The Great Migration: DAC Pioneers LMS Content Conversion

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ABSTRACT

Training and education organizations are evolving to enterprise resource platforms, which may require them to change learning management systems (LMSs) and move content and data to new applications and systems. This paper summarizes crucial lessons learned during the U.S. Army Defense Ammunition Center's (DAC) migration of 58 courses from their learning content management system (LCMS) and LMS to the U.S. Army LMS. The paper provides specific and actionable recommendations for others who may be moving content from one LMS to another using SCORM.

After years of cost escalation associated with the management and hosting of its LCMS and LMS and staffing a full-service help desk, DAC decided to migrate its courses from their legacy environments to the Army LMS, operated by the Army Training Support Center. DAC allowed six months for the migration. Since the LCMS produced SCORM 1.2-conformant content, early migration testing led DAC to believe the process would be relatively simple. DAC created a three-phase plan and exported the LCMS content. However, during Army LMS deployment testing, several issues prevented the successful migration of SCORM 1.2 content. The issues resulted from a combination of ambiguity in SCORM 1.2, vendor-specific functionality in the Army LMS, and vendor-specific functionality in the LCMS. With three months remaining, DAC reformulated the plan and converted the SCORM 1.2 packages to SCORM 2004 3rd Edition using sequencing and navigation to control learners' experiences. This resolved the deployment issues and resulted in an on-time migration that directly contributed to DAC saving over $2 million in licensing and hosting costs over 5 years. DAC's lessons learned will help other organizations that are changing LMSs, deploying content to a new LMS, or determining which version of SCORM to use.

ABOUT THE AUTHORS

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INTRODUCTION

The U.S. Army Defense Ammunition Center (DAC) Training Directorate provides ammunition, logistics, explosives safety, packaging, and hazardous materials certification training for military and civilian personnel, contractors, and international students as well as knowledge management services to Warfighters and business process owners across the U.S. Department of Defense (DoD) and North Atlantic Treaty Organization. DAC's training includes distributed learning, primarily in the form of web-based training, as well as instructor-led training in classrooms around the world. In 2008, DAC delivered 80 percent of its training via web-based training. Headquartered in McAlester, OK, DAC belongs to the U.S. Army Joint Munitions Command, the largest subordinate command in the U.S. Army Materiel Command. In addition to delivering training, DAC manages two DoD ammunition intern programs, the Quality Assurance Specialist (Ammunition Surveillance) and Ammunition Management career programs.

BACKGROUND

In 1999, DAC delivered all of its courses via instructor-led training to a total of 5,164 personnel (see Figure 1). With two on-going wars and Warfighters and DoD support civilians and contractors on increasingly longer international deployments, DAC has spent a decade transitioning from primarily classroom instruction to a combination of classroom and web-based training to reach vastly more learners. In 2000, DAC began converting some of its classroom courses for delivery via CD-ROM. However, when the instruction contained on the CD-ROM materials became obsolete, DAC had no way to recall the old CD-ROMs, and producing and distributing new CD-ROMs was both costly and time consuming. As a result, DAC could not ensure its learners were receiving accurate and timely instruction (ADL, 2009) in subject matter where technical content and regulations can change frequently.

Move to Web-Based Training

To reach a wider audience while maintaining control of their courses and course currency, DAC decided to move to web-based training. DAC defined a number of requirements during its learning management system (LMS) selection process. With learners representing active duty, civilian, and contract employees in all Services, one of the most stringent requirements for the selected LMS was that learners from any Service be able to access the content in a single location without Service-specific login credentials. At the time, no Service-hosted LMS provided this level of access across the Services without complicated sponsorship rules. In 2004 following a detailed LMS evaluation process, DAC decided to deploy SumTotal™ as its LMS to achieve multi-Service access and maintain control of its content. DAC also purchased the SumTotal™ learning content management system, a web-based content authoring and storage tool, as the development platform for all of their web-based training.

