Applying the Cisco Systems™ RLO Model to a Live Automated Training Build for Nationally Dispersed Learners: Takeaways and Lessons Learned

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Abstract - Instructional design theory and practice interact powerfully in live projects. This article describes one use of the Cisco Systems, Inc.'s Reusable Learning Object (RLO) approach (with their legal permission) to the building of automated RLOs for a national project. Through the definition of information as concept, fact, procedure, process, and principle to a live curricular build, a six-module automated training was created in 2006 for deployment beginning in 2007.

This project involves 12,000 geographically dispersed learners (of varying educational and cultural backgrounds) with a complex and regionally sensitive curriculum, with contents collected from national SMEs and deployed over an ontology-based database. The training involves evolving biological science materials and requires complex, real-time decision-making.

This article examines the applied principles of instructional design (cognition, learner profiling, Clark and Mayer's multimedia development and cognition findings, learner developmental phasing, and other theories) in a live project. It explores how the six modules were planned, created, alpha- and beta-tested and deployed.

Vocabulary flashcards, multiple-choice pre- and post-test assessments (for certification), and the beginnings of a decision-making simulation were created. Decision trees were used for the simulation and the planning for a full experience "wrap" for the decision-makers in the simulation. This paper addresses the use of metadata and "invisible" metadata for in-house password-protected use. Instructor notes added value for the occasions when instructors might choose to deploy the learning live F2F(face-to-face) or via online eLearning using these same digital materials, or when trainers might wish to use online spaces to bring geographically dispersed communities together.

Challenges. Real-world strategies for collecting, gaining copyright release, and labeling digital artifacts affected the instructional design. The push for the lowest common denominator among users restricted some curriculum design options. The "affordances" of a database and the collaborative teamwork of dispersed grant principal investigators (PIs) led to yet further limitations. Important multimedia, pedagogical agent strategies, and other elements were harder to create in a cautious environment. This will explore how difficult it may be to create regionalization and customization builds. This will advocate the importance of the malleability and pliability of RLOs for more effective eLearning and reusability.

Keywords: Cisco Systems, Inc. Reusable Learning Objects (RLOs), automated eLearning, instructional design

Introduction

The learning objects created for use in an online ecology may be deployed in a variety of ways. For the instructional designer (ID), the back-end build issues may be much less relevant than the functionalities that may be afforded through the so-called "ilities." What's more relevant to an ID may be the model used for the creation of the digital learning objects (LOs).

Instructional design (with technological collaboration) lies at the heart of creating a strong program, according to two writers with the Cisco Learning Institute: "Instructional design is critically important for effective e-learning and for the development of useful learning objects. In an e-learning setting, instructional design must be explicit in the selection, scope, sequence, and creation of experiences that support learning" (Mohler & Whitiker, 2006, p. 67). Any time there is a lack of instructor mediation, additional attention must be paid to the instructional design to mitigate (Giraldo & Acuña, 2005, p. F2B-20).

The lessons learned and takeaways from a recent project using learning objects (LOs) for both automated and instructor-led instruction offer some insights on one use of LOs in an ontological database that is "closer to" Web Ontology Language (OWL) than SCORM (but which may include a SCORM export / import feature at a later date).

Brief Project Overview

A project in 2006 involved the use of the Cisco Systems, Inc. Reusable Learning Object (RLO) Model as described in several of their widely available online publications. While minor adjustments were made to the model, the curricular build used the general templates and tools.

The learners would be individuals who work in US fields and with US crops. The multi-disciplinary curriculum would be delivered in a variety of ways: (1) Automated open-entry, open-exit, learner-paced with learner tracking (CMI or computer-managed instruction); (2) Remote, instructor-mediated via online interactivity (ILT or instructor-led training), and (3) Trainer-mediated in a face-to-face situation (locally or nationally).

A proprietary ontology-based database would be used to house the information, and this would be ported to a front-end open-source LMS for registration and minimal learner tracking. The learning outcomes were not only fact-based with new knowledge; they included deep learning (analytical, applied, procedural, and transferable in non-field-dependent ways).

The "givens" of the project were that there would have to be six modules with pre-defined topic areas. Each module would have a pre-test (to assess as well as to prime the learning) and a post-test (as a summative evaluation). The respective learning outcomes and contents of the modules hadn't been defined, but the general trajectory of the learning had. The template hierarchy from Cisco Systems' RLOs would be as follows: course, module, lessons, topics, subtopics (facts, principles, processes, procedures, and concepts). Each module would require defined learning outcomes. Learning objects would include photos, text, interactivity, image maps, vocabulary flashcards, interactivity, simulations, glossaries of terms, and WWW resources. Shareable content objects (SCOs) are the most atomistic or granular level of objects.

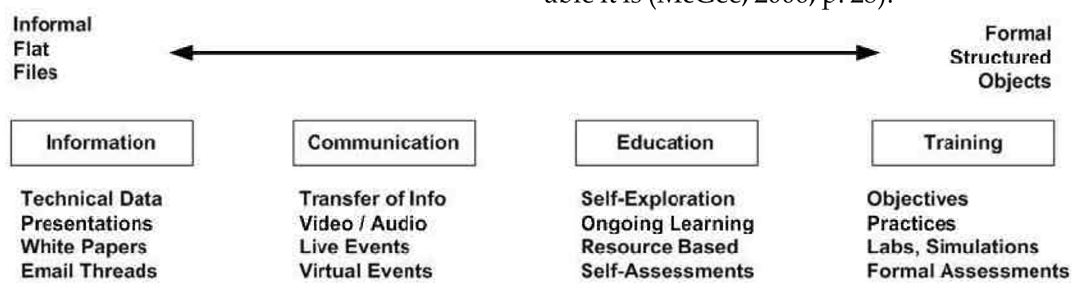
The pedagogical theories applied involved Cisco Systems RLO modeling, learning object design theories, cognitive load theory, multimedia design theories, and adult learning / andragogy problem-based learning concepts. Without these elements in the curricular build, the information would not be transformed into knowledge or skills. The content was built to be accessible, with plenty of annotation of images and plans to close-caption video. Some attention was focused on writing content that would translate well into other languages, like Spanish and German; this resulted in simple English with plenty of explanations. Words that could potentially translate into off-putting terms in other languages were avoided. The tone was kept neutral, impersonal, and professional. Jokes were out. Some in-field lingo was used as a piece of insider language, but was not a dominant part of the textual communications.

A national certifying agency would be accrediting this curriculum and using it for certification and the extension of CEU (continuing education unit) credits. The assessments would have to fit the multiple-choice model of testing by this agency, and the learning would have to be packaged in a modular way in hour-long units.

The ambitions for this project included the following: the ability to version content, the use of the database for interchangeable use of RLOs, the automated delivery, and the ability to apply different looks and feels to the same contents. Some of these objectives were achieved. A pithy observation by Geissler was used as a guiding principle: "Before any learning object can be reusable, it must first be usable" (Giessler, as cited in Mohler & Whitiker, 2006, p. 66).

Based on another model, the Taxonomy of Instructional Methods by Hokanson and Hooper, the learning through automated means would mostly be Level 2 (of 5 levels) or "applied ideas." With instructor-led learning, this could be escalated to higher levels such as that of "extending ideas" and "generating solutions" (Hokanson & Hooper, 2004, pp. 14, 18). Based on Gagné and Briggs' theory of instructional design, this build would involve all elements: verbal information, intellectual skills, cognitive strategy, attitudes, and motor skills (Gagné & Briggs, 1960s, as cited in Bayer, 1991, p. 290). The main competencies required would involve all three levels described by Giraldo and Acuña: cognitive, affective, and social competencies (2005, pp. F2B-22 to F2B-23). The cognitive piece would involve learning about the signs of potential risk and methods for assessing live situations; the affective piece would involve the motivation for learning the curriculum and becoming empowered; and the social competency would involve the proper interrelating with the proper authorities.

On the continuum created by the developers of the Cisco Systems RLO model, the training objective tends to be very high level as a formal structured object. (The Cisco Systems, Inc. RLO developers conceptualize the use of an e-Learning Solution Architecture as falling on a continuum of various needs.) The more granular a learning object is, the higher its reusability. The more integrated and complex, the less reusable it is (McGee, 2006, p. 28).



(Cisco Systems' "Reusable Learning Object Strategy...", Nov. 2001, p. 6)
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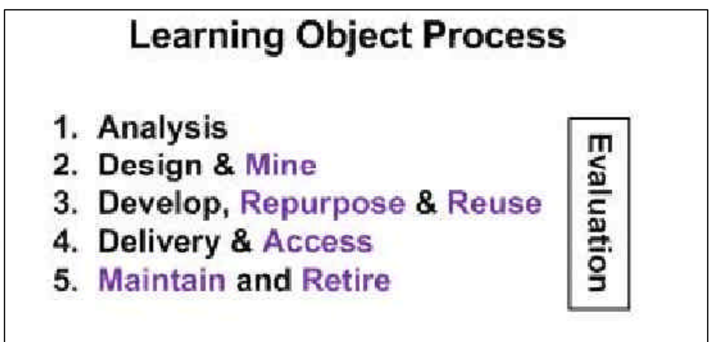
Cisco Systems Reusable Learning Objects (RLOs) and other Applied Theories and Models

The Cisco Systems RLOs model builds on the learning theory work of a range of individuals and organizations, per the acknowledgments on the credits page of their whitepapers. CISCO Systems CFP3 (Concept, Fact, Procedure, Process, and Principle) Reusable Instruction Objects (RIOs) is generally based on Dr. Ruth Colvin Clark's cognitive learning observations and Dr. Benjamin Bloom's Taxonomy of Educational Objectives. Essentially, their model defines the various Reusable Instructional Objects (RIO) that are formed through the classification of information and then may be coalesced into a Reusable Learning Object (RLO). An RIO contains content, practice, and assessment items.

This model has a two-level hierarchy: (1) Reusable Learning Object and (2) Reusable Information Object. The RLO brings together the learning experience, and the RIO is much more atomistic and granular (Cisco Systems' "Reusable Learning Object Strategy…", Nov. 2001, p. 16). The concept is that different RIOs may be integrated into an RLO based on different learning outcomes, subject matters and training / learning needs. The contents of an RIO have been defined in this model. In the following, what's italicized is not required but optional.

