Mobile Interactive Training: Tablets, Readers, and Phones—Oh, My!

Jo E. MacDonald, Eric M. Foster, & Joyce M. Divina
General Dynamics Information Technology
Pensacola, FL 32502
Jo.Macdonald@gdit.com, Eric.Foster@gdit.com,
Joyce.Divina@gdit.com

David W. Donnelly
Technical Training Director, N7
Center for Seabees and Facilities Engineering
Port Hueneme, CA 93043
David.W.Donnelly@navy.mil

ABSTRACT

Navy Non-Resident Training Courses (NRTCs) are self-study, enlisted training courses used to learn and advance in a Navy occupation, or rate. Until recently, these courses were entirely text based; however, the release of Adobe Acrobat 9 in 2008 enabled development of Level III-interactive PDFs with user-controlled animations, audio, videos, 3D images, and graded assessments with bi-directional remediation. With their media-rich content and engaging interactivity, the new NRTCs were well received by both the client and the end users. However, to meet the needs of today's military, training products need to be as broadly deployable as the forces that use them. For many young people, including the Soldiers, Sailors, Airmen, and Marines of today's military, hand-held devices such as smartphones and tablets have taken the place of desktops. Besides being lightweight and portable, they are capable of supporting a wide variety of applications touching every aspect of life. However, in the race to build new products to increase market share, corporations have produced devices with widely varying capabilities and support for the interactive features of the NRTCs. This paper reports an ongoing project to leverage the capabilities of mobile technologies to field Level III-interactive NRTCs. It describes challenges encountered, optional solutions proposed, technical breakthroughs achieved, and a conversion tool under development. The benefits are noteworthy: By providing service members anytime/anyplace access to interactive, media-rich training, mobile technologies can be used to prepare our highly mobile, expeditionary forces and thereby secure the future of our country.

Key words: Mobile, hand-held, training, smartphone, tablet

ABOUT THE AUTHORS

Jo E. MacDonald is a senior instructional designer for General Dynamics Information Technology with over 23 years of experience in all aspects of instructional systems design. Her experience in technology applications for education and training include the design and development of PC-based simulations, Web-based training, interactive multimedia instruction, educational videos, and standardized tests. Ms. MacDonald is passionate in her dedication to excellence and committed to ensuring that the focus of technology is always on maximizing learning.

David W. Donnelly is Technical Training Director at the Center for Seabees and Facilities Engineering, with 25 years of experience in instructional systems design and delivery methods. As a Southern Illinois University adjunct faculty member, he provides instruction on curriculum design, assessment of learning, and instructional methods and media. With his U.S. Navy (active and reserve) and civilian training implementation experiences, he has a special interest in bringing the full training experience through use of current and emerging technologies to the U.S. Navy.

Eric M. Foster is a lead graphic artist and an Actionscript/AIR developer with 10 years of experience creating Web-based simulations, interactive graphics, and 3D models and animations. Using a combination of programming languages, Mr. Foster has created various internal toolsets, interactive components, and end-user software applications employed in various training products. Mr. Foster assisted in the creation of the tools and processes used to convert Flash-based, Level-III interactive NRTCs into content that can be deployed on mobile devices.

Joyce M. Divina is an experienced computer programmer and instructional designer with 20 years of experience in computer programming and 10 years of experience in curriculum development. As a programmer/Web developer, she has designed and maintained Web-based applications and courseware for both the military and commercial sectors, including the U.S. Navy, U.S. Army, General Motors, and Cendant Corporation. As an iOS and Android enthusiast, Ms. Divina has a special interest in bringing the full Web experience to mobile computing devices.

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
DEC 2011		**00-00-2011 to 00-00-2011**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
Mobile Interactive Training: Tablets, Readers, and Phones - Oh, My!	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **General Dynamics Information Technology,Pensacola,FL,32502**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES
I/ITSEC) 2011- Interservice/Industry Training, Simulation, and Education Conference, 28 Nov ? 1 Dec, Orlando, FL.

