

DEVELOPMENT OF AN LCMS TO SUPPORT NUCLEAR SECURITY TRAINING PROGRAM MANAGEMENT

S.M. PEPPER
Pacific Northwest National Laboratory
Email: Shane.Pepper@pnnl.gov

M.M. TREMONTE
Pacific Northwest National Laboratory
Seattle, United States
Email: Matthew.Tremonte@pnnl.gov

J.M. WILSON
Pacific Northwest National Laboratory
Email: Joan.Wilson@pnnl.gov

K. CUNNINGHAM
Pacific Northwest National Laboratory
Email: Kelly.Cunningham@pnnl.gov

Abstract:

Using a Systematic Approach to Training (SAT) process to develop, manage, and deliver standardized training materials for staff with nuclear security job functions can be a challenging process for many organizations. To apply SAT, organizations must accurately analyze, design, develop, evaluate, collaborate, and track the development schedule to various target audiences. Furthermore, managing shared training content adds another element of complexity. Independent assessments of nuclear security training programs have found that a systems approach helps alleviate risks associated with these challenges. A solution that is commonly suggested is the use of a Learning Content Management System (LCMS), which allows distributed curriculum development teams to manage training curricula in a collaborative environment. An LCMS offers additional benefits, including:

- Alignment of competencies, job tasks, learning objectives, and other reference data to the curriculum material
- Provision of a defensible mechanism for answering questions from auditing agencies by aligning curriculum end products to their source
- Support of modular-based curriculum by leveraging connections across the training catalogue to allow materials to be tailored to the training need
- Promotion of common curricula across different technical areas to limit duplication of effort and harmonize messaging
- Increase of active collaboration across distributed curriculum development team.
- Direct linking of evaluation metrics and feedback to training curriculum

- Support for process improvements including being more responsive to branding changes, reducing level of effort to push final materials to training delivery systems.

This presentation will illustrate the benefits of leveraging an LCMS solution for building training curriculum for nuclear security organizations with a focus on a case study of an LCMS being built for the U.S. Department of Energy National Nuclear Security Administration's Office of International Nuclear Security, leveraging Drupal, an open-source Software as a Service architecture. This Nuclear Security LCMS balances security requirements with flexibility in designing a user-friendly system for promoting standardization of curriculum and re-use of information. The objective of this project has been to implement a web-based system to manage an SAT development process, creating relationships across the curriculum catalogue to increase program efficiency and sustainability.

1. INTRODUCTION

The strength of a State's nuclear security regime depends upon the strength of the sustainability regime supporting the systems and measures put in place by a State to reduce the risk of a nuclear security event occurring. One component of sustaining the nuclear security regime is the implementation of a robust human resource development programme that serves to provide initial and ongoing capacity building support for organizations with nuclear security responsibilities. However, managing the materials needed for fulfilling this mandate of supporting a nuclear security regime is a complex endeavor and presents some risks such as managing references across materials as changes occur to maintain alignment. Further, clearly identifying where each item within the training curriculum can be used to address specific job tasks and learning objectives will enable reuse across multiple courses or other engagement opportunities—critical to building greater efficiency into the training regime.

To address risks such as these, the Systematic Approach to Training (SAT) can be applied by organizations to develop, manage, and deliver standardized training materials for staff with nuclear security job functions. As SAT is applied, more content is created that needs to be aligned to the resulting curriculum. SAT requires organizations to accurately analyze, design, develop, evaluate, collaborate, and track the development schedule to various target audiences. Managing this shared content adds further complexity. Independent assessments of nuclear security training programs have found that standard tools such as word processing, spreadsheet, and slide presentation applications have limitations that prevent such a training regime from realizing its full potential. Rather, a systems approach would help alleviate risks associated with these challenges. A solution that is commonly suggested is the use of a Learning Content Management System (LCMS), which allows distributed curriculum development teams to manage training curricula in a collaborative environment. Typically, SAT requires a series of in-person workshops to develop curriculum. However, the COVID-19 pandemic has prevented subject matter experts from meeting directly with instructional systems design professionals to develop curriculum. This situation provided an additional justification for funding an LCMS acquisition.