Concept: Intro, Definition, Example, *Non-Example, Analogy*
Fact: Intro, Facts
Procedure: Intro, P-Table, *Demo*
Process: Intro, Stages, *Diagram*
Principle: Intro, *Statement*, Guidelines, Example, *Non-Example, Analogy*



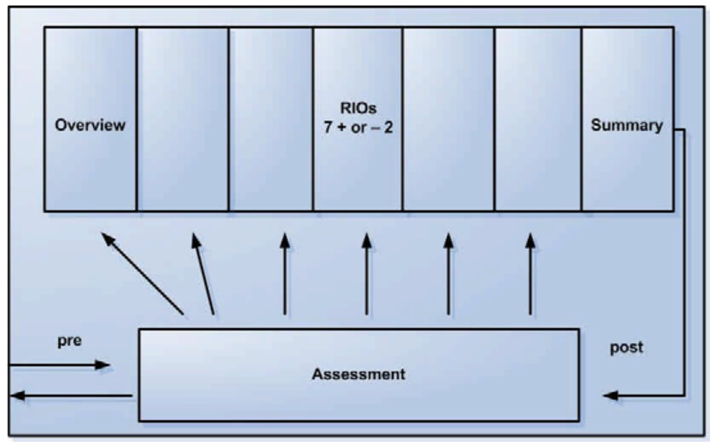
(Cisco Systems' "Reusable Learning Object Strategy…", Nov. 2001)
(Used by permission of Cisco Systems, Inc., Feb. 2007.)

Reusable Learning Objects (RLOs) may contain a combination of reusable instructional objects (RIOs), prefaced by overviews and concluded by summaries. A pre- and post-assessment contributes to the learning value ("RLO Definitions," 2000, pp. 1 –2). The model allows for a variety of types of eLearning experiences and artifacts to achieve a particular learning objective. The sequencing of the RIOs within an RLO (Reusable Learning Object) is flexible.

The Cisco Systems RLO model also includes suggested steps to the development process: analysis, design, development, and delivery. Maddocks and Barritt have added a "life cycle" of the learning object as part of their use of this model by including a "maintain and retire" layer at the end and more definition to the various prior steps (Maddocks & Barritt, 2002, n.p.).

Cisco Systems, Inc.'s Reusable Learning Objects (RLOs) with Reusable Instructional Objects (RIOs)

This RLO model offers vast flexibility in the definition and sequencing of the learning. It starts with the assumption of the essential nature of a particular piece of information. (This image was used with the permission of Cisco Systems, Inc., Feb. 2007.)



Reusable Learning Objects with Reusable Instructional Objects (RIOs: Content Items, Practice Items and Assessment Items) Embedded

("Reusable Learning Object Strategy: Definition, Creation Process and Guidelines for Building, Apr. 22, 2000, Version 3.1, p. 4)

Competitive advantage. What gives one model competitive advantage over another in the development of LOs often relates to the pedagogical theories underpinning the model, ease of training developers to use that particular design, efficiencies in the LO production, scaling efficiencies, the accuracy and quality of the LO output, conveniences for designers and clear articulation of LO development processes, and model credibility. The cost of using a particular model may be yet another important factor (Hai-Jew, "Creating and Using Digital Learning Objects," Apr. 19, 2007, Slide 30).

Project Shape and Scope

This recent biosecurity project involved 12,000 learners across the mainland US, Alaska, and Hawaii, as well as the various US territories. This collaborative project involved principal investigators (PIs) from three collaborating institutions of higher education located across the eastern seaboard and Midwest.

Learning objectives. The main learning objective was to activate the expertise and observation abilities of a number of individuals across the country to pay attention to potential anomalies that may indicate a potential biosecurity lapse or even a potential terrorism event. It also involved a behavioral response on the learners' end that involved a complex series of proper behaviors to assist in the verification of the presence of particular dangerous biotic elements. To achieve these aims, learners needed certain information, access to and knowledge of how to use particular tools, procedural knowledge, information about who to contact as a local resource, and a sense of others' roles and actions within the network.

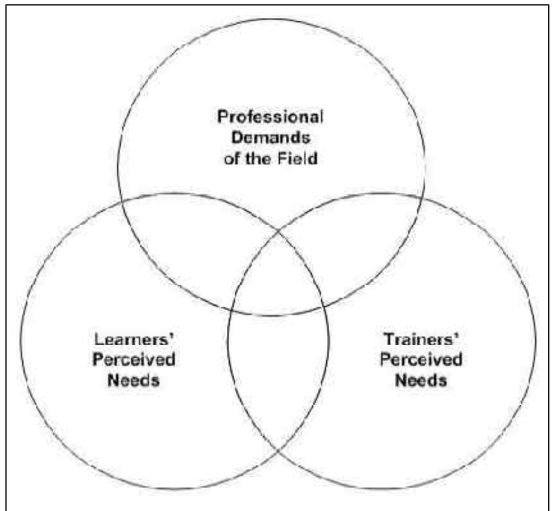
The learning had to be accurate, in-depth, applicable to live high-risk situations, and transferable across customized learning domains. The curriculum would ultimately be geographically variable. It would evolve depending on scientific findings and new information, so a large degree of flexibility would be needed in the curricular build. The learning would involve both the automation of delivery as well as instructor-led instruction.

Based on the five information types in the Cisco Systems RLO model, the most common types used here were "facts" and "procedures." "Concepts," "processes," and "principles" were used in explaining the functions within the network, but learners needed to know the "what" and the "what to do" ultimately.

The learners are adults with diverse backgrounds in this subject field and often with local area knowledge. Some would have limited English fluency. Some would be long-term experts in the field, and others would be non-experts. Because of their differences in learning, user control and reviewability of the learning would be important. Also, scaffolding which includes extra learning details would be critical to both groups. Downloadable materials for off-Web review may encourage further learning for the non-experts. Richer nuanced learning and expertise in other regions' issues could be enhanced for the experts. At some point, different eLearning paths may be customizable and made possible in an automated way—with the evolution of the technologies and a more sophisticated profiling of users and pre-testing / post-testing.

Strategies for higher level learning. One researcher observes that analogy is the easiest problem-solving method, and step-by-step problem solving (along with descriptions) and combined methods are the most difficult to convey and learn (Chu, 2005, p. 9). Story problems are useful for context-development, and worked problems and worked examples are critical for story problem instruction (Chu, 2005, p. 9). A model of online learning by McGee suggests that linear learning is conducive for memorization, routinization, and habitualization. A higher level would be branched learning, where learner abilities, knowledge, and skills would be engaged to determine the branching in the learning. Hyper content would bring learners closer to relevance and applicability in their deeper learning. And ultimately, learner-directed learning would offer a full transferability in their learning. (McGee, 2006, p. 28)

Application. The curriculum, given the defined six modules, would involve linear or generally chronological learning at its core. The introduction of instructor-led leadership would involve the potential of customization in the learning, the introduction of hyper-content, and more responsiveness (potentially) to learner-directed discovery work. Indeed, the learning objectives of this project involved the entire gamut of rote learning, drill and practice, role-playing (in the scenario-based simulations), and complex problem solving (in a simulated environment but with applicability to live high-impact environments).



Building to the Middle

An early question arose about what level of learning should be achieved. Between learners' perceived needs, national trainers' perceived needs, and the professional demands of the field, it seemed clear that the rigors of the field would likely define what the learners needed as takeaways. The highest and often most difficult learning is seen in "problem-solving transfer performance." Of course, learners would have to be able to make sense of the information and learning, and trainers would need to find the materials accurate, relevant, and timely.

Cognitive and Multimedia Principles at Play. The use of modular builds around related topics reaffirmed the "temporal contiguity principle," which suggests that learners learn better when verbal and visual materials are temporally synchronized.

In terms of multimedia principles, the spatial contiguity principle was followed as optimally as possible—with the goal of creating physically integrated text and visuals (Moreno & Mayer, 2005, p. 1). In other words: "Congruent with a dual-processing model of working memory, meaningful learning is fostered when the learner is able to hold a visual representation in visual working memory and a corresponding verbal representation in verbal working memory at the same time" (Moreno & Mayer, 2005, p. 6). However, a real-world aspect made this difficult, and that was the lack of specific visuals that applied to a particular concept.

A central tenet of the cognitive load theory suggests that cognition is limited. That idea was maintained during the curricular build. The intrinsic load is explained as the mental work imposed by the complexity of the content and the instructional goals (Nguyen & Clark, 2005, p. 3). The germane load is comprised of demands on the working memory by "mental activities directly associated with learning." Here, the working memory contributes to the mental focus on the learning task, and a well-built course should enhance activities that encourage the germane load (Chu, 2005, pp. 3 – 4).

By contrast, extraneous load refers to activities during learning that do not contribute to the learning. What is germane vs. extraneous depends on the defined goal of the learning task. "Learners may use much of their working memory to try to establish coherence between the two information sources. As a result, little or no cognitive capacity remains for germane load, especially if there is also substantial intrinsic load because of the learning material itself." Redundancy then is negative because it draws away limited mental resources from schema construction and automation of learning (Chu, 2005, pp. 3 – 4). It leads to "split attention." "Students learn better when extraneous material is excluded rather than included in multimedia explanations" (Moreno & Mayer, 2005, p. 1).

However, some other principles had to be contravened given the resource limitations of the project. First, there is the modality principle that suggests that students learn better when verbal information is presented auditorially vs. textually both for concurrent and sequential presentations. The learning here was textual, and any auditory aspect would have to have been through a computerized text reader. Indeed, defining this mode of communication would have added complexity that the team did not want to pursue because of the difficulty of translating that into other languages and because of the processing load needed to download or stream multimedia objects with sound. Also, instructor or trainer mediation would mitigate some of the aural-learning issues.

Project Stakeholders

On paper, the stakeholders to this project would be a non-profit national organization and its many satellite local offices charged with maintaining the safety of a particular aspect of US agriculture. There would be the 12,000 learners scattered across the country. There would be the trainers who regularly share their expertise around the nation. While there was one official subject matter expert (SME) and lead principal investigator (PI), he stood in for many from different regions. Off paper, there would be many community groups and others with expertise that could benefit from the learning, particularly in the automated form.

In terms of competition for offering like-curriculum, there was very little online that would overlap the same learning. It's possible that some of this learning was already available in password-protected eLearning spaces and possibly in some university classrooms.

A few meetings had occurred between the three grant PIs and various SMEs from across the country to brainstorm the modular outlines and to collect digital artifacts (mostly slideshow presentations and an occasional academic paper). An in-depth reading of the digital artifacts collected around which to build this project showed a range of expertise, various embedded photos in slideshows, and a range of speaker-audience relationships. The tones of most extant slideshow presentations were of high seriousness, but one took a humorous tact.

Several hundred trainers in this field would need access to the curriculum and the database in order to conduct their face-to-face and / or online courses. They could bring digital resources and knowledge to the curriculum, but they would have to be trained on the database, the instructional design, and methods for making changes to the information for their own training uses.