14. ABSTRACT
Navy Non-Resident Training Courses (NRTCs) are self-study, enlisted training courses used to learn and advance in a Navy occupation, or rate. Until recently, these courses were entirely text based; however, the release of Adobe Acrobat 9 in 2008 enabled development of Level III-interactive PDFs with user-controlled animations, audio, videos, 3D images, and graded assessments with bi-directional remediation. With their media-rich content and engaging interactivity, the new NRTCs were well received by both the client and the end users. However, to meet the needs of today's military, training products need to be as broadly deployable as the forces that use them. For many young people, including the Soldiers, Sailors, Airmen, and Marines of today?s military, hand-held devices such as smartphones and tablets have taken the place of desktops. Besides being lightweight and portable, they are capable of supporting a wide variety of applications touching every aspect of life. However, in the race to build new products to increase market share, corporations have produced devices with widely varying capabilities and support for the interactive features of the NRTCs. This paper reports an ongoing project to leverage the capabilities of mobile technologies to field Level III-interactive NRTCs. It describes challenges encountered, optional solutions proposed, technical breakthroughs achieved, and a conversion tool under development. The benefits are noteworthy: By providing service members anytime/anyplace access to interactive, media-rich training, mobile technologies can be used to prepare our highly mobile, expeditionary forces and thereby secure the future of our country.

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**	**Same as Report (SAR)**	**9**	

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std Z39-18

Mobile Interactive Training: Tablets, Readers, and Phones—Oh, My!

Jo E. MacDonald, Eric M. Foster, & Joyce M. Divina
General Dynamics Information Technology
Pensacola, FL 32502
Jo.Macdonald@gdit.com, Eric.Foster@gdit.com,
Joyce.Divina@gdit.com

David W. Donnelly
Technical Training Director, N7
Center for Seabees and Facilities Engineering
Port Hueneme, CA 93043
David.W.Donnelly@navy.mil

DOWN THE YELLOW BRICK ROAD

Navy Nonresident training courses (NRTCs) are self-study, enlisted training courses that are used to learn and advance in a Navy occupation, or rate. Until recently, these courses involved studying a training manual in either paper-based or static portable document format (PDF) and taking the associated test. However, the release of the Adobe Acrobat 9 family of products in 2008 enabled development of Level III-interactive PDFs with user-controlled animations, audio, videos, three-dimensional images, and graded assessments with bi-directional remediation. The products were well received by the customer, who then posed a follow-up question: "Can you make this work on mobile devices?"

A WISH FOR THE WIZARD

The drivers behind this challenge were twofold. First, learning is significantly increased when training is presented via well-designed multimedia. Based on extensive research by Mayer (2001), Mayer and Moreno (2003), and others, it has been demonstrated that (a) learning is increased when content is presented through both words and pictures, and that (b) as the complexity of the content increases, the impact of direct manipulation of media on knowledge transfer to the real world also increases (Metiri Group, 2008). Animations have been used in training to show process, demonstrate steps in a procedure, and illustrate system function. Not only do they attract trainees' attention—one of Gagne's (1985) nine events of instruction—but they also serve to motivate trainees, to help them form more accurate mental models, and to enable them to better understand associated instructional text (Lowe, 2001). Adding the ability to manipulate images increases trainee engagement, motivation, and learning transfer. For example, a three-dimensional interactive simulation can provide realistic practice in crane operations. Trainees manipulate the controls and immediately see the effects of their actions.

The second driver is the desire to take advantage of the ubiquity of mobile devices to make training more accessible. Most young people, including the Soldiers, Sailors, Airmen, and Marines of today's military, use hand-held devices such as smartphones and tablets on a daily basis. Besides being lightweight and portable, these devices offer a wide variety of applications touching every aspect of life. One of their most critical features, from a user's point of view, is instant access from almost any location to information. People demand "light mobile devices that enable them to multitask and access the Web while on the go" (Bonk, 2009, p. 294). Because people like them, use them, and even depend on them, they go everywhere that people go. They—and the applications resident on them and available from them via the Internet—are always present, always accessible.