The International Atomic Energy Agency (IAEA) recognizes the importance and the challenges of sustaining a nuclear security regime. The IAEA publishes international guidance regarding many areas of nuclear security through the Nuclear Security Series (NSS). NSS 20 identifies sustainability as one of the essential elements of States' nuclear security regimes.[1] NSS 30-G expands upon this concept in defining developing human resources as one of the national sustainability objectives for States' nuclear security regimes [2]. Multiple aspects of sustaining a nuclear security regime can be addressed by the implementation of an LCMS, including:

- Developing, implementing, and maintaining appropriate and effective integrated management systems including quality management systems
- Routinely conducting maintenance, training, and evaluation to ensure the effectiveness of the nuclear security systems
- Having in place processes for using best practices and lessons learned from experience
- Routinely performing assurance activities to identify and address issues and factors that may affect the capacity to provide adequate nuclear security, including cybersecurity, at all times.[3]

This paper will illustrate the benefits of leveraging an LCMS solution for building training curricula for nuclear security organizations with a focus on a case study of an LCMS being built for the U.S.

Department of Energy National Nuclear Security Administration's Office of International Nuclear Security, leveraging an open-source Software as a Service architecture. The objective of this project has been to implement a web-based system to manage an SAT development process, creating relationships across the curriculum catalog to increase program efficiency and sustainability. First, the LCMS "cost versus benefit" analysis process will be reviewed, considering the current state of training curriculum management practices and the proposed future state when an LCMS would be in use. Then, how good practices regarding software requirements development have been applied in the development of requirements for this LCMS will be discussed. Third, recommendations for conducting a "build versus buy" analysis will be shared, based upon the specifics of this LCMS case study. Next, the importance of applying standard agile software development practices that include user engagement early and often will be detailed. Last, lessons learned and next steps for this LCMS will be enumerated.

2. Cost Versus Benefit Analysis

When reviewing the core functions of an LCMS for nuclear security, the benefits quickly become apparent. Managing the alignment of competencies, job tasks, learning objectives, and other related data to curriculum material through managing spreadsheets, documents, and presentations creates a great deal of complexity and is prone to human error negatively affecting the management of training. Building curriculum in a system that manages this alignment promotes efficiency and ease of managing the training regime. Once these connections can be managed more effectively, modular-based curriculum developed through an SAT process leveraging these connections across the training catalogue allows materials to be tailored to a variety of training needs. Further, this approach can promote the use of common curricula across different technical areas to limit duplication of effort and harmonize messaging. Last, the publishing capabilities of an LCMS can allow users to determine the branding requirements separate from the content itself. This reduces the level of effort to publish final materials in the appropriate template and push them to training repositories and delivery systems such as learning management systems (LMSs) or content management systems (CMSs). An example relationship diagram for how an LCMS could interact with a training repository and an LMS or CMS is provided in Figure 1: LCMS to CRS to LMS Relationship Diagram.

However, as with any system, cost must also be considered. Change in any organization requires cost—such as funding to identify the cost versus benefit of the change or social capital to receive approval for the change. An assessment should be conducted to understand the current state regarding the cost of conducting the activities required by a training organization to manage the training catalogue. Further, management should be included in the conversation to start building a case with everyone in the organization from the persons working on building training curriculum every day to those making budgetary decisions at the top.

This project considered multiple cost factors when weighing the benefit of implementing a Nuclear Security LCMS. Some examples are applicable across multiple organizations. A suitable example is the inevitable re-branding that will occur as organizations evolve and change over time. It should not be difficult to imagine a world wherein an organization has 100s or over 1000 items in its training catalogue, and the organization's name or branding changes requiring the manual redesign of each of these separate Microsoft Word, Microsoft PowerPoint, images, videos, and other files. A second example to consider is how often the same content is reused across multiple curriculum items. When an organization develops step-by-step procedures for a type of equipment, these same steps and images may be applicable across

