An E-Learning Primer

Susan Codone, Ph.D.
Raytheon Interactive
Pensacola, Florida
November 2001

Dr. Susan Codone is the Manager of Interactive Multimedia at Raytheon Interactive in Pensacola, Florida. Susan manages daily production of courseware for the Training Support Agency Requirements contract and serves as the company liaison with the Navy. Susan has a B.S. from the University of Montevallo, an M.B.A from the University of West Florida and Ph.D. in Instructional Design from the University of South Alabama.

A RayPaper

Raytheon

Table of Contents

E-Learning: A Definition

By its name, e-learning can best be understood as any type of learning delivered electronically. Defined broadly, this can encompass learning products delivered by computer, intranet, internet, satellite, or other remote technologies. Brandon Hall, a noted e-learning researcher, defines e-learning as "instruction delivered electronically wholly by a web browser, through the Internet or an intranet, or through CD-ROM or DVD multimedia platforms." Increasingly, the common understanding of e-learning relates exclusively to *web-based training* -- or learning products delivered via a web browser over a network. Morgan Keegan's investment analysis team deems e-learning as a technology that fully leverages the distributive power of the Internet and encourages investors to consider the "e" in e-learning to represent "effective".

E-learning is sometimes classified as synchronous or asynchronous. Both terms refer to "the extent to which a course is bound by place and/or time," according to *The Distance Learner's Guide* (Prentice Hall: 1998). **Synchronous** simply means that two or more events occur at the same time, while **Asynchronous** means that two or more events occur "not at the same time."

For example, when you attend live training – like a class or workshop--then the event is synchronous, because the event and the learning occur simultaneously, or at the same time. Asynchronous learning occurs when you take an online course in which you complete events at different times, and when communication occurs via time-delayed email or in discussion list postings.

Using E-Learning

E-learning products can be applied in a variety of ways that can often evolve beyond their original intent. For example, e-learning products may be used to:

- Deliver introductory training to employees, customers, or other personnel
- Offer refresher or remedial training
- Offer training for credentialing, certification, licensing, or advancement
- Offer academic/educational credit via college and university online learning
- Promote and inform an audience about products, policies, and services
- Support organizational initiatives by increasing motivation through easily accessible learning
- Offer orientation to geographically disparate personnel
- Create a variety of essential and nonessential learning opportunities for personnel
- Provide coaching and mentoring through online instruction and collaboration
- Build communities of practice using distributed online training and communication
- Standardize common training through fixed content accessible to all users

E-learning can be acquired and used in two primary ways: by purchase of commercial off-the-shelf (COTS) products, or through customized builds of content produced for specific purposes. Soft-skill content, such as leadership or business training, can often be purchased from a variety of vendors who mass-produce e-learning products. Or, organizations may order customized

training from vendors who specialize in designing training for specific content not already available on the commercial level, such as a training program on a new product or service.

There are many more uses of e-learning in place now in many organizations, and new uses will continue to emerge as organizations build and deploy new learning products. Morgan Keegan investment studies indicate that the e-learning market can be stratified into three levels: the academic, corporate, and consumer markets – each with their own demands and uses. Also, as the Internet continues to mature and expand and bandwidth increases, new e-learning applications along with new audiences will also evolve to leverage technologies yet to be introduced. Additionally, organizations interested in e-learning should continuously monitor emerging industry standards via the federal Advanced Distributed Learning initiative and the Sharable Courseware Object Reference Model (www.adlnet.org).