Fielding training as a mobile application would enable what Bonk (2009) and others refer to as ubiquitous learning, or u-Learning: using technology to learn without consciously making a decision to learn. The ubiquitous presence of learning opportunities enables learning to be "personalized and customized for a 24/7 experience . . . , [allowing] flexibility and choice in the learning process" (Bonk, p. 295). One of the goals of military training is to create lifelong learners who quest for knowledge. Making Level III interactive NRTCs available on mobile devices would not only make training for advancement accessible when and where needed by today's highly mobile expeditionary forces, but would also enable the instant access to needed knowledge that characterizes lifelong u-Learning.

INTO THE FOREST

The primary problem with migrating the NRTCs to mobile devices was the wide variance in the capacity of the different mobile platforms to support the interactive features of the NRTCs, which had been developed in Adobe Flash and JavaScript. A review of the capabilities of each platform (see Table 1) suggested three delivery options: standard PDF with text and static graphics, HTML with Adobe Flash, and HTML 5. Of these options, only HTML with Flash provided the full functionality available in the current interactive PDFs. Every other option involved the loss of at least some of the functionality that had contributed to the effectiveness of the enhanced NRTCs.

Table 1. Platform Capabilities

Approach	Function Loss	Compatible Platforms						
		iOS	**Blackberry**	**Android**	**NMCI**	**eReader**	**WebOS**	**WinMo7**
Print Version (PDF)	Animations Interactive graphics Bi-directional remediation Glossary rollovers	X	X	X	–	X	X	X
HTML with Flash	None	–	X[a]	X	X	–	X[a]	–
HTML 5	Complex animations converted to video Nonlinear animations lost	X	X	X	–	–	X	–

[a] A Flash player is currently in development.

Based on compatibility alone, it was clear that a blended effort involving multiple strategies was the best solution. This was confirmed by a further analysis of the level of effort required and life-cycle maintenance (see Table 2).

It was determined that supporting the three different versions in a blended solution would be considerably more efficient than supporting even two stand-alone versions. The next step, after informing the customer of these findings, was to begin work on a prototype.

Table 2. Conversion and Life-Cycle Maintenance

Approach	Conversion Requirements	Overall Conversion Effort	Impact to Life-Cycle Maintenance
Print Version (PDF)	Information contained in interactive graphics/ animations must be converted to static graphics. Document will need to be reformatted.	Minimal	Minimal: two nearly identical versions requiring separate support for: • Interactive graphics • Print-optimized graphics
HTML with Flash	Word document will have to be converted to HTML templates.	Moderate	Minimal to moderate: two nearly identical versions in which graphics are 100% identical but separate support is required for: • HTML document layout • Interactive PDF layout
HTML 5	Complex animations must be converted to videos. Flash interactions will need to be incorporated on the JavaScript level instead. Nonlinear animations may be converted to JavaScript/ HTML5, but may be costly.	Moderate, if nonlinear animations are discarded; more if they are to be re-created in JavaScript/ HTML5	Substantial to major; separate support required for: • HTML document layout • Interactive PDF layout • HTML 5 animated content and interactivity • Interactive PDF animated content and interactivity
Blended Solution	Cumulative	Cumulative, but with a fair amount of overlap	Cumulative maintenance of graphics, but unified delivery method

LIONS AND TIGERS AND BEARS

The process of converting the existing interactive Adobe Acrobat documents to a format compatible with mobile devices presented a series of challenges. It seemed that each solution, while solving one problem, generated new problems to be resolved.