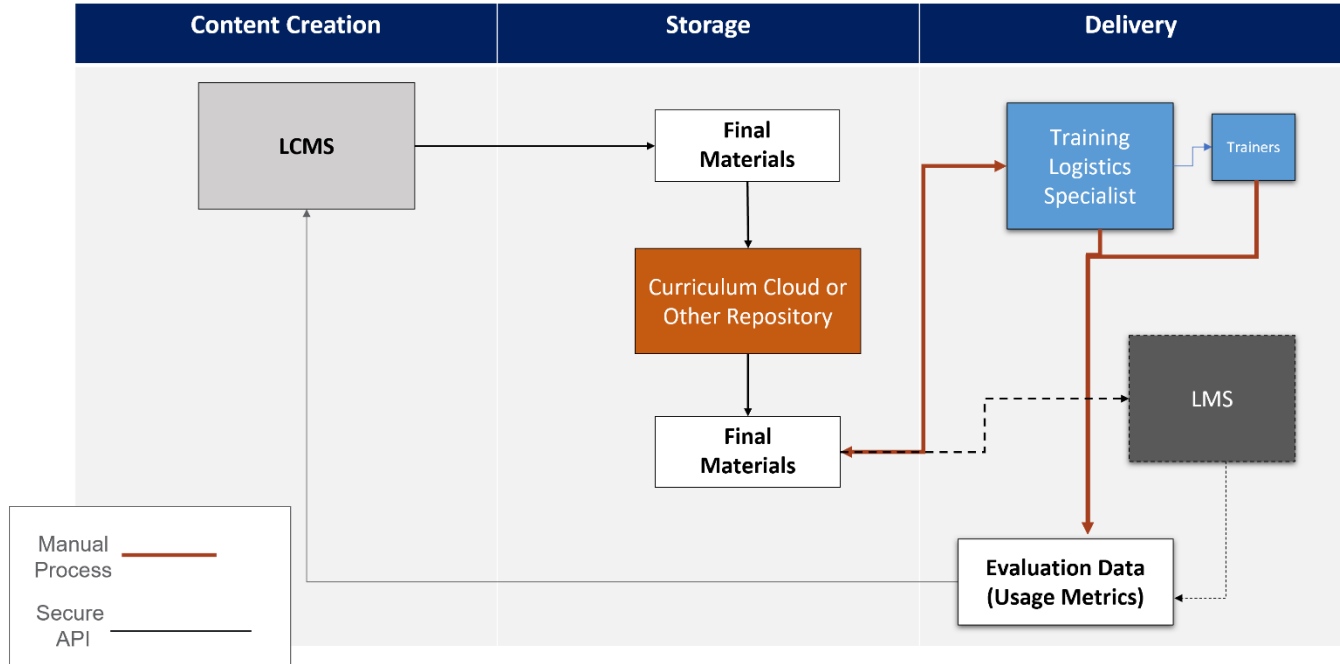


Figure 1: LCMS to CRS to LMS Relationship Diagram

multiple procedures. Maintaining consistency manually across multiple Microsoft Word documents can be prone to human error. Taking this example a step further, dwell upon managing training objectives across multiple types of media such as spreadsheets, Microsoft Word, and Microsoft PowerPoint files. What labor cost is incurred to the organization when a change happens to a particular portion of content that is used in multiple places? What social cost is incurred when those managing the curriculum must go through the materials again with a fine-tooth comb to assess the impact of such changes? What barriers exist in the current structure of the organization that limit the scope of organizational experimentation and change?

Estimating these costs and comparing them to the implementation cost of an LCMS can be illuminating. Labor costs for re-branding a training catalogue include activities such as the redesign of templates, implementation of those templates upon the affected files, quality assurance checks, management approvals, revising tracking tools, and revising curriculum repository contents. By working this from a bottom-up estimate, these organizational labor costs can add up quickly. They could be considered the cost of doing business; however, there is an opportunity to apply a systems approach to building efficiency into the training curriculum development process.