SumTotal™ Systems hosted the LMS and the learning content management system as DAC's legacy systems in their commercial facilities, but DAC formed a project team that assumed the responsibility for supporting all other aspects of operating the DAC LMS including running a help desk, defining and providing login credentials to learners, and trouble-shooting login and access issues. To reduce costs and workload, DAC outsourced some of these activities to a local university so trained student workers could staff the help desk; however, DAC personnel still had to provide official responses to numerous learner inquiries. As the number of DAC learners grew, the cost of supporting these activities also escalated. Figure 1 shows the dramatic increase in distributed learner throughput in 2006 when DAC moved its distributed learning program from CD-ROM training to web-based training. The number of learners DAC trained increased by 800 percent with the help of web-based training (ADL, 2009) and has continued significant growth each year since then. Delivering the majority of training online made it more cost effective to train individuals distributed around the globe.

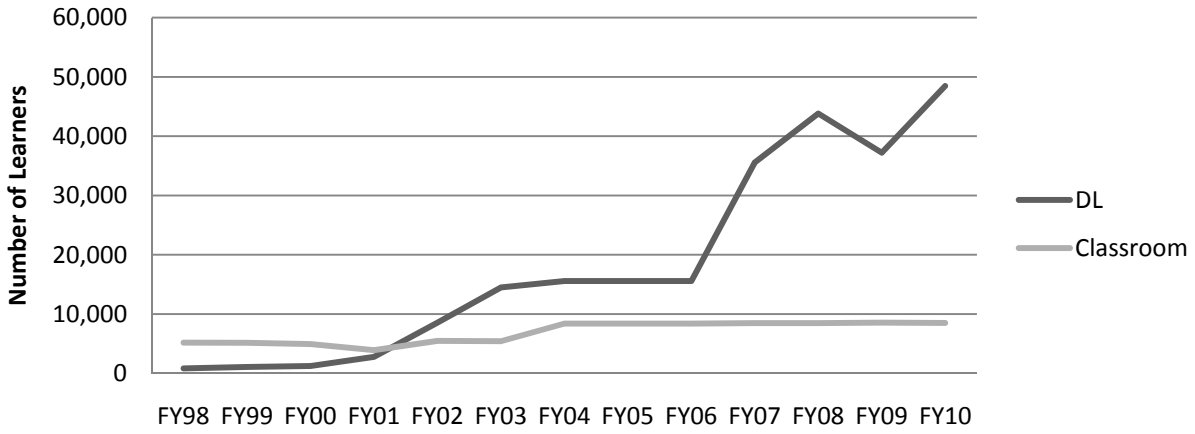

Figure 1. DAC Learner Growth from 1998 - 2010

Move from Commercial Hosting to DoD Hosting

In 2009, to comply with DoD Information Assurance Certification and Accreditation Process (DIACAP) requirements, DAC migrated their hosted support from commercial hosting provided by the legacy LMS vendor to the University of Military Intelligence (UMI) at Ft. Huachuca, AZ. UMI already operated their own DIACAP-approved instance of DAC's legacy LMS, so this migration brought DAC into compliance with DIACAP requirements. It simultaneously allowed DAC to update their software version of the LMS and integrate the LMS with the Army Training Requirements and Resources System (ATRRS). ATRRS is the U.S. Army system of record for establishing training requirements, determining training programs, managing class schedules, allocating class quotas, making seat reservations, and recording student attendance (ATRRS, 2011). Automated integration with ATRRS significantly reduced DAC's process of manually updating learner records from the LMS in ATRRS, but the move to UMI brought some challenges, too.

Unfortunately, the off-the-shelf LMS upgrade, recommended by the LMS vendor, cost DAC time and effort, and the "upgraded" system did not have the functionality enhancements DAC had hoped to get. Ultimately, the migration from commercial hosting to hosting at UMI took six months and when the 160,000 active learners were cutover to the DAC LMS at UMI, our annual LMS operation and support costs were cut by one-third from nearly $1 million to approximately $600,000. Table 1 shows our approximate LMS operating and support costs from 2008 through 2010.