The team's primary concern was to retain the integrity of the interactivity in the original Acrobat documents as much as possible. These highly interactive, media-rich training manuals represented a major step forward in making NRTCs more visually and cognitively engaging, and no one on the team wanted to take a step backward to the text and static graphics of the past. The initial goal, therefore, was to capitalize on the abilities of each device to offer as many of the animations, interactions, and video as possible. If a device was capable of handling a particular type of interaction, it was imperative that the interaction be part of the solution. However, for devices that could not support that type of interaction, the solution would also need to include an alternative presentation. The easiest solution would have been to develop separate versions of the NRTCs for different mobile platforms, but that would have created a life-cycle maintenance nightmare. The optimal solution, therefore, was a tailorable program that would enable developers to "develop once" yet hit the widest number of mobile targets possible.

As mentioned earlier, the greatest obstacle to developing such a solution was the wide variety of devices encompassed by the broad term "mobile technologies." Mobile devices include smartphones, eReaders, Netbooks, and tablets, and each type of device has multiple versions with vender-specific capabilities as well as different screen sizes, resolutions, and orientations. In addition, devices have different means of user input that must be taken into consideration. For example, an interaction using a mouseover to display a pop-up works well with a mouse or stylus but becomes clumsy and frustratingly difficult if the pop-up is obscured by the user's finger on a touchscreen.

Exploratory Tests

To learn more about the capabilities of the different platforms, a representative Adobe Acrobat document was selected that contained most of the different types of media and interaction used in the NRTCs: static diagrams and photos, user-controlled video, simple simulations, slideshows, mouseover displays, and quizzes with remediation. We sent the sample PDF document to an array of mobile platforms:

- iPhone 3GS
- iPhone4
- iPad (1st generation)
- HTC Evo Android phone (running Froyo)
- Kindle eReader (3rd generation)
- Nook eReader (1st generation)
- Blackberry Storm

A PDF produced in Adobe Acrobat 9 requires both Adobe Flash and JavaScript to provide interactivity and multimedia richness. The test demonstrated that most of the PDF viewer applications available for mobile devices do not support this vital combination. As noted in Table 1, support for Flash was lacking on more than one platform. Clearly, the problem required a different approach.

Instead of looking at differences, the team then began looking for commonalities. They found that there is one significant feature that all of the mobile devices surveyed have in common: they all have Web browsers. This finding suggested that an HTML solution, using JavaScript instead of Flash-based interactions, would work on the widest array of devices.

Initial Conversion Results

Using the "Save As" feature of Adobe Acrobat 9, the team converted the sample PDF document into HTML v3.2 and HTML v4. The resulting files were disappointing. The interactions were nonfunctional; the formatting was haphazard; and the fonts changed arbitrarily from one section to the next. Clearly, the solution was not going to be as simple as exporting from Acrobat. What the export function did provide, however ugly, was a basis from which to go forward. The team decided to proceed manually from this point and to make notes of places where the process could be improved and automated.

Challenge #1: Nonstandard Text

One of the first problems discovered was that the HTML generated by Acrobat was heavily laden with unnecessary text-formatting tags. Using the advanced search-and-replace functions in a full-featured text editor, the unneeded tags were stripped from the document. Then CSS styles were created to replace all of the hard-coded font definitions. In addition to using style sheets to automate and standardize the formatting, the team developed a programming script to automate this entire clean-up process.

Challenge #2: Oversized Static Graphics

The static graphics (drawings, diagrams, figures, and photographs) exported by Acrobat presented an unexpected challenge. When the PDF documents were originally created, the graphics were not resized as they would have been for display on a Web page. The original graphics were imported into the PDF at the highest resolution possible for printing purposes and merely resized within the PDF document. During Acrobat's export process, the graphics were exported at their full, original size. As a result, most of the graphics had to be resized for use in a browser. While this process could be automated, human intervention is required to determine optimal sizing.

Challenge #3: Flash Interactivity

Having resolved the problems with the conversion of text and static graphics, the team next turned their attention to the most complex problem of the conversion process: finding a suitable alternative for the Flash interactions. Adobe Flash works reliably on only one mobile platform: Android. Because of the variety of Flash interactions used in the interactive PDF, it was not possible to devise a one-size-fits-all solution. Instead, each type of interaction had to be addressed individually.