Roles and Staffing

The research literature on team composition for SCORM-compliant LO development suggests quite a few more members than many academic entities will generally fund. For example, the Carnegie Mellon Learning Systems Architecture Laboratory (LSAL) suggests that teams be put together to address learning object building piecemeal. These teams should consist of the following members: Instructional Designers, Content Authors, Content Programmers/ Developers, Media Producers, Subject Matter Experts, and Content Librarians (Pasini, "An overview…" 2004, p. 38). In less ideal work situations, it often means that the ID and others will play multiple roles. The upside to this is that there's often a lot of outside-expertise learning; the down side is that this means that team members have to invest a lot of time and effort.

The PIs filled the roles of SME, computer technology specialist, and instructional design. The development work was split between two developers. Several team members assigned to the curricular build had a difficult time understanding the Cisco Systems RLO methodology and templates, and there were personnel shifts that affected the leadership over the instructional build.

The deadlines were established by whenever a national conference was scheduled at which they would have to present. The first major deadline involved a quick "proof of concept" early on, and the pacing of the project never let up from there. The deadlines were grueling because the grant had already been extended because a prior ID could not actualize the complex curriculum based on the RLO model design and did not understand how to use the database.

Because of how busy the PIs were on their respective campuses, many decisions got shifted from one member to another, or decisions devolved to the ID. The concept was to keep moving the project forward and to keep it malleable enough to make fixes as needed. The concept of "ownership" was not conducive to the build, and bylines were kept to a minimum—except for the few digital images that were "lent" to this project by one national SME.

The Communications Piece

With geographically dispersed team members, a project lead maintained a sense of teamwork. She set up online spaces for the sharing of digital contents and the archiving of some digital information. She arranged ways for the ID to send massive working files with embedded graphics.

The PIs met for weekly telephone conversations during which they planned next steps. The ID was invited to participate, but given the serious time crunch, chose to avoid those meetings. Rather, the interactions were handled mostly by email and the occasional telephone call. For on-campus meetings, those were held on campus but were also kept to a minimum, given the time crunch. For local team members, they could post and update their materials on shared drives.

Each team member created an electronic persona on email. As to how accurate these characterizations might be, it's hard to say. However, cultivating a responsive and friendly persona tended to be helpful for cooperation purposes.

In terms of a virtual persona used to pursue digital resources from SMEs from other universities, having a Google profile (on various servers) and an email address that ended in .edu seemed to be helpful. Also, being able to name-drop one of the PI's names or a prior name in a chain of references was conducive to such "cold calls."

Planned and Actual Workflows

A defined workflow may enhance trainer development of other curriculums onto this database. If there could be some simple way to create a workable curriculum and move it forward in terms of regional segmentation (with geographical uniqueness, risks, threats, strengths, and training needs), the power of the learning would be magnified. The general workflow, while it seems linear, was recursive and iterative. Parallel to each of these steps would be feedback from the PIs and SMEs. (The illustrated workflow follows in the Appendix.)

1. **Environmental Scan and Project "Blueprint" Analysis:** Study the desired curriculum, Cisco Systems, Inc. RLO model, the handful of digital items, the projected learners, the apparent and non-apparent stakeholders, and the defined learning objectives. Study the branding of the various organizations, and keep that branding consistent.
2. **The Learning Trajectory:** Brainstorm the modules, and consider any possible content that would fit in each module. Storyboard and outline the learning.
3. **Information Gathering with Copyright Releases:** Collect the relevant digital information—for informational needs. Get copyright releases for all digital objects used. Avoid using any phrasing from an original source that would cause potential copyright problems.
4. **Project Stylebook:** Start a stylebook for the project. Define the technological parameters for handling digital images, digital video, interactive elements, and others.
5. **Multimedia Plan:** Write up the multimedia plan. Work with the various individuals who may contribute to the multimedia builds. Work with a photographer to collect relevant images. Script videos. Capture relevant screen shots.
6. **Writing:** Write the learning contents. Design automated interactivity into the learning.
7. **Database Upload:** Upload the contents to the database.
8. **Alpha and Beta Testing:** Set up an alpha and beta testing plan, and follow through. Bring live learners in to get their experiences with the learning.
9. **Revision:** Revise contents.
10. **Assessment Creation:** Create the assessments. Ensure that these fit the requirements of the potential accrediting agency. Make sure that the assessments reflect any changes made to the main curriculum.
11. **Technology Testing:** Test the automated outputs from the database.
12. **Future Planning, Simulations, and Hand-off:** Hand off the project with sufficient future planning for additional builds, including simulations.

Writing workflow. A simplified description of the steps to the writing first began with the brainstorming of an outline of the learning structure. Next, plenty of research and reading followed. The annotated notes were then written up with formal American Psychological Association (APA) citations. Similar information was clustered. The facts were then chunked with subheadings. These pieces were placed in the learning sequencing. Strategies for delivering the information visually / textually / with interactivity via multimedia and such were designed. Credited images and graphics were then integrated with the text. This planning was all recorded and organized on the Cisco Systems, Inc. RLO templates, with proper captioning and crediting. This information was uploaded onto the database, and on that, additional changes were made in a recursive fashion. As changes were made onto the live database, documentation was achieved on the working files. Once a core curriculum was created, additional instructional planning was added for the different types of delivery (instructor-led face-to-face and instructor-led via online delivery).

As with many team-led projects, the learning objectives and directions changed a fair amount. This meant that rapid prototyping of the curriculum was helpful but that flexibility would be assumed at every turn. It meant that the information collected should be as thorough as possible, but some of it would have to be set aside for potential use later or simply for background information. The ID also had to maintain clear understandings of the interconnections between the various pieces of information, because one change often had ripple effects throughout the curriculum.

The revision piece required condensing the drafted curriculum into segmented periods of learning. Some of the learning devolved into opt-in additional learning pieces. The fundamental assumptions were that the learners were learning individually (and in an automated way), but group work could be brought into play in instructor-led circumstances. The learning would hit the fundamentals, and in case of an emergency, supplementary learning could be built onto the system. The learning would focus on training, not theory per se. However, a brief segment would address assumptions built off of historical events.

Tapering of ambitions. General workflow steps were quite ambitious at the beginning, but had to be cut back as more of the work dynamics became clear. For example, getting copyright release and the necessary signatures for the Cisco Systems, Inc. model took about half a year of phone calls and emails. The requisite digital images required plenty of email requests, and only one individual out of a half-dozen experts in the field deigned to contribute slides.

Data hungry learning model. This learning model, as with much eLearning, is a data-hungry one. Rehak suggests that there needs to be a content object collection at least 10 times the community population size for there to be sufficient material available to meet the diverse learning needs of that population. Another model suggests that a standalone academic degree program (8 semesters of learning for 40 courses total) would require 14,000 content objects (Rehak, 2006, pp. 44 - 45).

Instructional (Curricular) Design and Authoring

In a way, it's difficult to separate the instructional design piece from the database technologies. The way the teaching and learning is designed, the way information is portrayed and structured (in an ontology), the types of diagrams and images used, the types of technologies, all touch on incendiary issues of mental maps, expertise, turf, and ambitions for the project.

As with any team project, the push for absolute consensus often led to builds that followed the simplest path and often to the lowest common denominator. The difficulty in creating and / or accessing high quality digital photos offered another challenge. Varying schedules and the physical distances between the team members also led to other challenges. Some protectionism of information (siloing) by some team members also caused some productivity challenges. The need for a time limit on the learning for each module (an hour) caused challenges in terms of defining required vs. optional features. The curricular build was an iterative process. The instructional design strategies and terminology were not fully clear to all the team members, and the complexity of the model used also caused some confusion.

Evolving Technologies

The technology angle offered plenty of challenges and benefits.

- **Technologies**

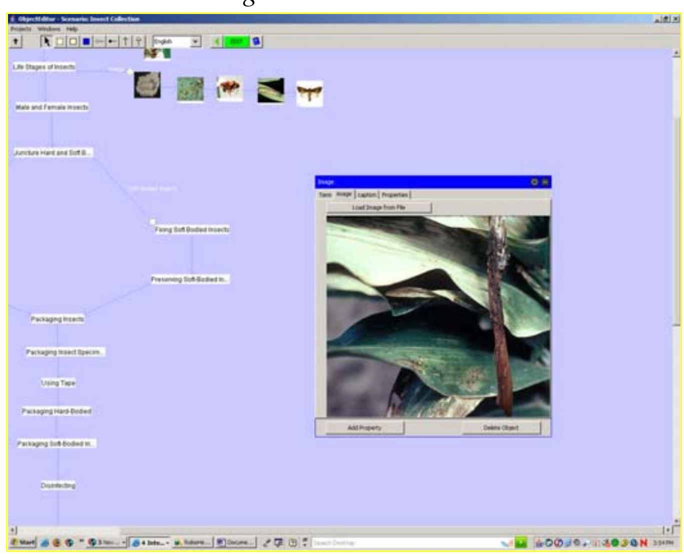
One early and continuing issue was what proprietary or open-source software would be used to build the digital learning objects. SoftChalk Lesson Builder™, Tegrity™, and Camtasia Studio™ all would provide fine digital learning objects. The digital materials would have to be accessible. They would have to have a wide base of users. The digital materials might age out if a software program went defunct, so those were all considerations.

The decision makers had chosen a pure proprietary database approach. This meant that no platform-independent third-party-created objects would be encouraged. No digital video nor sound files were encouraged either. Rather, the idea was that everything would be built into the database in an all-in-one. The content creation tools would be integrated into the database. The database would be a repository of raw materials that would be output automatically as learning objects. The database would automate delivery of the learning. It would deliver materials for instructors to use for their trainer-led courses. It would simplify and standardize the types of digital materials being used. Standardization would possibly involve the size of the LOs, the length of the learning, the tone and type of language used, and the setup of the learning objectives. This approach, while hard to grasp initially, would fit in with the RLO model in the sense of the creation of "pristine" learning objects. The affordances made possible by the database would be that of different versioning of outputs through rule-scripting. Essentially, the curriculum co-evolved with the evolving database.

Two writers for Cisco Systems, Inc. assert: "A useful learning object should also be 'pristine' and lend itself to consistent data transformations to minimize rework to support new navigation, branding, modality requirements, sharing, and repurposing" (Mohler & Whitiker, 2006, p. 66). They explain further: "A pristine learning object…strives for the creation of the learning object agnostic of layout, style, navigation, and branding."

Images Up Close

The database allows for enlarging of images for verification and instructional design.