Table 1. LMS Approximate LMS Operating and Support Costs

Category	**2008 – 2009**	**2009 – 2010**
Hosting	$508,000	$147,000
Licensing	$305,000	$305,000
Support	$123,000	$170,000
TOTAL	**$936,000**	**$622,000**

Following the move to UMI, DAC continued deploying training via the legacy LMS; however, the anticipated costs to operate and support the LMS were projected to increase significantly from their 2009 – 2010 levels for the 2010 – 2011 year. UMI planned to move their own system inside a firewall, so that move left DAC bearing the full cost burden as the sole system supported outside the firewall. Likewise, DAC personnel were still handling many of the learner issues and administrative functions for the LMS as well as funding the operation of the DAC training help desk.

Move to the Army LMS

Always eager to find a better return on their investment, DAC learned about changes to U.S. Army policies for access to Army Knowledge Online (AKO), the Army's knowledge management portal. These changes opened the possibility of providing Service-wide access to the Army Learning Management System (Army LMS) housed inside of AKO. After investigating the learner access considerations for Army Knowledge Online, DAC determined it was possible to achieve substantial cost savings by leveraging the existing Army LMS system and support capabilities which were available to DAC from the U.S. Army at no additional cost.

In April of 2010, DAC formed a distributed migration team consisting of DAC personnel in McAlester, OK; Serco staff in Oklahoma City, OK, Pittsburgh, PA, and Houston, TX; DAC help desk personnel at Oklahoma State University in Stillwater, OK; Army LMS support personnel at Ft. Eustis, VA, and the Army LMS vendor in Baltimore, MD. Our team created a comprehensive plan with a phased schedule for moving all of our courses and course support from the legacy LMS and the learning content management system to the Army LMS by 30 September 2010, the end of the fiscal year, to avoid incurring additional hosting and support costs in fiscal year 2011. Since ATRRS serves as the system of record for all learner transcripts, we decided to migrate only course content packages from the legacy LMS to the Army LMS and not to migrate any of the learner records data contained in the legacy LMS. This saved substantial time and costs, but required us to ensure our learners could complete all of their in-progress course materials before the migration or they would be forced to retake courses they had already started. The plan included a communication strategy with milestones to inform all registered DAC learners about the migration and provide them with deadlines and multiple reminders, well in advance of the final 30 September 2010 migration date, to complete their courses in the legacy LMS without losing their data. In addition to message updates on the DAC training portal, each learner received multiple personal emails reminding them to complete their training and print any necessary certificates or other records contained in the legacy LMS before 15 September.

This gave learners a two-week buffer in the event they failed to meet the 15 September deadline. Figure 2 depicts our Army LMS migration plan.

MIGRATION PROCESS

DAC decided that the course migration would include 58 of their courses varying in seat time from approximately 1 hour to over 20 hours. As part of the plan, we defined some control factors for evaluating the results of the testing. First, the learner experience had to replicate that encountered in the legacy LMS as closely as possible. Second, the learner experience had to include simple and intuitive navigation. Third, the content packages deployed in the Army LMS had to result in a relatively low probability of operational issues (e.g. failure to launch, inability to record learner data). Fourth, we wanted to minimize the amount of programming changes required to the Sharable Content Object Reference Model (SCORM) Version 1.2 content packages we exported from the legacy system to enable the early and rapid migration of a large number of courses. In addition, any content solution identified should be interoperable between systems in the event a future migration was required.

Pre-Migration Testing

We immediately began testing the SCORM 1.2 content packages exported from the legacy system in the Army LMS's Content Testing Environment (CTE). The CTE