First, the team converted Flash-based slideshows into JavaScript-based slideshows using a generic, reusable script. In addition, they determined they could automate this process by using Flash to export the individual frames of the slideshow and to produce a text file with the appropriate JavaScript slideshow scripting ready to cut and paste into the HTML document. There was considerable excitement when a test demonstrated that the JavaScript slideshows worked quite well on all platforms, including the Kindle and Nook eReaders.

Converting the Flash animations was far more problematic. Initially, the plan was to convert the animations to HTML5-compatible video. Although this seemed like a straightforward solution, it soon became apparent that nothing is straightforward when trying to implement a theoretical standard that is split between three completely different implementation strategies. The HTML5 <video> tag, which is compatible with all latest-generation computer browsers except Internet Explorer 8.0, supports any number of video formats, in that it will stream the data file to the user's computer; however, no single video format is supported by all the browsers used on the various hand-helds (see Table 3).

In the end, the team targeted MPEG-4 and Ogg-Theora to cover the broadest number of devices. Then, in a burst of inspiration, the team realized that they were limiting the capabilities of the solution by seeking replacements for all of the Flash interactions that had been created for the interactive PDFs, particularly since one of the mobile devices—Android—is Flash enabled, and others—Blackberry and WebOS—are developing that capability. The Flash files, together with the new interactions created in MPEG-4 and Ogg-Theora, could be part of a pool of alternative interactions.

Table 3. Support for Video Formats

Format	iOS	Android	Safari	Chrome	Firefox	Opera	Blackberry
MPEG-4	X	X	X	X			
Ogg-Theora				X	X	X	
WebM				X		X	
GP3							X

Note. Browser manufacturers have pledged support for WebM in the future to promote cross-platform compatibility.

The development team then programmed a decision tree in JavaScript (see Figure 1) that checks for support and then delivers the appropriately formatted content to the target platform—desktops as well as mobile devices! This advancement was a major step forward in creating the "develop once/use multiple times," platform-independent solution they had envisioned, particularly since it widened the solution's applicability to the desktop/laptop environment as well.