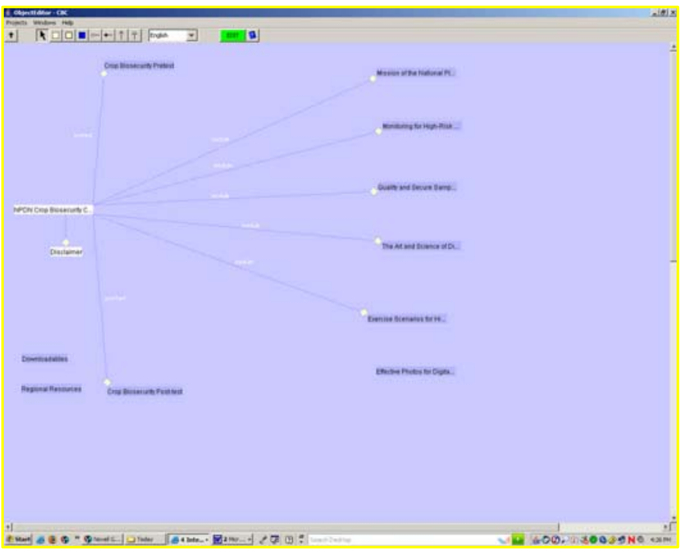
- **The Ontology of Knowledge represented in the Database**

The database represented different types of information as an ontology, with classes and instances. "Instances, also known as *individuals* in description logic systems, represent things in the world. Classes, on the other hand, represent categories of instances that are similar in some way. An instance can be a member of one or more classes."

"Whereas the ontology is useful for systematically storing and retrieving concepts used in e-learning, it is also beneficial to explore the relationships between the cognitive basis of ontologies and the cognitive processes involved in learning. Generally, an ontology is a knowledge representation system that attempts to mimic the way people organize concepts in their own memory. Furthermore, an ontology is created incrementally by systematically adding new concepts, and in the process possibly restructuring knowledge about existing concepts to be compatible with the new concept. This dynamic nature of concept acquisition in ontologies is a model of how people acquire concepts" (Amoretti, 2004; Rosch, 1978; Smith & Minda, 2000, as cited in Beck, 2006, p. 33). The research literature suggests the use of a diverse team of domain experts to create ontologies and advise a double-check loop for internal consistency (Beck, 2006, p. 36).

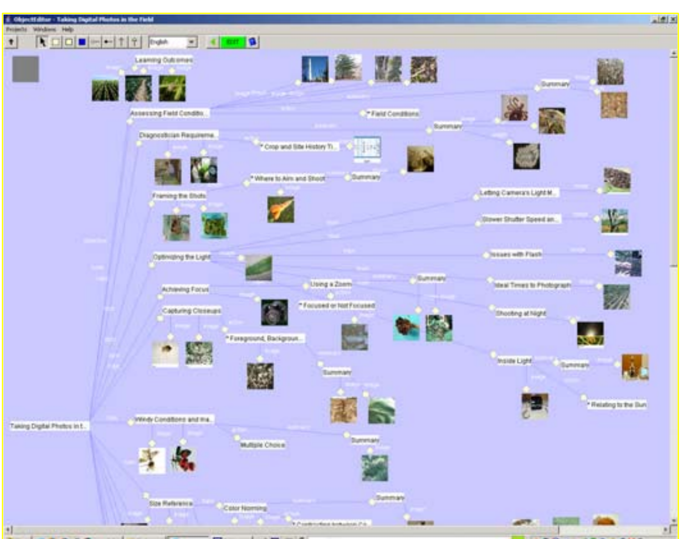
Different Levels of Interrelationships

This screen shot shows a top-level layout of the learning.



A Lesson within a Learning Module

A learning module offers more high-level learning while a lesson offers more of the nitty-gritty. Within each lesson are learning aids like glossaries, images, interactivity, and automated lessons.



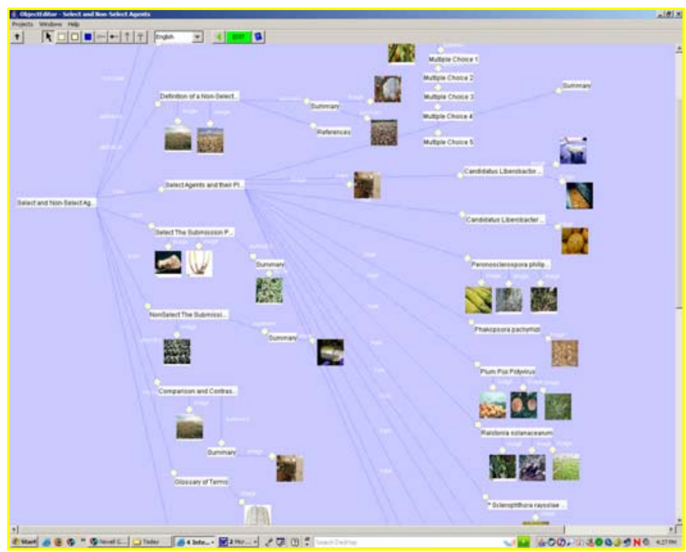
• **Access to Contents for Critique / Transfer Issues**

Another intriguing challenge occurred after the curricular build was made to the database. The main SME had a difficult time seeing how to take the information off of the database. And when a change in personnel brought a multimedia expert on to spearhead the curricular design, this individual also had a difficult time visualizing the raw contents as delivered in an automated interactive way. For the SME, efforts were made to deliver the curricular materials in MS Word files; for the latter, this individual ended up having to turn the various content into PowerPoint™ slides that were easier to evaluate and understand.

Ways to head off this challenge in the future would be to get all the main players familiar with the various aspects of the technologies. It would help to discuss methods for accessing the curriculum.

Seeing the Screens from the Raw Database

Several team members had a hard time visualizing screens from the raw materials on the database.



Another challenge of transfer was that of moving raw text from a word processing program into the database. A straight "copy and paste" often resulted in some dropped formatting and additional "computer garbage," which required tedious cleanup efforts.

• **Designing a Multimedia Plan**

Different ways of representing information—in text, tables, charts, visuals, interactive maps, slideshows, sound files, or video—could easily change the way information is understood and internalized. These access different learning modalities and broaden accessibility routes.

The multimedia plan. A multimedia plan described the role of each module in relation to each other and the learning rationale for the inclusion of a multimedia piece within the particular section. A "graphics key" was used to indicate the type of multimedia: digital photos, image maps with rollovers, digital slideshows, digital video, or interactive segments. The multimedia included different elements like the following:

- an interactive image map to show the interrelationships between the main organization and its partner agencies;
- an interactive map of wide-ranging risks stemming from particular pathogens;
- digital videos of step-by-step processes and procedures for sample collection, while maintaining high standards against cross-contamination;
- digital video of learners interacting with diagnosticians, officials, and other relevant individuals;
- slideshows of particular relevant agents;
- diagnostic photos;
- illustrations of important transferable principles;
- graphical and textual descriptions of processes;
- comparison and contrast images;
- interactive simulations for the uses of particular equipment and tools of the trade;
- interactive timelines to show histories and processes;
- multimedia narrations of certain scenarios with embedded decision-making;
- interactive practices of particular skills for the learners (such as how to process a scene, how to observe and capture relevant information, and how to avoid common mistakes);
- flashcards to practice unique terms related to the field, and other elements, and
- downloadable / printable checklists, timelines, and maps showing work processes and other information.

The entire plan itself covered all six modules in the learning. It included a sense of internal prioritization.

This ended up not included in the final build because of the focus on the main contents and main learning. Also, the use of the database alone to create the outputs foreclosed on the ability to use various technologies for Flash outputs—early on in the project.

- **Exporting Materials from the Database**

The idea behind having learning objects is that they might provide savings, convenience, and quality benefits. Such objects have to be coupled and decoupled easily. The learning has to be rich (Weller, et al., 2006, pp. 139 - 140). A higher bar has been set with reusable learning objects in the sense that authors assert that these need to help in the creation of new knowledge (Hodgins, 2006, p. 49). Hodgins has even called for a periodic table of all data (p. 52).

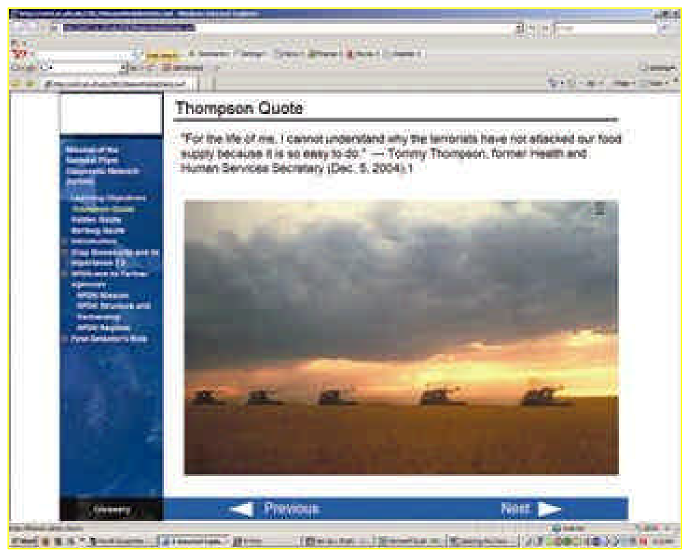
Exporting and sharing learning objects has long been a stated goal. However, while LOs may be imported or exported, stored, called up, and sequenced, this particular project did not focus on importing any LO (just straight data entry). There was no effort at exporting the LOs to any different non-proprietary database. This highlights some of the real world challenges of getting a shareable database of learning objects to work without a clear profit motive, substantial funding, client base, or change in educational / training cultures.

- **Curricular Form vs. Database Flexibility**

The sequencing of learning often involves some deeper awareness of learners' needs and their development as they progress through particular learning. By contrast, the database does not have any inherent built-in sequential learning, but rather the guidance by rules for when a particular learning element should be deployed. Trying to work with a developer for the proper rules-based delivery of learning materials may offer a unique set of challenges. The opportunities afforded by a database for flexible storage and deployment of learning objects are many. Different levels of granularity of information and assignments may be created with the rule-scripting of a programmer. This setup would allow for easy add-ons of other learning objects and digital data for broader learning. This learning may also be delivered with very low technological barriers given the WWW accessibility and use of Flash.

The Output (Image Redacted)

Plenty of effort and time may be invested in how the learning looks on the other end. One "model" that has been difficult to escape has been that of the PowerPoint™ slideshow look and feel, the extant current model against which a flexible interface may be built.



- **The Faculty Template Front-End**

The plug-and-play assumptions of many faculty and their harried schedules may make them less likely to simply upload raw content into a basic database that doesn't have the usual glitzy "digital bubble wrap" to make it more usable. However, using a template may offer a non-thinking non-generative approach in terms of instructional design (Rogers, Hsueh & Gibbons, 2005, n.p.). Another complicating factor relates to the large numbers of potential users of this database, which may offer pressures for standardization and more centralized control for easier use. Imposition of a formula or template would belie the flexibilities of the database. At the time of this project, there was an online manual that had been created for how to use the database, but all users were trained by the database's originator and maintainer (who was also one of the project PIs). Too often, such endeavors fail to consider the need for bridges between the faculty and the technologies, and the difficulties of integrating the technology in an applied way gets under-estimated.