Benefits and Risks of E-Learning

As with any learning medium, the use of e-learning offers benefits as yet not realized in traditional training, while also presenting new risks to both producers and users. Let's examine the potential benefits of e-learning first. On the positive side, e-learning products:

- Energize content with illustrations, animations, and other media effects
- Offer increased fidelity to real-world application through scenarios and simulations
- Enable just-in-time, personalized, adaptive, user-centric learning
- Offer flexibility and accessibility
- Engage inexpensive, unparalleled distribution capabilities to potentially a worldwide audience
- Create stability and consistency of content due to the ease in which revisions can be made
- Standardize content by centralizing knowledge and information in one format
- Cross multiple platforms of web browsing software
- Are less expensive to produce and distribute on a large-scale than traditional training
- Eliminate travel and lodging expenses required for traditional, in-person training
- Encourage self-paced instruction by users
- Supports increased retention and improved comprehension of content
- Lends itself to streamlined, easily scalable management and administration of courses and users

Clearly, e-learning has many advantages. Like any other training format, though, it also has disadvantages and risks associated with its production and use. Before committing to e-learning, consider the following:

- Access sometimes varies based on user capabilities
- Internet bandwidth limitations and slow connection speeds sometimes hamper performance
- User reaction and participation often depends on the level of individual computer literacy
- Development costs can exceed initial estimates unless clear production goals are established
- Not all content is suitable for delivery via e-learning
- The loss of human instructor contact may be disconcerting to users
- Industry standards for development and delivery are still emerging
- Implementation is challenging if not well-planned in advance of development

Careful thought and planning must go into a decision to purchase, implement, and utilize e-learning products – both those bought off-the-shelf or those customized for specific purposes. This is often referred to as the "build or buy" decision. Or, organizations can adopt a hybrid approach by purchasing some COTS products while building other customized training. In either case, organizations considering e-learning should conduct a comprehensive analysis of their needs, goals, education or training plans, and their current infrastructure to determine if e-learning is a suitable pursuit.

Designing & Developing E-Learning

The process of designing and developing e-learning products, which can include courses, seminars, workshops, online learning portals, chat sessions/discussion groups, and more, involves a careful mixture of personnel resources, hardware and software specifications and applications, standards for interactivity and media, and design parameters based on user capabilities. Vendors that produce e-learning products usually have well-defined resources dedicated to design and production, along with standard production schedules and timelines. Organizations considering building their own products should consider these resources as essential to the production and deployment of e-learning as well. These components are explained further below.

A.   Personnel Resources

What type of team is necessary to build e-learning products? Typically, personnel involved include instructional designers, graphic artists, programming or authoring specialists, project managers, subject matter experts, quality assurance personnel, and a webmaster or database specialist capable of administering and managing the courseware via a learning management system or a simple web learning portal. The table below depicts these personnel resources and their typical responsibilities:

Table 1.0 Personnel Needed for E-Learing Production		
Personnel Category	**Typical Educational Background**	**Common Responsibilities**
Instructional Designer	Bachelor's or Master's degree in Instructional Design or Technology	Plan and design learning materials
Graphic Artist	College training not always required, but helpful; often skills are learned on the job	Illustration, animation, web production, media production
Programmer or Authoring Specialist	Associate's or Bachelor's degree in computer science, software engineering. Significant experience in programming/authoring often substitutes for formal education.	Scripting and coding in an authoring application, programming language, or web editing (HTML, javascript, etc.)
Subject Matter Expert	None required; significant experience in content to be taught is crucial.	Clarify content, provide real-life examples, insert scenarios and authentic problems into courses
Quality Assurance Technician	Many degrees apply to this domain. Training in quality management techniques is crucial	Carefully evaluate courses for grammatical, aesthetic, and content quality
Webmaster/Database Specialist	College or other training in computer science or web development	Post courses on intranet or Internet; manage websites, learning portals, LMS
Project Manager	Degree in management or technology, sometimes accounting	Manage production schedules, personnel assignments, customer relationships

B.   Determining Content Suitability

Obviously, all educational content is not suitable for development and delivery in an electronic medium. Sometimes an instructor is absolutely necessary for effective learning, as when human demonstration or intervention is required, or when total fidelity to real-world events is necessary. Other content clearly is acceptable for e-learning development. How do you know which content is best for e-learning?