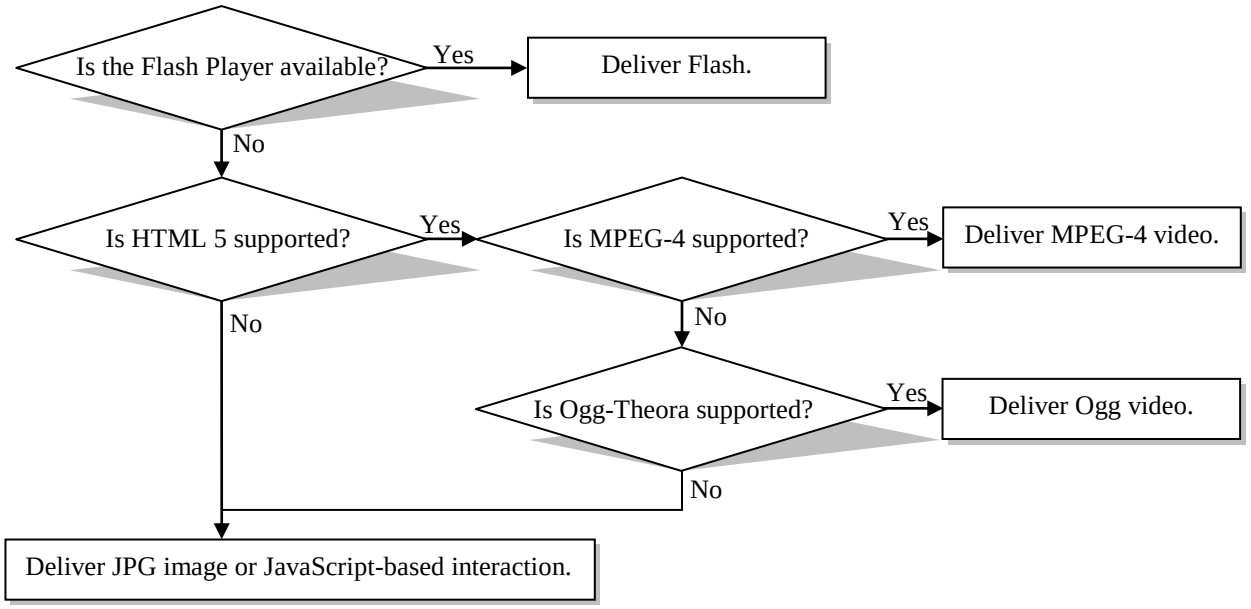

Figure 1. Video Decision Tree

Challenge #4: Pop-Ups

With the implementation of this protocol, the last hurdle was providing platform-specific user controls for pop-up information, such as definitions and brief explanatory information. In the PDF NRTCs, pop-ups display when the user holds the cursor on a hot spot. As soon as the cursor moves away from the hot spot, the pop-up automatically disappears. This functionality has been well received by users who appreciate the seamless integration of help as needed without having to constantly click to open and close windows of information.

Unfortunately, the pop-up functionality became problematic when enabled on a mobile device's touch screen. To activate a rollover on a hand-held touch screen, users had to place their finger on the hotspot and hold it there. In many cases, the user's hand partially obstructed the pop-up. However, if the user moved his or her finger to read the pop-up, the pop-up would disappear. To correct this problem for Flash-enabled devices, the Flash files were edited to utilize "click" interactions rather than rollovers. For devices that did not support Flash, scripts similar to those used for the slideshows were developed to open the published Flash files, analyze the hotspots, and generate HTML image maps and associated PNG or JPEG images for displaying the content.

Enhanced Remediation Interactions

With all of the technical challenges presented in the conversion effort, one aspect of the change provided a welcome respite: enhancement of the functionality used for knowledge check remediation. The PDF NRTCs included interactive knowledge checks in the form of multiple-choice questions with auto-remediation. When the NRTCs were converted to HTML/JavaScript, a new feature set became available with capabilities that eclipsed those available for PDFs. Not only was the team able to replicate existing testing and remediation interactions, but they were also able to enhance them. In the Adobe PDF version of the NRTC, selection of an incorrect answer to a test question triggers the document to automatically branch to the section of the NRTC from which the question was taken. Although the team had initially attempted to highlight the relevant phrases or figure, they were not able to overcome the combined shortcomings of the Acrobat JavaScript API and the restrictions on Acrobat Reader. With the conversion to HTML, the team was finally able to implement this strategy.

THE WIZARD REVEALED

The result of the conversion effort is a semi-automated process that produces an HTML-based course that delivers the best possible self-paced distance learning experience possible, given the capabilities of the client device. It does so by interrogating the device to determine its capabilities, beginning with its support for the highest level of interactivity (Level III). It then automatically customizes the output to the device, whether that device is a desktop computer, a tablet, an eReader, or a smartphone (see Table 4). The benefits for training are considerable—for users and for the organizations responsible for training them.

Table 4. Cross-Platform Compatibility

Content		Compatible Platforms						
		iOS	**Blackberry**	**Android**	**NMCI**	**eReader**	**WebOS**	**WinMo7**
Level III	Nonlinear Flash interaction	–	X[a]	X	X	–	X[a]	–
	Nonlinear HTML 5 canvas interaction	X	–	X	–	–	X	–
Level II	Flash animation	–	X[a]	X	X	–	X[a]	–
	HTML 5 video	X	–	X	–	–	X	–
	JavaScript slideshow	X	X	X	X	X	X	X
Level I	Still image	X	X	X	X	X	X	X
Audio	Flash audio	–	X[a]	X	X	–	X[a]	–
	HTML 5 audio	X	–	X	–	–	X	–
	QuickTime audio	X	X	–	X	–	X	X

[a] A Flash player is currently in development.