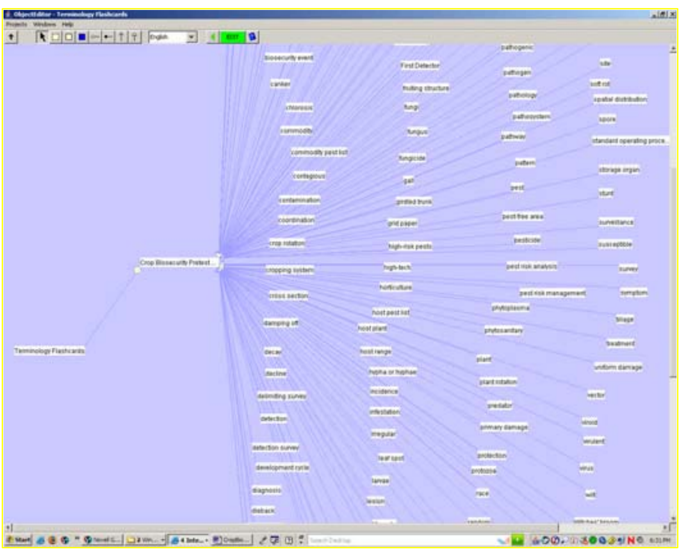
• **The Design Back End**

Inputting data right into a database from the "back end" may seem a little like "roughing it" for some IDs. For this particular project, the elegance and graphical feel of the interface mitigated for some of the rough edges. The spatial layout offered a mind-mapping sensibility. It also allowed for rapid prototyping of learning onto the database and easy revision.

The great flexibility of this database for various ways to store and present information would also make it difficult for instructors to use it for the design and upload of curriculum without a front-end templating and explanatory piece. However, given the year-long rights by a private company for use of their RLO model templates, it made sense not to progress with building a front-end piece to the database yet.

Flashcards

An informational domain often involves new vocabulary. This screenshot shows some of the new words set up in a way for easier practice, memorization, and use.



• **Metadata**

An important part of earlier-version SCORM objects relates to the use of manually-input metadata. IEEE's learning object metadata goals suggest that these standards enable learners to "search, evaluate, acquire, and utilize" learning objects. These enable sharability, LO recombination and decomposition, extensibility to multiple domains, and security and authentication, among other goals ("WG 12: Learning Objects Metadata"). The metadata fields in this project included item labeling, captioning, instructor notes, LO type, and other information. Embedded graphical notations in images that needed to be invisible to general learners, to protect providers of sensitive information, were coded out from user access.

• **Instructor Notes**

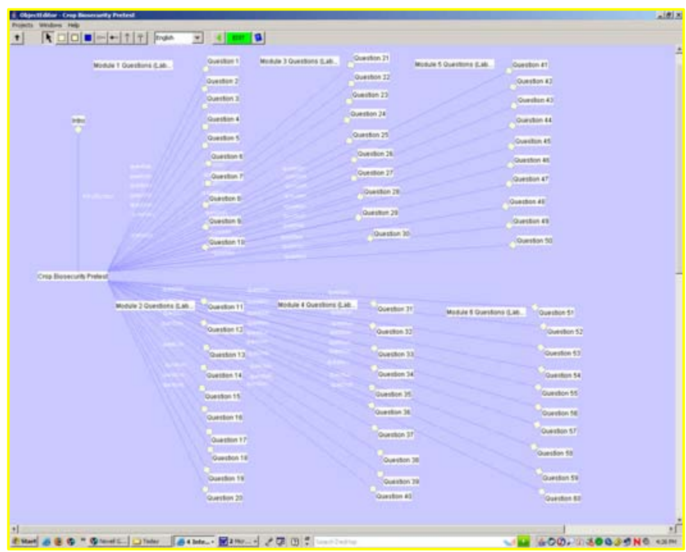
How instructor notes would be displayed or output was not pursued in depth during the project. Rather, the notes were input to explain the learning value of each Reusable Instructional Object (RIO). The instructor notes included the learning activity, context, ideas for additional learning, learning method, and the skills that would be developed by the learners. Reusable e-learning development is defined as "the cloning, modification, and customization of existing files or source codes for developing…another web-based application" (Chang, V., 2002, p. 2) for learning.

No definition of dependencies. For the stand-alone aspects of the LOs, no dependencies were directly defined. However, the outline of the learning clearly defined relationships and levels of learning.

Hawryszkiewycz suggested various object classes for an LMS that used RLOs and software agent support, and the list included the following items: the learning activity ("what happens in each step of the learning process"), subject metadata ("what is being taught"), environment ("the setting of the learning goals, and the technology support for a learning method"), learning method ("the way learning will take place"), and competence ("particular skills or abilities that are developed by the learner") (Hawryszkiewycz, 2003, n.p.).

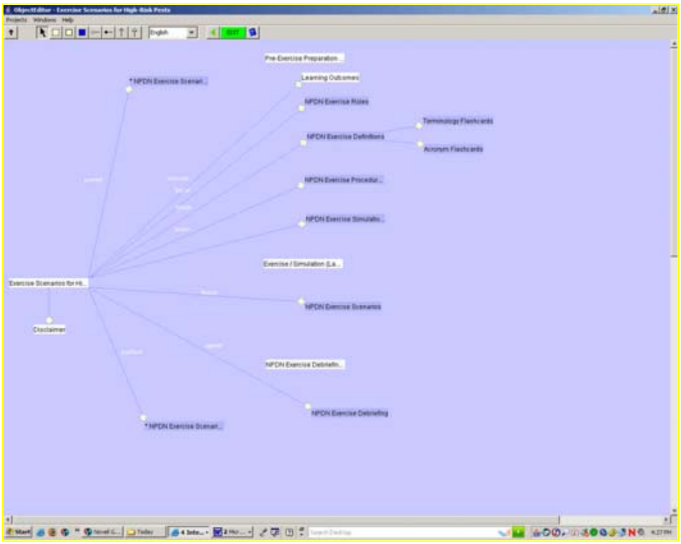
The Pre-and-Post Assessment Layout

The flexibility of a database allows for easy randomization of questions.



Database Flexibility and Quality Information Upload

A database offers the archiving of learning objects and their delivery in flexible configurations. A stylebook defines how labeling should be done for the learning objects to keep the work consistent and to maintain some order. A SME caretaker may maintain the shared database of learning objects and vet for information quality, copyright releases, formatting, integrity of the learning, and timeliness. The research literature suggests that the metadata of various content repositories may be inconsistent and unreliable *with a variety of users (Broisin, Vidal, Meire, & Duval, 2005, n.p.).*



- **The Challenges of Versioning**

One of the largest challenges for this SCORM-compliant database is to deliver regional and culturally sensitive materials to learners in different areas. Ways to identify and archive optional images and text was difficult. Partitioning the database for uses by different regions may also be difficult. Dynamic content aggregation would enhance this function.

- **Personalizing the Learning**

An additional and similar challenge would be the whole process of personalizing learning to each individual who comes to the site based on learner profiles, pre-tests, and other elements. With instructor mediation, this could be handled well. Without it, in the current state, this issue would not be addressed in any automated way.

- **Simulations, Scenarios, and Real-Time In-field Decision-Making**

The simulations designed for this project were only at the conceptual stage; next-stage builds were planned for actualization under a different grant. This simulation module would form a critical anchor-point to the learning because it would culminate the learning in a virtual applied situation. It would empower learners in an automated asynchronous user-to-computer simulation or could even be a synchronous national coordinated computer-mediated effort.

Simulations need to be as "real world" (high fidelity) as possible and as practical for real time transferability in assessment and decision-making, but the quality build would depend in part on the available digital resources, information, and technologies harnessed. An effective simulation has to be accurate; it must be engaging in a cognitive and full-sensory way, with purely digital inputs. The on-ground nuances of decision-making (cognitive fidelity) and strategizing (within that particular domain of knowledge) need to be captured from the SMEs, so over-simplifications should be avoided whenever possible. A simulation should not teach negative externalities as undesirable side effects. In an emergency situation, decision-making may be pressured, and the relative "safety" (the absence of ill effects—ruined crops, ruined livelihoods, costly inefficiencies, misdiagnoses—if mistakes are made) of a simulation may be elusive. However, the decision-making and the behaviors needed for that potential situation need to transfer into the real-world environment, particularly in the case of a critical incident, extended event, or outbreak. SME oversight of how decisions get made in live circumstances may add very rich learning. A debriefing may add the value of worked-out examples and anomalies to regular procedures—to broaden the learning (and ultimately, the applicability). The more full-sensory detail that may be evoked from a life situation, the better the designed learning.

Chunking of complex processes. The processes that the learners should master involved dozens of procedures and decisions—based around a potential biosecurity event. These could be discretely organized and then interlinked into a smooth generally chronological process. This was an example of an atomistic build, which would allow for greater interchangeability. (Debriefings could be done at a more atomistic level as well to enhance applicability and memory retention.)

Simulations are necessarily limited in terms of the ability to emulate the actual. Customizing and regionalizing these (to fit local conditions) would demand a lot of focused work; in addition, simulations tend to be even more data-hungry than the automated learning introduced earlier. The more sensory experiences and details there are, the more upfront work is needed for information collection and digital building. Also, the options offered to learners fell within the realm of the predictable. How people think and behave under pressure may be irrational. All of these factors offered unique simulation-writing and design challenges.

Some takeaways from the simulation should be the application of domain knowledge, the use of the procedures suggested for analysis and reasoning (with localized applications), the effective collection of particular information and samples, and the potential use of think-aloud strategies to carry them through their choices. Another simulation takeaway would be transference—the empowering of learners to take action by contacting those within the network for support, and to access relevant research information to aid in their work.

Branching in Decision-Making. Designing potential branching through the system was also possible given the database flexibilities. One rule could be scripted that would ensure that a learner got to every process even if his / her chronological method was different than another person's.

The assessment piece for those going through this virtual simulation involved many factors surrounding standard operating procedures (SOPs) with legal, regulatory, and other implications. The outcomes involved role clarity by individuals about his /her own roles and others' tasks and responsibilities within the system and scientific knowledge. These involved decision-making, field observations, actions taken in the field, the accurate and safe submission of a variety of sample types, the close following of a chain of communications in a complex inter-agency interplay, the use and understanding of timelines, and the empowerment of learners. The complex scientific and agency terminology were also to be used accurately during the simulation.