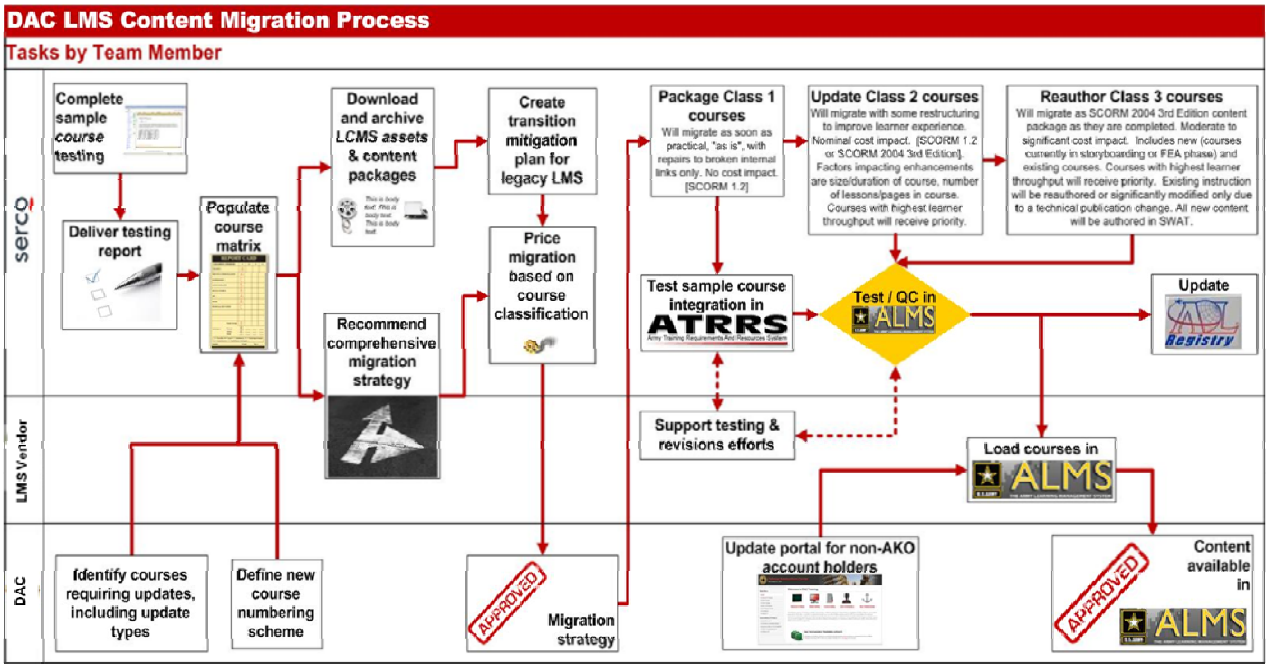

Figure 2. DAC Army LMS Migration Plan Diagram

is a separate instance of the Army LMS designed solely to test new content before it is deployed in the actual Army LMS. The packages easily imported into the Army LMS CTE. At this stage we identified a standard series of modifications necessary for all content packages to ensure the four control factors previously mentioned were met.

The control factor modifications included:

- updates to the title, course instructions, system requirements, exam start, and exam summary pages to remove legacy LMS-specific language and instructions;
- the addition of all course resources/reference materials as portable document format (PDF) files inside the content package since the Army LMS would not support hosting of individual, unpackaged resources linked from SCORM content packages;
- changes to all links within the course to associate them with resources contained within the content package rather than to individual resources housed within the LMS;
- updates to the video files to use Flash, the Army LMS video player, instead of the proprietary video player used by the legacy LMS;
- the consolidation of lessons into single sharable content objects (SCOs) to enable forward and backward navigation between individual screens controlled by the content package itself rather than the Army LMS;
- the addition of a "Taking an Exam" page directly in front of the course assessment to facilitate the construction of sequencing rules and to notify learners they would have only three attempts to pass the assessment.

We tested three courses of varying lengths and complexities. Our basic testing process included verifying that:

- all elements of the course appeared on screen and functioned as authored in the legacy system;
- all elements of the course appeared in the Army LMS-provided table of contents;
- the Army LMS properly recorded learner performance for passing and failing the course.

As a result of this testing, we defined three classes of content to migrate to the Army LMS to achieve the best learner experience and to quickly move a large volume of courses.