In parallel with determining these operating costs, engagement with the commercial off-the-shelf (COTS) LCMS vendors should be conducted to assess the relative cost of procuring, implementing, and maintaining an LCMS product. An organization should take care to include its organizational labor costs in addition to a contract it may put in place, as this can be a hidden cost to some. A quick survey of the landscape could confuse a layperson with the variety of terminology. A useful set of definitions for the similar technology platforms available from COTS LCMS vendors is provided below:

- CMS: Manages the creation and modification of digital content, typically focused on web-based publishing
- Digital Asset Management System: Software that organizes media such as images, video, and documents

- LMS: Used by training organizations to register, track, and monitor training activities; often does not provide content authoring capabilities.
- LCMS: Integrated content authoring and publishing platform allowing instructional designers to create and publish materials for training delivery.

3. Applying Good Practices for Software Requirements Development

Care must be taken to prevent locking in the “how” a software product would be built from the start, as much as the “what” in terms of the functionality desired. For the Nuclear Security LCMS case study, requirements analysis was conducted incorporating the multiple roles that would make use of the Nuclear Security LCMS. This Nuclear Security LCMS has an objective to balance security requirements with flexibility in designing a user-friendly system for promoting standardization of curriculum and reuse of information. This approach included user engagement with a variety of user roles such as curriculum developers, training program managers, translation coordinators, subject matter experts, information security, and others as appropriate. To foster conversations with these prospective users, use cases must first be developed to drive the development of software requirements—using the standard formula of “as User Role X, I require Y to perform Z task.” This analysis is to be conducted through establishing a general set of use cases that can drive the development of further details through facilitated discussions or consultancies. Before determining whether the LCMS would be built or procured, the LCMS project team conducted a series of such facilitated discussions with groups of users from each of these roles to elicit further details based upon the general use cases provided. These consultancies served to establish a set of wants versus. needs for each user group, from which the LCMS project team could determine the requirements for this system. These needs formed the basis of the requirements for an LCMS that was rooted in the SAT approach to curriculum development.

Given the unique nature of the training materials being developed, information security considerations must be elaborated further. The method for elaborating information security requirements is a useful example for how the other user roles were consulted. Information security was considered from the outset from a variety of perspectives—user access, cybersecurity infrastructure, usage requirements, and other considerations. To do this, representatives from each LCMS user role and from each organization that would be using the LCMS were consulted in a series of additional requirements development consultancies. These consultancies enabled the development of information security requirements that would meet the needs of all stakeholders to promote buy-in from the start.

4. Build Versus Buy Analysis

With the scope in hand and the need for an LCMS identified by the organization, the organization must determine how to obtain the LCMS, either build or buy. Based upon the scope (requirements), the Nuclear Security LCMS team conducted market research and analysis to determine the expected cost and schedule for the LCMS procurement. Market research through reviewing the available COTS products can be a means of assessing the feasibility of the defined requirements. To determine the investment and timeframe required to successfully implement an LCMS, direct engagement with prospective COTS LCMS vendors is required. Assessing whether the stated requirements can be met by procuring or adapting an existing software product is a necessary step as experience identifies that the cost for building a software

product from scratch can create greater risk than buying an already developed product—as long as the COTS product sufficiently meets the stated requirements.

To conduct a fair and robust analysis, a Request for Information and/or a Request for Quote process should be completed with COTS LCMS vendors along with an assessment of the cost to build the product. Any COTS LCMS vendors that have already been considered through the market research and analysis should be notified of the request so that they can determine whether they wish to provide information or a quote. Care must be taken to abide by contracting regulations and not allow proprietary information provided by the vendors to be seen by the organization preparing the custom software bid in-house. The Nuclear Security LCMS project managed this process by having the team sign non-disclosure agreements and carefully deciding who would be part of contracting process. Objective assessment criteria must be defined to allow for a fair assessment of the different options presented, considering the requirements that can be met by COTS LCMS vendors out of the box and those that would require further development. The rubric defined could include factors such as cost, scope, schedule, security, customization, requirements fit-gap, etc. This data became critical to helping the Nuclear Security LCMS team determine to build an LCMS based upon the open-source Drupal CMS platform, rather than awarding a contract to a COTS vendor.