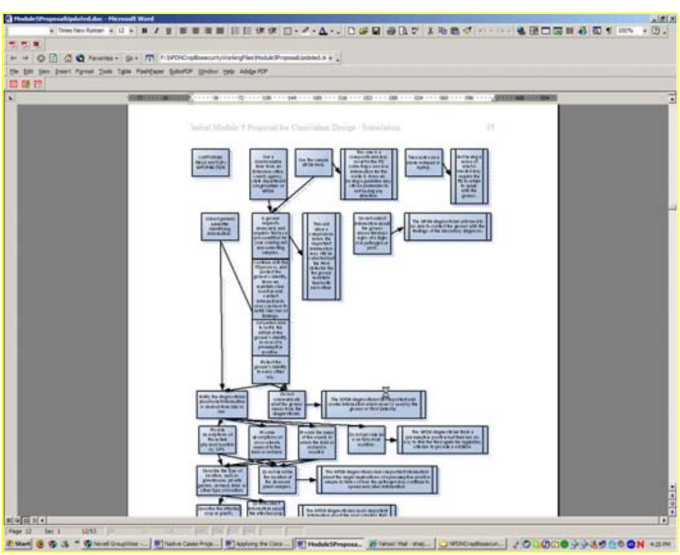
A simulation would allow cost savings. It would allow for synchronous interactions in a fast decision-making environment. It would allow for online mitigations for distance. It would allow learners to function in a non-emergency environment. It would optimally promote relationship building among individuals working in the particular field. It would also allow various entities to practice their official roles in this network. It would promote further deep learning.

Two authors suggest that the conceptualization of the different learning scenarios in which learning objects may be used is critical to their successful building and use. "To adequately reuse learning scenarios, information about context and experiences must become available," write J.M. Pawlowski and M. Bick. The authors note that the development paradigm of reusable learning objects has shifted from "content orientation towards activity- / process-orientation" (Pawlowski & Bick, 2006, p. 84). Field-dependent learners will need more context than field-independent ones (Elen and Clarebout, 2005, p. 45).

Planned debriefing. A built-in debriefing was built into the post-simulation experience for learners to raise questions, share observations, and bring in from-life professional experiences to bear on the subject matter. The distance mitigations by using an LMS enhanced the quality of the learning.

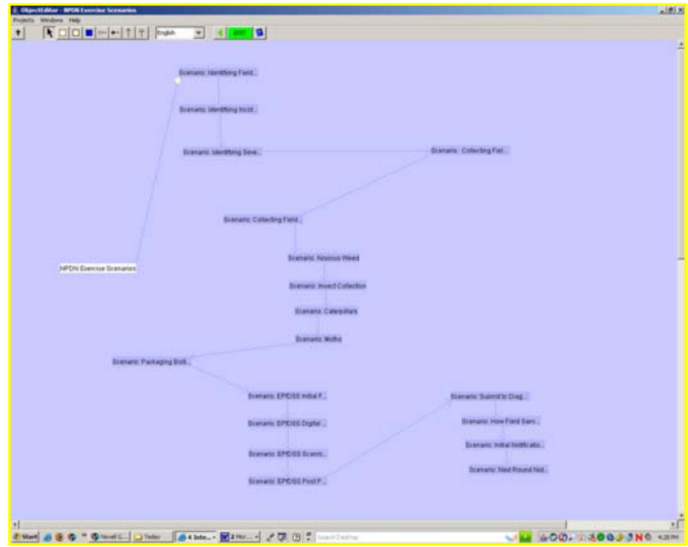
Simulations of Actual Decision-Making

In an environment of incomplete information and quickly changing dynamics, the learners must make the right judgment calls and act on their knowledge in ways that will allow an accurate and speedy response by regulatory agencies.



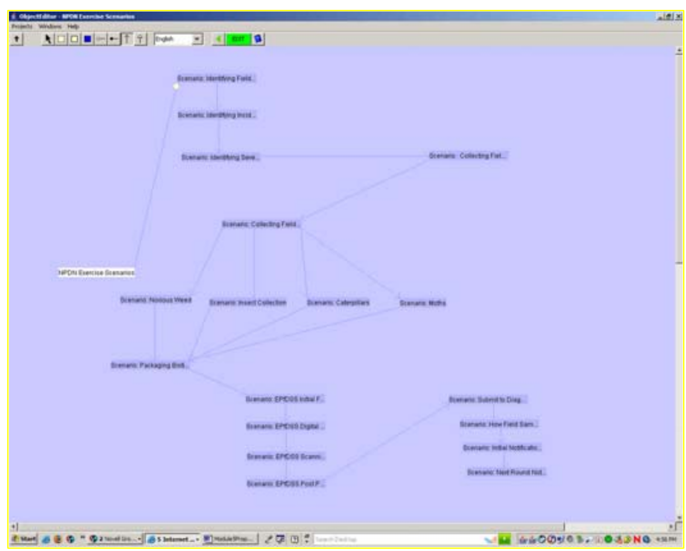
Simulations

A simulation may take learners through a linear, branched, or other sort of chronology. This screenshot shows an initial draft of a linear progression.



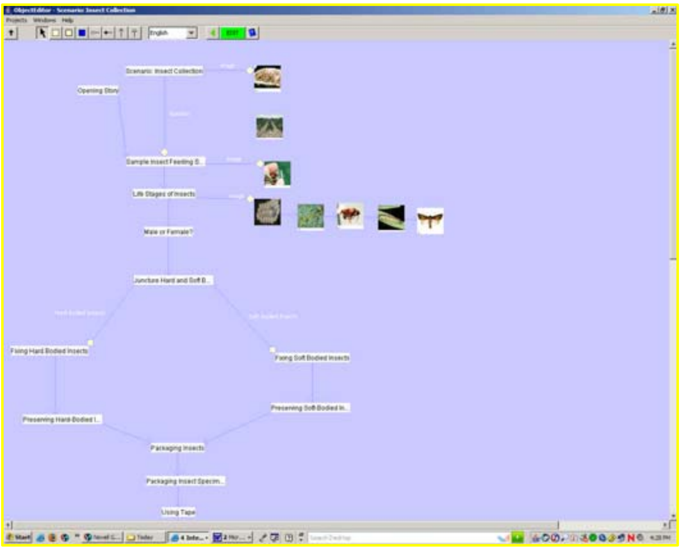
Complexity in Simulations

More complexity may be built into the directional flow for learners. Scripting may ensure that a learner experience every possible path, even if each experiences it in a different order (based on their own decision making).



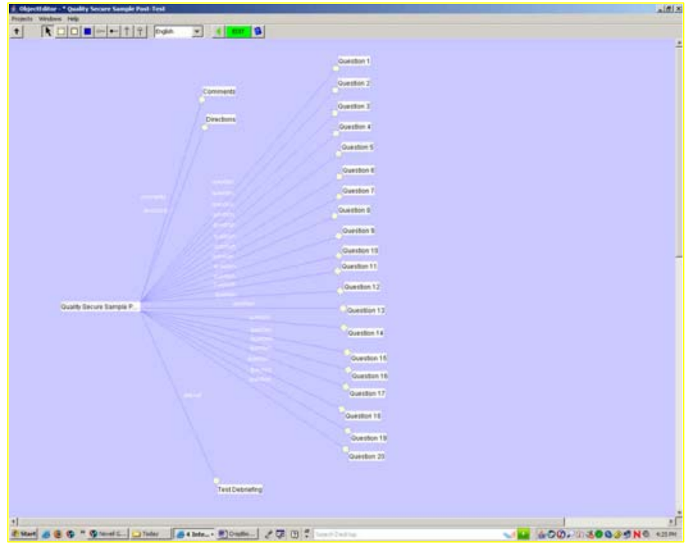
Branched Decision-Making

This screenshot shows an initial draft of branching logic for a simulation. The graphics are limited here because what was being developed first was the logical flow.



Designed Interactivity

Segments of the learning involve basic tests that include T/F, multiple choice and other "automatable" types of questions.



- **Designing (Automated) Interactivity and Potential Human-Mediated Community Building**

Interactivity offers value for learners going through an automated course. It helps maintain user activity, interest, and retention. Continual feedback from learners will enhance the curriculum and learning experience—if that feedback is solicited and applied to the learning. A potential downside only involves interactions that may be too formulaic or those without learning value. Instructor-led courses with live learners may engage an even deeper level of interactivity.

The computer-driven interactivity built into this system used very standard query-and-test sorts of interactions. The richness of instructor-led interactivity was possible given the LMS used, but the curricular build did not go into suggestions for promoting virtual teaming, virtual community building, or planned synchronous and asynchronous interactivity. The most powerful interactivity was designed into the simulation piece.

Song asserts that a learning environment may be designed for interactivity through learning goal orientation contexts with the design factors being: group composition, task design, distribution of authority, and evaluation practices (Song, 2004, p. 45). This research suggests that whoever leads ILTs using this curriculum may consciously build a sense of learning community through live human synchronous (chat) and asynchronous (threaded discussion) interactions.

Designed opportunities for interaction could be integrated into the scenario-based multi-sensory simulations, and embedded with real-world contingencies.

Learning as a conversation. In the research literature, a number of different strategies have been created to achieve learning. A.S. Gibbons suggests that there are four main challenges to the instructional design of learning objects in design architectures: the failure to recognize that "instruction is a conversation," that the instructional conversation is about cause-effect systems, that effective instruction is "a form of story-telling about cause-effect systems," and that the learner has to be brought into the storytelling (Gibbons, 2006, p. 19).

The conversation of this particular learning involves the threat to US agriculture whether from within or without, and whether from intentional or unintentional actions. It also shows the importance of the voices of each of the potential participants, who play critical roles in supporting the overall safety of a large part of US agriculture.

Instantaneous computational design of an instructional conversation. Gibbons writes: "Today the problem of learning objects may seem to be a matter of determining what the objects are and how to sequence them, but it is really a problem of the *instantaneous computational design of a conversation* intended to support learning through different types of events that accomplish story-telling in which the learner participates" (Gibbons, 2006, pp. 19 – 20).

Potential for community building. Part of the discussions in this project suggested the probability for building a community of learners in different regions in order to co-train and to face particular threats together. Participants could—synchronously or asynchronously—share expertise, collaborate, and problem-solve together in a shared virtual learning environment. The LMS, outside of the database, would allow for just such synchronous and / or asynchronous interactivity, based on the training of the facilitators / trainers. To enhance their work, various learning sequences or atomistic learning objects could be employed. One research literature observation echoed this concept: E. Roberts describes an initiative at Tamkang University in Taiwan with an integrated environment "where learners experienced instruction in a SCORM-conforming LMS but were then routed out to a collaborative environment where they could interact with fellow learners" (Roberts, 2005, p. 39).

- **An Evolving Database**

Yet another challenge was building not to a static site but a fast evolving one with new functionalities, new metadata fields, and near-constant creativity. The automated output display (file type) of the learning changed during this ID's stint. The disjunction between what a non-developer could imagine wanting and the complex back-end scripting and builds needed technologically proved to be a source of small tensions.