User Benefits

From a user's standpoint, anytime/anywhere learning has been advanced exponentially. Mobile devices are an integral part of young people's lives. Hand-helds wake them up in the morning and stay with them throughout the day. For today's youth, hand-helds are the primary means of communication, entertainment, and information retrieval.

This innovative technology solution means that naval personnel will also be able to use their mobile devices to access NRTCs for rate training and advancement anytime and anywhere. In addition, they will have ready access to just-in-time training to refresh their skills while on the job in the field and in remote areas where even a laptop would be an awkward accessory. Moreover, they will have full access to the interactive multimedia that makes these NRTCs so far superior to their flat, text-based predecessors, allowing learners to manipulate equipment, rotate images, zoom in on details, etc.

Benefits to the Training Organization

Training has always played a critical role in ensuring readiness, but training is expensive. Besides the initial outlay for development, there is the cost of reproduction, dissemination, and maintenance of the curriculum materials as well as the cost of buying and maintaining the delivery technology. In today's lean financial climate, training organizations must find new ways to increase the effectiveness of training while decreasing its cost. This solution assists in both of these areas.

Cost Benefits

The move to mobile interactive NRTCs netted a considerable cost savings for the Navy customer for whom they were developed. It used to cost $40.00 to print and mail a printed and bound NRTC, whereas the downloadable electronic version costs $0.00 after the initial outlay for development. With a target population of 6,000 personnel requiring this manual, those numbers translate into a $240,000.00 saving in one year alone. Because there are two books per specialty area, the potential savings is $480,000.00 in just one year, and this figure does not take into account repeat orders resulting from lost or severely damaged books.

The savings realized through development of downloadable NRTCs more than pays for the cost of converting text-based NRTCs to media-rich, interactive documents. The base cost of conversion will vary, of course, depending on the nature of the material being converted—the number of graphics, their sizes and file types, the number and complexity of user interactions, the audio or video formats used, and so forth. The ideal situation, certainly, is to plan for cross-platform compatibility during the initial development of an instructional product. Such forethought will pay sizeable dividends by eliminating the cost of conversion later.

However, when it is necessary to convert existing materials, the cost of conversion can be recouped

through the associated cost benefits. Because the NRTCs are automatically tailored to play on any platform, there is no need to factor in the cost of developing and maintaining multiple versions of the NRTCs. Moreover, this benefit will continue no matter what new platforms are introduced because the solution is HTML-based, and HTML will continue to be the standard for Internet development. Also, because the NRTCs can be played on users' personal devices, there is a reduced hardware requirement for training and likewise a reduced requirement for all the associated costs of housing, maintaining, and updating that hardware.

Training Benefits

Even more significant than the savings, however, is the benefit for training itself. This conversion solution provides a self-contained, fully interactive manual that can be downloaded and used on any platform (Linux-, Windows-, or Mac-based personal computers; tablets; Android- or iOS-based smartphones; Kindle or Nook eReaders; etc.). It brings the training source to trainees for use when they want it and when they need it, leveraging the capabilities and ubiquity of mobile technology to provide totally self-directed learning. Finally, unlike traditional text-with-static-graphic PDFs, which can also be downloaded and played on multiple devices, this solution provides video, interactivity, and simulated practice to engage learners in the content and increase retention and learning transfer (Mayer, 2001; Mayer & Moreno, 2003; Metiri Group, 2008). In doing so, it becomes a valuable addition to the training community's toolkit, either as a standalone product or as a means of augmenting existing training.

TO KANSAS AND BEYOND

Mobile devices present a considerable challenge to training developers because of the wide variance in their capabilities and support for various media formats. The development of a solution for overcoming these technical disparities by providing a customized output based on the client platform's capabilities represents a significant technological breakthrough for fielding NRTCs and other technical training courses. However, there is always room for improvement.

