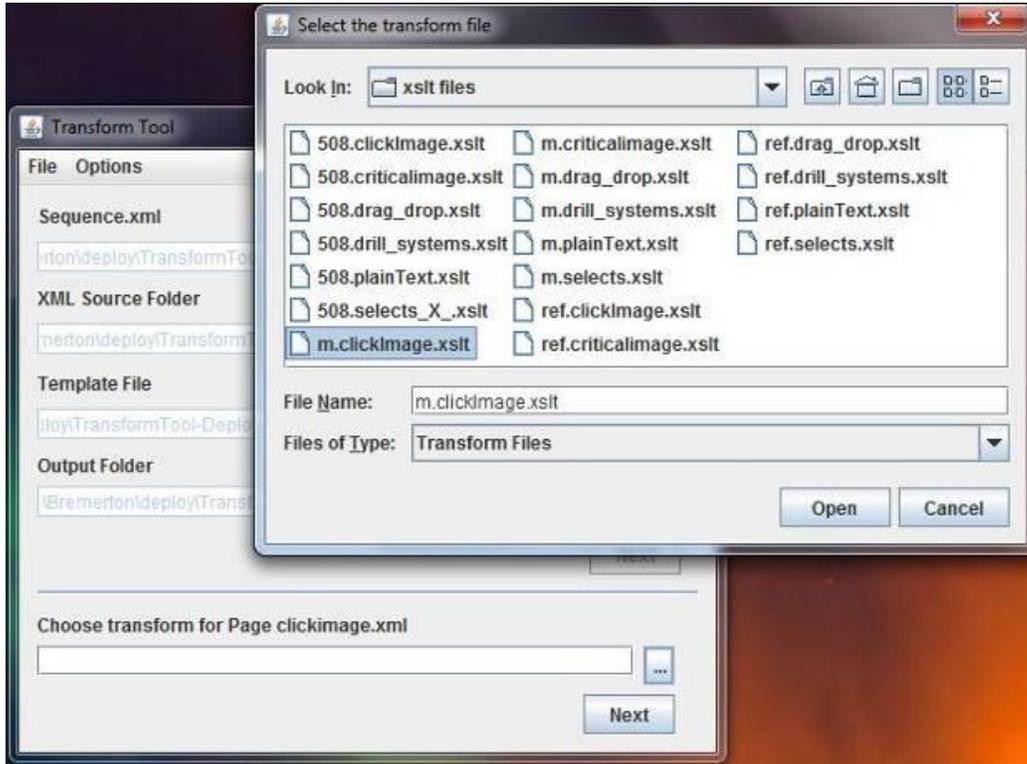


Figure 9. Transformation Utility

NEXT STEPS

Having confirmed that it is possible to generate alternate versions of Flash-based interactive e-learning efficiently using existing technology, there is a need for further research into the specific requirements of end-user communities for Section 508-compliant, mobile, and text reference e-learning. Results of this research should allow refinement of the target pages that each transformation is capable of producing.

Creating and implementing these XSLTs and continuing to refine the support infrastructure, such as navigation and SCORM calls, will result in an automated development process.

An additional next step involves developing the means for learners to signal their preference for an alternate version, or device awareness in the case of mobile browsers accessing servers associated with learning management systems.

LESSONS LEARNED

At the beginning of this research and development effort, it was thought that the XSLTs might pose a major technical challenge. Instead, they have proven to be fairly straightforward and therefore less daunting than the challenge of understanding in detail the specific needs of the target learners, particularly the vision-impaired.

For every interaction an ISD can envision, the need is to clearly and comprehensively determine what and how the target page should display. To engage a representative user group in the initial designs, ongoing testing, and final validations, is a people-intensive proposition requiring organizational resources and willpower.

IMPLICATIONS FOR MANAGERS

Project managers will be pleased to know that development efficiencies and cost reductions are intrinsic to this solution, if the training is built from a library of instructional interaction templates.

With the use of XSLTs and an XML-based e-learning platform, quality courseware and associated variants can be developed to realize specific efficiencies originally envisioned:

- Instructional design investment is maximized through a well-designed, reusable instructional interaction library
- Manual manipulation of content is minimized
- Instructional interaction reuse is maximized by decoupling presentation elements from content
- Change management and life-cycle maintenance costs are reduced with single-source content.

CONCLUSION

The research and development effort described in this paper successfully demonstrated that technology can be used to meet the needs of multiple e-learning end-user communities without compromising innovative, high-quality interactive instructional design.

The research team applied XSL Transformations, additional CSS formatting, and support functions to the subset of interaction templates associated with the Flash-based sample courseware. With almost no additional effort, what resulted were the three additional course variants: 1) Section 508 interactive/low bandwidth; 2) mobile/PDA; and 3) text reference.

A focus on accessibility led to the decision to transform to the lowest common denominator, HTML, ensuring the broadest availability.

There are obviously situations for which custom design and custom development are appropriate and/or necessary: training created specifically for mobile devices, for example, or a design that requires rich media, such as Adobe Flash.

However, given the ease with which transformations can be automated, and the fact that they provide cost-effective solutions to the real-world needs of many learners, it seems reasonable to suggest that all XML based e-learning should take advantage of XSLTs to provide the courseware variants described in this paper.

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