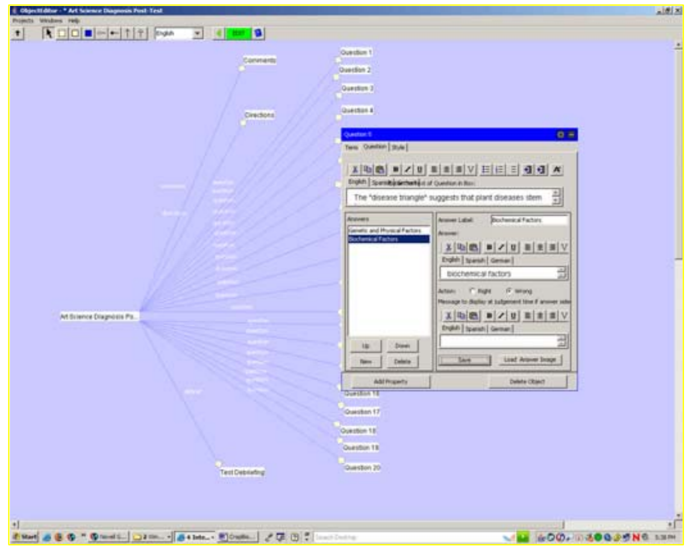
The creator / manager of the site described this database in another article about some of the essential functionalities. "All multimedia content associated with a domain can be decomposed to atomic elements and stored as objects. Pathways through the material can be created by navigating through a concept map either manually or automatically. Query processing facilitates retrieving objects in response to a particular need which can either be an explicit request for information, or a direction from an automatic tutoring process" (Beck, 2006, p. 35). The evolving database (like any) also had an occasional bug that had to be identified, replicated, and reported for a speedy and effective fix.

Text-Heavy Elements

Some learning elements include a fair amount of text along with graphics. This offers some challenge to the presentation of the learning materials on the automated delivery end in terms of layout.

Input Window for Information

This screenshot shows the working screen for data entry. The background spatial layout shows interrelationships between various elements in the database.

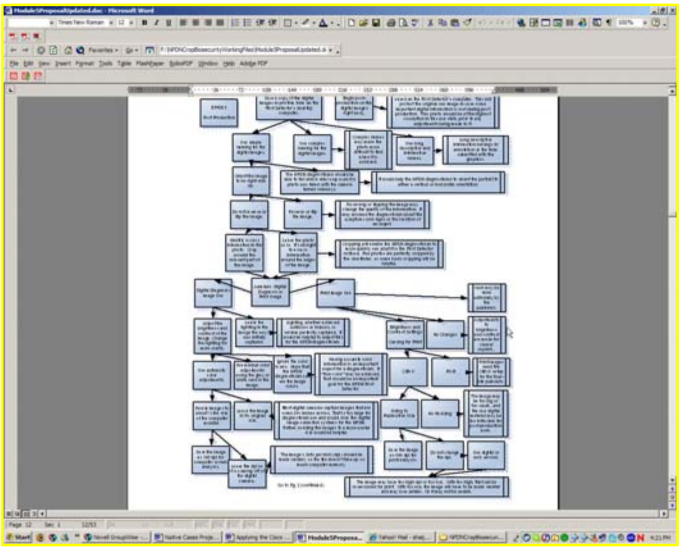


Building and Using a Stylebook

Stylebooks are usually created when a number of IDs and developers are working on a shared project, and there's a need for following particular guidelines. For any project that involves complexity, it makes sense to document naming protocols, digital file handling and size definitions, branding plans, contact information for team members, locations of online resources for research, URL locations of automated file displays, and any other relevant information. This stylebook also included alpha and beta testing plans for issues of content, language, learning, and interactivity. For this project, a digital stylebook was created and made available through the shared drive, email, and a shared online collaboration space. This was updated now and again as decisions were made. Having a documented standards list for reference was helpful.

Decision-Making via a Simulation

Supporting learners through real-world decision-making via simulations means anticipating any number of decisions and paths. This becomes more difficult as the learning becomes nuanced. All relevant factors for making a decision should be clear, without discouraging possible respondents from acting on what they see. Lack of clarity may lead to a multiplier effect of compounded mistakes.



Handling Digital Information

In a proper instructional design, information gets transformed into knowledge. Building knowledge and learning of that knowledge off a database of information requires plenty of data. The informal expression is that this is a "data hungry" model. One of the major strengths of the Cisco Systems, Inc. RLO model is that it acknowledges this data hunger and works on the core level of atomistic information (harnessed for learning purposes).

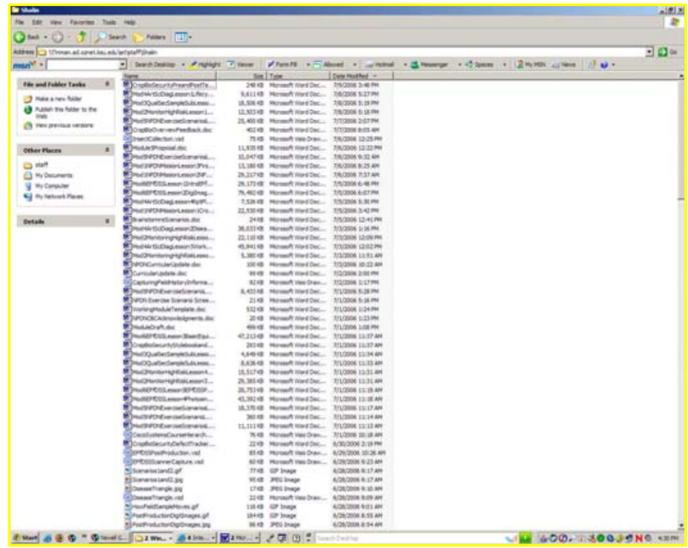
The handling of the raw information, the basic stuff of LO design, is important on a number of levels. One level is the legal one, involving intellectual property rights and the documentation of ownership and copyright releases. Another is the research realm, the importance of cultivating multiple streams of information for accuracy and cross-checking. Another level involves the informational domain—and the standards for sifting relevant information.

Working files. For projects, statements of work (SOWs) are used to document the decision-making and contents. These were highly helpful in terms of applying the Cisco Systems RLO templates and tracking where information was placed in the learning. These MS Word files were divided by lessons, with a separate document for each, and included all text, graphics, and other relevant data.

Copyright release. Text files were used to record copyright releases for digital contents. All work that stems from a source should include proper American Psychological Association (APA) or Modern Language Association (MLA) documentation methods. Getting copyright releases for all materials used is critical. The metadata should indicate ownership of the various elements aggregated for the learning.

Documentation

Plenty of back-end and planning files were created in order to identify, research, and write the curriculum that went public. These files should be saved for future reference. Some value gets



lost in the translation between the planning files and what goes live.

Defining info type. For the Cisco Systems, Inc. Reusable Learning Object (RLO) model, information had to be put into a category of concept, fact, procedure, process, and principle. Understanding clearly how each of these were defined and used was central to the curricular build process. When applying any model, it really does help to read all related manuals and to garner insights about that type of curricular build. Getting it wrong—whether by layer of learning or information type—meant back-tracking and patching and mending the curriculum.

Defining nuance. For learners to differentiate between minute points, it helps to offer many tools for differentiation. For example, how are observers to differentiate between a common threat and one that has major financial and health implications? In this particular project, the differences between these two things were minimal and nuanced, and while experts in the field suggest that differentiations may be made, this work suggested a vigilance and a deep knowledge base beyond most non-experts.

Protectionism of information. An ID, like instructors, tends to find value in disseminating information and helping others understand it. However, on a biosecurity project with password protected access to the various resources, the concept is to protect sensitive information and to disseminate it only through controlled channels. This was the only project that this ID ever worked on in which she had to promise to delete particular data and had to handle some files that may have been somewhat sensitive.

Copyright release for images. A table used for copyright release records involved the subject matter of the image, the owner of record (whether that be an organization or individual), a contact name and information (email, telephone, fax, and URL), a copy of the official photo credit and date, the date of the agreement and terms of agreement, any image information such as a caption / cutline or annotation, the resolution size, and then a thumbnail of the image for verification.

Consistent naming protocols. All digital information was labeled according to set naming protocols for accuracy (particularly images), and any additional information embedded in annotations were captured in the metadata, to avoid any data-loss in the transfer.

Extraneous information. Research often turns up extraneous information. Much of this may be used on background to inform the learning, but much may also be set aside for possible additional learning inclusion. An initial tendency may be to overload the curricular build with any new find, but per the rules of effective writing, all information should be filtered through the learning objectives. One helpful rule is to realize that an ID must learn more than what goes public. What goes public should be a small percentage of what is known.

Cross-boundary learning. An ID should be a generalist, a person who dabbles in a range of fields, a kind of proverbial "jack of all trades, master of none." As a non-expert approaching a curricular build, an ID will usually lack the deep assumptions and specialized knowledge of the SMEs, who often have long-immersed themselves in the field. Knowing that one is at a disadvantage, an ID would do well to immerse himself / herself into the learning as much as possible. In most projects, an ID will run up against the frontiers of knowledge, beyond which it's all new research or unknowability.

Primary SME contributions and work. The input of the primary SME was highly important for the success of the project. The use of his resources, including access to 30,000+ copyrighted images from his professional stores, greatly enhanced the project.

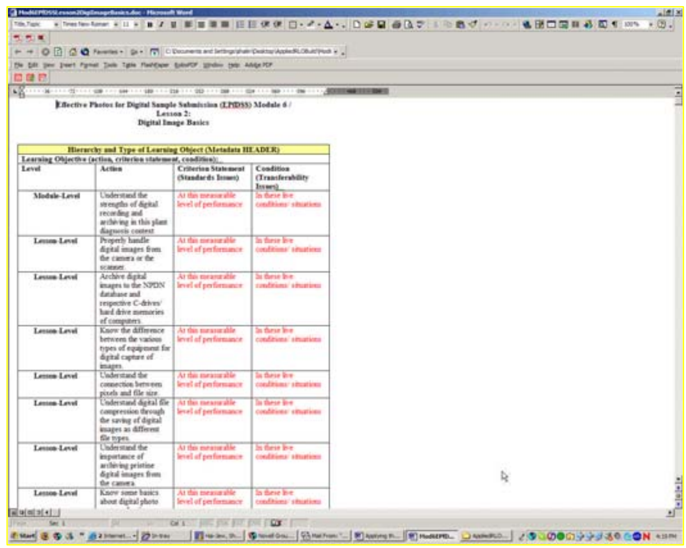
An updating plan. An important aspect to information handling includes a plan about what needs to be updated and when for durability and an extended object "life cycle." Any data revisions could ripple through the curriculum, so having clear documentation of the curricular outline and knowledge of the database would be important in terms of uploading the revised information. For credibility, the information must maintain a logical consistency, accuracy, and recentness. For this particular project, an updating plan could include policy shifts in related organizations, updates in scientific finds, changes in methodologies for learners, role redefinitions, and new terminology.