Consistent use of reliable criteria used to identify courses deemed suitable for conversion is imperative. Standard instructional design methodology recommends certain criteria for the development of content in a web-based medium, either for new development or legacy course conversion. A common criterion is the dynamic nature of the content; the long-held view is that content destined for web deployment should be static in nature, remaining substantially unchanged over a long period – perhaps a year. This perception, while correct in some cases, is gradually losing importance as a predictive criteria for web development as web design continues to evolve.

Additionally, content stability or instability can be mitigated by careful instructional design. For example, a course on terrorism certainly cannot be considered static in nature; new events occur almost daily, which expand the knowledge base on how terrorism occurs and how it can be contained. On the surface, investing in web development of such dynamic content may seem inadvisable. However, with a design that incorporates frequent updates, links to changing web content such as news organizations or military intelligence, or simply an instructional home page that can be easily updated, core content can be preserved while the dynamic nature of the Internet is used to provide broader information inclusion. Further, if the authored output of the course is in a format that is easily editable, such as HTML, changes can be made after deployment without a significant investment in programming resources.

Brandon Hall, a nationally-recognized e-learning consultant, recommends several criteria to guide course selection for WBT development. Concurrently, the federal Advanced Distributed Learning (ADL) initiative has published a series of documents collectively titled <u>Guidelines for Design and Evaluation of Web-Based ADL Applications</u> (www.adlnet.org) which recommend further criteria to guide content selection for WBT conversion. The conversion criteria questions contained in the following table are adapted from both Hall's and the ADL criteria.

Table 2.0	**Criteria for Determining Suitability of Content for Conversion to Web-Based Training**

To determine content suitability for WBT development, conduct content analysis using the following questions:

1. Does the number of potential users justify the cost of development?

2. Does the target audience have computers and access to the Internet?

3. Will the target audience be receptive to web-based training?

4. Will Internet distribution of the content provide a method of instruction that is easier, faster, cheaper, safer, and/or more engaging than other formats in current use?

5. Is the content suitable for chunking in small units as reusable learning objects?

6. Is the content adaptable to embedded learner control, and will the intended instruction become more effective if the user controls the pace of delivery?

7. Can the content be more effectively delivered with multiple technologies, i.e. multimedia (sound, video, animation, etc.)?

8. Will the content be strengthened from computer-generated illustrations and animation?

9. What impact will immediate assessment feedback have on users?

10. Is the content adaptable to either linear or dynamic navigation?

11. Will the content benefit from dynamic links to other external web sites?

12. Will the content be strengthened by the use of supplementary audio used as instructional commentary or explanatory sound effects?

Other criteria for WBT development center on instructional outcomes. David Merrill states that the following instructional strategies are suitable for multimedia development:

- instruction that provides information about a system or object
- instruction that provides information on the parts of a system or object
- instruction that provides conceptual or categorical information
- procedural knowledge
- process, principle, or information on how a system works

According to Merrill, each type of learning outcome listed above can be effectively generated and delivered in a multimedia format because of the ability to dynamically illustrate and teach these concepts.

Finally, the most important determining factor in the suitability of content for web deployment can be found in the course objectives. If the objectives are scripted in such a way to meet the criteria listed above, or if they do not mandate actual student physical or tactile performance, then it is likely that the content can be delivered in a web-based medium. As bandwidth increases inventive measures to increase simulation and interactivity will also incorporate objectives requiring physical demonstration, opening e-learning to content that requires these characteristics.

C.   Hardware and Software Resources

Designing, developing, and delivering e-learning products requires a mixture of hardware components and software applications, along with an robust infrastructure capable of sustaining multiple users and networked applications. For users, though, the required resources are much more minimal. Let's begin by looking at what is typically required to create e-learning.

The personnel listed above must have hardware resources and software applications to utilize in the design and development effort. These needs typically include development workstations along with a networked server to support collaborative development. Additionally, if hosting services are offered, then a hosting infrastructure must exist, containing primary and backup servers and the requisite connections to host both online courses and the management applications used to manage and track usage. Software resources include authoring applications; web editing tools, graphic production tools, multiple browsers, scripting applications, and learning management systems.