- Class 1: To move the bulk of the courses out of the legacy LMS as quickly as possible, courses with medium-to-low learner throughput would migrate as SCORM 1.2 content packages. SCORM 1.2 has limited functionality and multiple conformance levels, making content interoperability nearly impossible, but it replicated the legacy LMS experience. However, DAC never considered the legacy LMS experience ideal because the exam was accessible to learners at all times.
- Class 2: Courses with the highest learner throughput would migrate as SCORM 2004 3rd Edition content packages with sequencing and navigation, a feature not available in SCORM 1.2. Sequencing and navigation allows instructional designers to specify rules to control the learner experience while ensuring content interoperability across systems. For Class 2 courses, the team decided that the exam would not be accessible to learners until they had completed all content screens.
- Class 3: Courses undergoing updates at the time of the migration and all newly developed courses would migrate as SCORM 2004 3rd Edition content packages with sequencing to ensure an excellent learner experience. The exam would not be accessible to learners until they had completed all content screens.

During pre-migration testing, we only considered scenarios in which learners would take an entire course in one attempt or sitting versus scenarios in which they would exit and re-enter each course multiple times from multiple locations within the course before completion. We tested for a single pass attempt, a single fail attempt, and a new registration. Also, we never tested for a situation in which learners might attempt to retake an exam they had already completed.

As a result, in late June 2010, after we had exported 20 courses identified as Class 1 from the legacy LMS and prepared them for migration, we identified issues with how the Army LMS accounted for attempts on the content. This resulted from a combination of factors. The first factor was SCORM 1.2's failure to address attempt limits, thereby allowing each LMS to specify its own definition of an "attempt" on a course. The second factor was a consequence of the first; in the Army LMS, an attempt equated to a launch of the course. This created difficulties for DAC learners who might exit a course midway to take a break and then re-enter the course later, a very common practice in the longer courses.

Working with the Army LMS support staff and an experienced SCORM programmer, we attempted several work-arounds with SCORM and Army LMS proprietary functionality, but each potential work-around created other issues for learners and would have resulted in content packages that were not fully interoperable in the event of a future LMS migration.

Overcoming System Limitations

To overcome the potential control problems in the Army LMS with attempt limits and course exits and re-entries, we revised the migration plan, almost weekly for a period of time, to ensure we would not encounter other issues in the migration. The team ultimately abandoned the Class 1 strategy to deploy all 58 courses as SCORM 2004 3rd Edition content packages using sequencing and navigation to control content presentation and attempt limits on the exam within the content package. This solution ensured that all of the courses would be fully interoperable. It also created a better learner experience because the content package controlled the entire learning experience rather than relying on an LMS to provide any features or functionality. Given the relatively short remaining time frame of three months, the team decided to focus our efforts on the 20 courses with the highest learner throughput in the event there wasn't sufficient time to move all of the courses before the end of the 2010 fiscal year.

While the decision to migrate all courses as SCORM 2004 3rd Edition content packages did create fully interoperable content packages, it also presented some challenges. Beginning with the existing legacy DAC SCORM 1.2 content packages the team had already exported, we modified the packages to include all of the standard revisions identified in the initial migration plan. In addition, we decided to use the reprogramming opportunity to prevent learners from accessing the final assessment until they had completed all instructional materials, something that was not possible with SCORM 1.2. Converting those SCORM 1.2 content packages to SCORM 2004 3rd Edition with sequencing and navigation required significant manual programming. To achieve this, the team contracted with a sequencing and navigation expert who was able to devise interoperable work-arounds for nearly all of the system-specific issues encountered during production testing.

Production Testing

Based on the lessons the team learned in our pre-migration testing and to ensure the SCORM 2004 3rd Edition content packages functioned properly and were fully interoperable, we performed exhaustive testing on each content package in Rustici Software's SCORM TestTrack system. TestTrack is widely recognized as a stable SCORM 2004 3rd Edition-conformant platform, is freely available via the web, and provides debugging capabilities to assist programmers in the event of errors in the content or content package. We also tested every course in the Army LMS CTE to ensure the actual learner experience functioned as planned in a system as close to the final Army LMS platform as possible. Early in this round of testing, we identified a performance discrepancy between TestTrack and the Army LMS CTE in some of the courses. After talking with staff from the Advanced Distributed Learning (ADL) Initiative, Rustici Software, and the Army LMS, our programmer identified the discrepancy as a bug in the Army LMS. The Army LMS support staff verified the bug and asked the LMS vendor to create a patch to resolve the problem.