Centralizing reference files. The glossaries in this project evolved synchronously but also tended to evolve different definitions, even for similar words. One takeaway lesson was to centralize the development of the glossaries for consistency.

Backups. File backups should be done regularly, given the possibility of data loss with systems crashes. Indeed, the main database crashed several times in a six month period. The backing up of files include all the usual securities around databases. In addition, from the ID view, backups extended to working files so segments of the learning may be recreated sensibly in the face of potential data loss. This redundancy proved useful several times when rebuilding had to be done for image loss, multiple-choice interactivity loss, and other information disappearance or corruption.

An Adaptation of the Cisco Systems, Inc. RLO Template

A model has to be adaptable to the particular needs of a project to be effective. The Cisco Systems, Inc. RLO template more than afforded the flexibility needed to support the learning.



Building for the handover. An unspoken aspect of information management is the build for the handover. This means that everything is documented, and the ID (and other team members) must be very generous with sharing files and explaining actions and the work.

Pedagogical agent. One of the concerns that arose in the evolution of the pedagogical design was the absence of rapport between the automated curriculum and learners. "The quality of most ILT (instructor-led training) is dependent upon the knowledge and abilities of the instructors and the rapport instructors build with their learners" (Pasini, "The role of SCORM…" 2004, p. 3). An artificial rapport may be created through the use of a pedagogical agent. This agent could be the vehicle through which additional learning and insights could be delivered.

Various discussions on this resulted in a plan for five different agents representing different regions and aspects of the curriculum. It was decided that these agents would not be animated but static facial images in order to not be distracting. The database would be able to possibly version different looks and feels among regions, but the pedagogical agent strategy was not actualized because of a change in project priorities.

Building pre- and post-assessments. The measures of effectiveness (MOE) and the measures of performance (MOP) are critical to any RLO build. Assessments to evaluate the effectiveness of the automated learning may only be built after the curriculum has solidified and gotten initial approvals. After all, an assessment must be consistent with what the curriculum covers. Fitting an assessment to the time, credit, assessment methodology, and goals of the accrediting agency proved crucial. A "test-first" instructional build could be used if the curriculum was fully understood at the beginning; this build would involve the writing of the assessments first and then building a curriculum to support learners in performing well on that assessment (Ardis & Dugas, 2004, pp. F1C-25 to F1C-30). As additions are made to this curriculum, it may help to experiment with an assessments-first approach to see if that streamlines some of the inputs needed for the research and design.

Regionalization / localization challenges. The power of expertise often is localized to a particular context. In this project, the power of localization was set as a goal for future renditions. The technological build in the current state would not allow for the creation of different tones, images, standard operating procedures, changing local circumstances, threats, methodologies, and other factors. This flexibility was set as a goal for a future release of the database. In addition, given the data hunger of the model, much more digital content would need to be collected to actualize the regionalization / localization challenges.

Designating a content / curriculum caretaker or the use of "collaborative filtering." It would make sense to have a content (vs. purely technological) caretaker for the database to ensure standards adherence and content quality. Or a kind of "collaborative filtering" may be put into place for community members / trainers to sift through the new (and aging-out) materials and decide their respective quality, relevance, and acceptability. The issues of processes and procedures are arrived at collaboratively and at much higher levels than the instructional designer level, but the ID may contribute ideas or draw attention to certain policy needs. Here, power may devolve to local areas but only to a degree—within the limits of national control and cohesion.

"Build it and they will come." The leaders on the project clearly had to present their work at various national conferences, work the professional relationships, and publicize this effort in order to get buy-in. Such a resource will need leadership to ensure its use and continuing efficacy. The "build it and they will come" concept apparently does not apply in this situation of a national curriculum for geographically-dispersed learners. The low cost of entry (free) would enhance the dissemination; however, barriers to the learning include the costs of time and energy invested, the potential fear of failure in the learning, and possible technophobia re: eLearning. An examination of how to motivate learners in such a circumstance may have research value.

Alpha and Beta Testing

Alpha testing involved bringing in SMEs to critique parts of the curriculum and to offer feedback, which translated into direct revisions. Beta testing was planned for the accrediting agency members and others involved in this field—at a distance. This was to also include face-to-face trainer-led feedback and the use of rubrics for check-offs. The true transferability of the learning will depend on how the trainees respond in a range of live and complex context—potentially in the face of a biosecurity threat, whether naturally occurring or human-made.

Conclusions

The Cisco Systems, Inc. RLO model offers a directed raw-data-level approach that results in a solid curriculum, if the proper design work is invested in early on. This example of a live and automated curricular build surfaced observations about the instructional design work required to use this model effectively. Each curricular build, with its unique context, seems to be a necessarily new one. An ontology-based database offers particular learning affordances (abilities and limits) in a designed e-learning ecology (J.J. Gibson, 1977, as cited in Rabinowitz & Shaw, 2005, p. 50). Not every aspect of eLearning has to be SCORM-compliant; there may be mixes and matches for flexibility (Pasini, "The role of SCORM…" 2004).

SCORM not "The Question." The focus on SCORM seems to miss the point. The guidelines for building SCORM-compliant objects are fairly general, and the various teaching and learning needs of various projects depend on the learning objectives, curriculum, learners, and pedagogical strategies. The ability to create, use, share, and deliver learning objects offers superb learning functionality for various situations, but those are issues that relate to the contents of the objects.

The SCORM piece allows for the necessary functionality of storing, organizing, and deploying these works in a particular learning order. As Pasini notes, there's some freedom within the SCORM definitions. "SCORM does not address how to make effective e-learning, nor does it describe or prescribe what makes, or how to make, good SCORM content. The SCORM documents are highly technical and specify what types of functionality systems must have in order to be compliant while allowing each system or tool vendor some flexibility to maintain their proprietary advantages" (Pasini, "The role of SCORM…" 2004). Others suggest that the amount of metadata (60 entries) suggested in earlier versions of SCORM would be onerous (Qu & Nejdl, 2003, n.p.).

Too often, the SCORM modeling assumes a single learner, self-paced and self-directed, in an automated space (Rehak, as cited in Akpinar, Y. & Simsek, H., 2005, p. T3A-7). It assumes more formal learning than informal (Collis & Strijker, May 21, 2004, p. 2). The "ilities" may be what should be carried forward, with potentially different ways of achieving them. This seems much more to be a question answered by software developers and programmers.

How this particular project evolves will depend on others who will be brought on to support this and on the funding that it acquires for its next stages of development and dissemination. Project success in the long term may depend on strategic partnerships that the respective organizations create.

Certainly, when this project goes live with national learners and various coordinated synchronous events, other discoveries will be made about the learner interface, the curriculum, and the various technologies. Further evaluations of the curricular efficacy may be done through more standardized evaluations of the learning objects based on quality standards (Morales, Garcia, Rego, Moreira, & Barbosa, 2005, p. F4B-12).

Many goals have been discussed for this curriculum: making this learning ubiquitous, transferring such learning onto portable devices that may assist in real-time decision-making in a live context, and customizing the learning with regionally-specialized learning objects and information. Parallel learning may be created with regionalizing of the curriculum. Real-time live interactions may be arranged with SMEs. Different strategies for embedding, housing, and delivering various types of multimedia may be built into this database. The certification may be automated, and learners may progress through the curriculum with various sorts of post-test "gating." The learning itself could be disaggregated at the modular levels for focused refreshers, depending on learner needs. Informational repositories of trainer experiences, synchronous learner tasks, asynchronous assignments, and other information may add value to the learning.

New biosecurity threats on the horizon may be quickly explained and information deployed through digital means. The various SMEs in this subject area may benefit learners globally through the LMS with the back-end database. In a sense, the leads on this project are just starting to plumb the potentialities of this curriculum combined with this flexible database.

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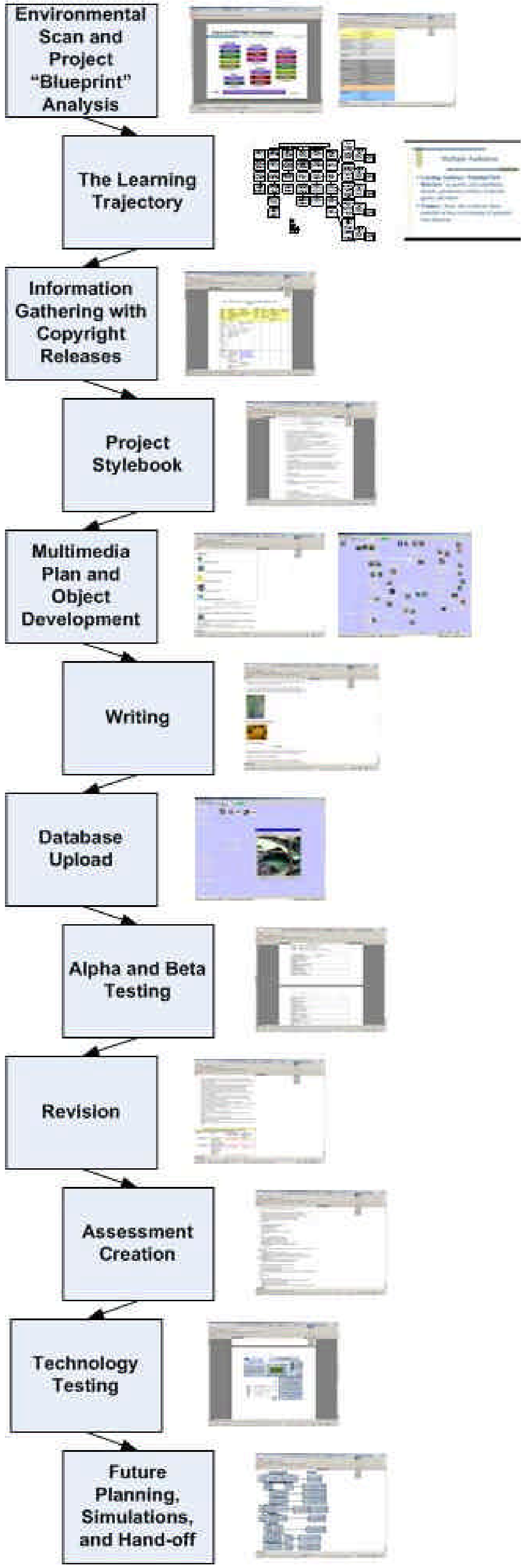
Appendix


Environmental Scan and Project "Blueprint" Analysis
The Learning Trajectory
Information Gathering with Copyright Releases
Project Stylebook
Multimedia Plan and Object Development
Writing
Database Upload
Alpha and Beta Testing
Revision
Assessment Creation
Technology Testing
Future Planning, Simulations, and Hand-off