For e-learning users, all that is typically required is a personal computer workstation capable of operating multimedia-based applications (typically a Pentium-level processor), a modem or other connection, access to the network on which the content is located, and a web browser.

D.   Interactivity & Media

Most organizations desire highly interactive e-learning to both engage users and motivate involvement. And why not? Interactivity is the major promise of e-learning. We assume that more interactive training means more animation and student interaction and ultimately improved learning and retention. Although the web delivery platform is not entirely at odds with highly interactive web courseware, bandwidth availability and access quality are factors requiring urgent attention in courseware design. Despite the instructional quality of the courseware, low bandwidth and poor access are two factors that may effectively degrade usage quality and discourage continuing use of e-learning products.

Table 3.0 contains a description of four interactivity levels typically used as guidelines in evaluating interactive multimedia courseware, whether deployed in a web medium or only on a computer-based platform. Most web courseware at present can be characterized as level one or two – occasionally low-level three. Because of bandwidth limitations, media and simulation-rich courses (levels three and four) have thus far remained primarily on the computer-based platform, typically delivered via CD-ROM or DVD.

Table 3.0 Interactivity Levels & Definitions	
Interactivity Levels in E-Learning	**Interactivity Definition by Level**
Level 1: Low Interactivity (Page-Turner)	Normally knowledge or familiarization content provided in a linear format, sometimes referred to as a page turner. Level 1 is primarily used for introducing an idea or concept. The user has little or no control over the sequence and timed events of the lesson material. Minimal interactivity may include simple graphics and/or clip art and simple forward/backward navigation.
Level 2: Moderate Interactivity with Emulation	Involves presentation and recall of more information than Level 1 and offers more control over the content. Typically used for non-complex operations and maintenance lessons or more complex knowledge presentations, such as simple procedures and steps. Emulations or simulations may be presented via original graphics and simple animation, usually with accompanying audio narration. Navigation options expand to include menus, forward/backward, branching, index/map pages, and glossaries.
Level 3: Intermediate Interaction/Simulation	Involves interaction with more complex information and allows an increased level of control. Video, graphics, or a combination can illustrate or simulate the operation of a system, subsystem, or equipment, model procedures, or display complex images. Users may be required to alternate between multiple screens to keep pace with the content. Multiple branches (two to three levels) and rapid response are provided to support remediation. Emulations and simulations are an integral part of this presentation, however these are not full free play simulations. Graphics include complex original images, animations, videos, and complex audio support.

Table 3.0 Interactivity Levels & Definitions	
Interactivity Levels in E-Learning	**Interactivity Definition by Level**
Level 4: Advanced Interaction/Simulation	Involves detailed presentation, comprehension, and recall of highly complex information and allows almost full control over content. Most tasks and procedures are demonstrated with full interaction, similar to simulator technology. Content is extremely complex and involves more authentic scenarios to improve knowledge transfer. Complicated operation and maintenance procedures are normally practiced with level 4 and involve all of the elements of levels 1 - 3 plus the following: advanced interactivity, extensive branching via multiple menus, and complex animations and video.

E.   Connection Speeds and Design Parameters

Correlating desired interactivity levels above Level Two in a web environment with short download speeds becomes problematic as more memory-grabbing course components are included. Table 4.0 presents maximum download times in seconds for varying modem connection speeds based on estimated web page size, known here as course "play-ability." While users may connect from an employer-based T1 line or better, many will also attempt to connect from home, obtaining a variety of connections dependent upon their modem and quality of their phone lines.   Please note that these are download times under ideal conditions; under times of heavy Internet traffic, these times will likely increase.