Refining the Solution

Efforts are currently underway to refine the solution. Two of the remaining challenges involve testing support for video on older Blackberrys, which are in common use in the military, and devising a strategy for converting nonlinear, Level 3 Flash animations. Currently, the only alternative is to provide linear video or a slideshow of a recorded interaction and direct the user to access the NRTC on a computer or laptop to experience the full interaction.

Another goal is to refine the development process. During the manual conversion of an interactive, multimedia PDF into a mobile-friendly, Web-deployable HTML file, the team frequently noted areas in which the process could be streamlined. They are currently using Flex, an open-source framework for developing cross-platform applications, to create an Adobe Air desktop tool that will automate almost every technical aspect of the entire conversion effort.

The results are encouraging. After the developer selects the exported HTML file, the tool will clean up the file, associate a standard style sheet with it, and incorporate the standard JavaScript files for common interactions. The program will then display each exported static graphic, query the user to select a size for it, and provide a preview of the result. The tool will then "call" Flash with a script that analyzes the interaction type and exports the associated graphics with a text file and any required JavaScript. The developer can then cut and paste the interaction scripts in the appropriate places in the HTML.

Some aspects of the development cannot be automated. As previously noted, for example, the developer must set the size of the graphics and manually position the interaction scripts. Also, there is no way to automate the marking of the exact remediation location for knowledge checks and test questions because the original PDF document recorded only the general vicinity of the answer. Overall, however, the automation achieved will not only reduce development time but also require less technical expertise of the labor force assigned to the conversion.

A Look to the Future

The exponential growth of technology in the past 20 years has presented a dizzying onslaught of new products that can be exploited for training. The advanced capabilities of Adobe Acrobat 9 made it possible to turn print-based NRTCs into highly interactive, engaging, media-rich training. The current effort built on this foundation with the development of a conversion solution to enable customized delivery of media-rich, interactive training content to various mobile devices based on each device's unique configuration.

What lies ahead? Makers of mobile devices have already developed dual-core smartphones with video/keyboard docks. There are even 3D smartphones

that require no special glasses to see the three-dimensional images. Bluetooth technology has negated the need to actually hold a "hand-held"—users can interact with their mobile devices without even taking them out of their pockets—and Near Field Communication (NFC) may eventually eliminate the need for common access cards as well as all the other cards that people carry. Head-up displays (HUDs), which present data to users in their normal field of vision so that there is no need to look at an instrument panel, are becoming more common on car windshields, and there is research even now to create Web-enabled HUDs that can be integrated into eyeglasses and contact lenses.

Only one thing remains constant with every new Web-enabled technology: its dependence on HTML as its bridge to the Internet. Because the solution described herein uses an HTML-based standard for training development, it can be used to develop products that can be deployed on any Web-enabled device—now or in the future. Its flexibility, which is in keeping with the flexibility and adaptability demanded of today's military, provides training organizations a forward-looking tool that can be used now and in the future to help prepare our forces and thereby secure the future of our country.

REFERENCES

Bonk, C. (2009). *The World Is Open*. San Francisco: Jossey-Bass.

Gagné, R. M. (1985). *The Conditions of Learning and Theory of Instruction* (4th Edition). New York: Holt, Rinehart, & Winston.

Lowe, R. (2001). Beyond "Eye-Candy": Improving Learning with Animations. Retrieved April 27, 2011, from http://www.auc.edu.au/conf/conf01/downloads/AUC2001_Lowe.pdf

Mayer, R. E. (2001). *Multimedia Learning*. Cambridge, UK: Cambridge University Press.

Mayer R. E., & Moreno R. (2003). Nine Ways to Reduce Cognitive Load in Multimedia Learning. In R. Bruning, C. A. Horn, & L. M. PytlikZillig (Eds.), *Web-Based Learning: What Do We Know? Where Do We Go?* (pp. 23–44). Greenwich, CT: Information Age.

Metiri Group. (2008). *Multimodal Learning Through Media: What the Research Says*. Retrieved April 27, 2011, from http://www.cisco.com/web/strategy/docs/education/Multimodal-Learning-Through-Media.pdf