5. Importance of Agile Software Development Practices

The Agile Manifesto was published in 2001, characterizing that software developers should change from a waterfall approach of development to one that sees greater value in collaboration with the customer and responding to change throughout the project life cycle.[4] The LCMS project team leveraged these agile software development practices to focus on directly engaging prospective users from the beginning during requirements assessment, as development began, and as working software became available for testing. Further, user experience subject matter experts were an integral part of the team to inform the optimal path forward. This practice of actively engaging multiple prospective user groups allowed for their feedback to inform adjustments early in the software development process to how the stated requirements would be fulfilled. Identifying such changes early can allow the software development team to minimize impact to the project scope and schedule when implementing such fixes.

A balance must be struck in clearly defining requirements close enough to when components of the software are being developed, while adapting the approach based upon feedback, and minimizing the need for rework. Once requirements were clearly defined and work began, the Nuclear Security LCMS software development took place in a series of evolutionary sprints to accommodate this risk. Each sprint contained a series of repeatable tasks including software development, peer review, acceptance testing within the software team, usability testing, and accepted testing by users as the product became user testable in the later stages.

Ideally, each sprint consisted of a clearly defined set of scope. In some cases, project team determined during an active sprint that the requirements for a given scope needed better definition. Ideally, this work could be delayed until the requirements were better defined. For example, requirements gathering facilitated discussions with instructional systems design subject matter experts early in the development to define the content model that would drive the Drupal CMS upon which the Nuclear Security LCMS was based. The end state was not so clear to the end users in the early stages of these conversations. This lack of clarity required repeated requirements-gathering facilitated discussions to narrow the scope to the exact needs of the end user organization and required a good deal of rework of the

content model as more was learned about the end state. In turn, this situation pushed out the delivery timeline for the content model being built into the Nuclear Security LCMS. In other cases, this flexibility to delay the work was not always feasible, and there were other instances in which the team had to re-balance the scope to allow for better requirements development mid-sprint, reducing efficiency of work to meet the project objectives.

6. Next Steps, Good Practices, and Lessons Learned

The Nuclear Security LCMS development continues with a planned completion of the initial base product at the end of May 2021. The initial product will be usable by one organization; however, the Nuclear Security LCMS has been designed to allow multiple organizations to leverage their branding and implement their SAT requirements in the same platform. Further, the LCMS functionality will be expanded to integrate with a curriculum repository that will be the point of use for configured training materials. This work to evolve the Nuclear Security LCMS for multiple user programs will continue through 2021. It is also expected that as the base Nuclear Security LCMS product begins to be used, additional functionality will be identified and need to be assessed for feasibility, priority, scope, schedule, and budget. In the initial approval stages, a multi-year budget plan was presented and approved, taking some level of this additional work into account.

Several good practices have been identified out of the project to build a Nuclear Security LCMS. These include:

1. Engage with prospective user community from the beginning with requirements development and carry this engagement through development into user testing.
2. Conduct a robust build versus buy analysis that includes a study of the current COTS LCMS vendor landscape to enable a well-informed decision-making process.
3. Balance the “wants” with the “needs” of the software functionality. Identifying existing “pain points” in a process can facilitate this.
4. Understand the capabilities of the software when identifying the wants and needs of the LCMS. This understanding will provide a clearer picture of how the system will function.
5. Require collaboration and continuous communication between the user experience team and the software development team to help mitigate rework and changes.

In addition, many lessons were learned during the building of the Nuclear Security LCMS that will be useful for others to consider should they undertake similar projects:

1. Balance speed of schedule with clearly defined requirements. Starting development without clearly defined and agreed upon requirements can create unnecessary rework.
2. Clearly define roles, responsibilities, and expectations for the different types of testing to be conducted—for the Nuclear Security LCMS, these included system acceptance testing, usability testing, and user acceptance testing.

ACKNOWLEDGEMENTS

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