Table 4.0 WBT Course Play-ability at Varying Connection Speeds				
	Maximum Download Time in Seconds for Varying Modem Connection Speeds			
Page Size	**14.4 Modem**	**28.8 Modem**	**33.6 Modem**	**56K Modem**
75 kb	52 seconds	26 seconds	22 seconds	13 seconds
100 kb	69 seconds	35 seconds	30 seconds	18 seconds
150 kb	104 seconds	52 seconds	45 seconds	27 seconds
200 kb	138 seconds	69 seconds	60 seconds	36 seconds

Given these connection speed differences, it is constructive to look at typical page components in a low-level 2 web-based course. Table 5.0 contains these page components and their typical size in kilobytes.

Table 5.0 Typical WBT Page Components		
Page Component	**Description**	**Typical Kb Size**
Navigational Interface	Usually cached; typically downloads once and then is resourced throughout the remainder of the course	10-20 kb
Text	Determined by character count; usually minimal user of kilobytes on each page	1-10 kb
Graphics	Files saved as .gifs can be quite small, ranging from 3-20 kb; compressed jpeg format used more often; kb size increases depending on complexity and dimensions	3kb to 160 kb
Animations	Low-level Flash animations can be quite small; more complex animations can easily reach 200-300 kb. Other formats are available for streaming video but require plugins	10kb, 100kb and higher
Narration	In a compressed .wav format, 15 spoken words in a 4-second audio file equals 55 kb; 30-45 words in a 15-18 second file equals 150 kb	depends on length of file
Average page components such as these can easily add up to over 300 kb per page, increasing download times substantially even on a 56K modem connection.		

So what is the answer? Obviously, the current Internet and connection opportunities available to most home users will not effectively support highly interactive courseware. But…as bandwidth increases over the next few years, we will see the e-learning industry produce more engaging multimedia interactions with more extensive audiovisual components, such as animation, character agents, streaming video and audio, and even virtual reality in the form of avatars and more. In the meantime, careful design can produce extremely engaging courseware even at more static levels of interactivity.

F.   Development Timelines – How Long Does it Take?

Developing e-learning products is gradually becoming a more efficient process as the industry sets standards for production and delivery and as development applications become stronger and more robust. Still, the industry average for developing a one-hour e-learning product averages about 250 man hours of development time. One hour of e-learning typically equates to a product with approximately 120-180 "frames" or screens of instruction if built in a linear, page-by-page fashion. Most users will complete 2-3 screens per minute. If the content is built in a vertical scrolling fashion, estimates may vary.

Production usually follows a standard process of analysis, design, development, implementation, testing, revision, and delivery. The table below explains major production steps along with reasonable production timelines.

Table 5.0 Acceptable Production Metrics for E-Learning Courseware with Hourly Variances		
One-Hour WBT	**Two-Hour WBT**	**Three-Hour WBT**
8-12 weeks	12-16 weeks	16-20 weeks
Typical Production Schedule Milestones for 1 Hour WBT Course (*Conversion*)		
Milestone Production Steps	**Acceptable Production Timelines**	
Develop Design Plan; Gain Approval	2-3 days	
Develop Rapid HTML Prototype	4 weeks	
Deploy/Post for Prototype Review	1 week (for reviewers)	
Gather & Make Revisions; Complete Development; Perform Internal Quality Reviews	2-4 weeks	
Deploy/Post for Full Review	1 week (for reviewers)	
Gather & Make Revisions, Post for Final Review	1 week	
Make Final Revisions	2 days	
Test in LMS	2 days	
Release Final Course	1 day	
Total	**8-10 weeks development + 2 weeks of reviews = 12 weeks of average production time**	

Delivering and Managing E-Learning

As mentioned earlier, the primary delivery vehicles for e-learning products are CD-ROM or DVD, intranets, the Internet, and even satellite and web broadcasts of classes and conferences. When content is delivered via CD-ROM or DVD, it is typically referred to as "computer-based training", while content delivered via browsers is usually identified as "web-based training". Regardless of the delivery mechanism, the delivery medium is usually determined well in advance of content development.

Creating an implementation strategy for e-learning products is helpful and will contribute to an efficient rollout of what users may consider to be a radically new form of training. E-learning products by themselves do not often contribute to efficiency; they must be effectively administered and managed, which requires continuing attention on the part of the sponsoring organization.

Whether the e-learning products are COTS products or customized for a particular use, return on investment (ROI) can best be calculated when the number of users can be tracked, along with their completion percentages, performance on assessments, completion times, frequency of use, demographics, and their feedback and response to the training. The best method for managing e-learning is to install and configure a learning management system (LMS).

An LMS is a comprehensive software application, usually web-based, that automates record-keeping and course administration for a scalable number of users. By using an LMS, users can securely log in to a customized entry point for e-learning courses, select courses they want to take, launch the content, communicate with online instructors and other students, and participate in other collaborative features. In turn, the organization can collect user metrics and automate many functions, while simultaneously configuring the system to populate a database of users, courses, and related data. Most LMS applications have the following features:

- Course administration, including tracking , automated grading, document management, scheduling, and resource tracking
- Skill inventories, skill gap identification and analysis, and prescribed training capabilities
- Multiple assessment formats
- Workflow automation
- Blended learning (combining various forms of e-learning, such as web-based training and instructor-led, classroom training)

Another important feature of many LMS applications is their ability to serve as a content repository, collecting and grouping content and thereby preserving an organization's knowledge capital in one location. This feature capitalizes on the growing trend of blending training and knowledge management. Additionally, e-commerce applications can be merged with LMS systems, allowing organizations to offer courseware for fee via the Internet or intranet.

Full implementation of an LMS usually requires dedicated servers and – even more important – dedicated personnel. A webmaster or database specialist is needed, at least part-time, to configure, refine, and manage the application efficiently.

How Raytheon Can Help

Raytheon Interactive, located in Pensacola, Florida, is a vital part of the Raytheon Company. Corporately, Raytheon is a global technology leader providing products and services in the areas of commercial and defense electronics, business and military aviation, and training services. In Pensacola, Raytheon Interactive works from a twenty-year legacy of expertise in the design of training systems, print-based and instructor-led courses, and e-learning products.

Raytheon's facilities in Pensacola encompass offices and laboratory spaces that are intra-networked across a common development environment. Suites for courseware production, software and network engineering, administration and management, and a 2,500 square foot RF-shielded SCIF collaboratively support the design and development of training products and delivery systems for unclassified or classified content.

So, how can Raytheon help your organization? Currently, Raytheon provides training products and services to clients within DOD, the federal sector, and to corporations throughout the U.S. Our capabilities to build, host, and manage training include the following:

- Design, development, and delivery of interactive, online e-learning products

- Design, development, and delivery of print-based and instructor led courses

- Consistent production of web-enabled courseware conformant with ADL SCORM (Advanced Distributed Learning Shareable Courseware Object Reusability Model) and emerging IEEE/LMS (Institute of Electrical and Electronics Engineers/Learning Management System) standards

- Installation and configuration of enterprise-level learning management systems

- Hosting and courseware administration services

- Integration e-commerce into e-learning, enabling revenue-producing courseware

- Management of training-related computer networking and engineering technical services

- Secure, scalable online testing and assessment

Let us know if we can help. For information on e-learning, training, or any service listed above, contact:

Dr. Susan Codone
Manager, Interactive Multimedia Production
Raytheon Interactive
600 University Office Blvd, Suite 6
Pensacola, FL 32504
850-476-1750 ext 694

scodone@raytheonpns.com
www.raytheoninteractive.com

References

ADLNET. (2001). Guidelines for Design and Evaluation of Web-Based ADL Applications [On-Line]. Available: http://www.adlnet.org.

Hall, B. (1997). Web-Based Training Cookbook: everything you need to know about online training. John Wiley & Sons, NY. Also see: www.brandon-hall.com.

Merrill, D.M. (1997). Instructional strategies that teach. CBT Solutions. Nov-Dec. p. 1-11.

Morgan Keegan E-learning Investment Reports (2001). E-Learning: The Engine of the Knowledge Economy. Available: http://www.learnativity.com/marketreports.html