Meanwhile, the Army LMS support staff continued their acceptance testing in the Army LMS while awaiting installation of the bug patch. To keep the migration moving and get some learners migrated into the LMS as soon as possible, the team decided to migrate any course that was ready as soon as it was accepted by the Army LMS support staff, rather than in accordance with the phased schedule we had been working towards. Awaiting development, testing, and deployment of the patch in the Army LMS resulted in some delays in the Army LMS acceptance testing, thereby delaying deployment of some of the courses from the revised schedule. However, in mid-September 2010, the Army LMS support staff accepted and deployed the vendor's patch, and most of the remaining courses became available to learners in the Army LMS in time to meet the 30 September deadline. The bug resolution process worked smoothly and quickly, but had the bug been more complicated, it could have prevented the on-time migration of content into the Army LMS.

OUTCOMES

Despite the six-month migration timeline and delays resulting from the previously identified incomplete initial testing and system bug, the team successfully migrated 48 of 58 courses, including the highest throughput courses, by the 30 September 2010 deadline. We experienced technical difficulties with the

remaining 10 courses, all of which had very low learner throughput, which required additional consultation with the Army LMS support staff followed by some reprogramming and more testing. The team was able to migrate all of the remaining courses to the Army LMS by the end of calendar year 2010.

Since the team successfully migrated the majority of courses by 30 September 2010, we avoided spending approximately $90,000 on a three-month duration contingency plan put in place to keep the legacy LMS operating at the University of Military Intelligence in the event of difficulties encountered with the migration. While the migration itself, including the purchase of some new authoring tools to replace the legacy learning content management system, cost approximately $331,000, we nearly cut in half the 2010 – 2011 costs versus the 2009 – 2010 costs. If the operating and support costs for 2009 – 2010 had remained constant in the following years, then the total savings resulting from the Army LMS migration would be over $2 million in the five-year period from 2011 – 2015. See Table 2 for a breakdown of the costs by year.

Table 2. Change in Approximate DAC LMS Operating and Support Costs

Category	08–09 Legacy	09–10 UMI	10–11 Army LMS	11–12 Army LMS^
Hosting	$508,000	$147,000	$000	$000
Licensing	$305,000	$305,000	$000	$000
Support	$123,000	$170,000	$000	$000
Tools*	–	–	$10,000	$000
Migration^	–	–	$231,000	$000
TOTAL	**$936,000**	**$622,000**	**$331,000**	**$000**

* Represents a one-time cost for authoring tools
^ Represents anticipated costs

LESSONS LEARNED (LL)

Throughout the migration, the team documented and reported all of the lessons learned in the event that we, or others, might migrate content from one LMS to another in the future. With any software or courseware project, there are always unanticipated issues that can create problems that result in additional costs and delays. While many of these lessons learned seem obvious, with a large project like this in front of a prospective LMS migrator and looming deadlines, it is easy to forget some of these simple concepts.

LL #1: Include Multiple Contingencies and Reserve Funds

Always build extra time and resources into the schedule for unanticipated issues and technical errors that may be outside of your direct control. One of our team's contingency plans included paying the legacy system vendor licensing fees to continue operation for three months beyond 30 September. Thirty days prior to 30 September, with everything seemingly on schedule, team leaders notified the legacy system provider that we would not need the additional licensing for the contingency plan. This was an extremely risky decision because we had no ability to control a remedy to the bug in the Army LMS and we were reliant upon the Army LMS support team to complete testing and installation of the patch in time for us to migrate the highest throughput courses. This created tremendous anxiety for team leaders because we would have either failed in our migration attempt or been successful in our migration attempt, but forced to pay nearly $100,000 in licensing costs to the legacy system provider.

The team was fortunate that we could influence the Army LMS support staff to recognize the bug and patch it quickly and that the Army LMS support staff accepted and installed the patch from their vendor in time for us to meet the scheduled deadline. However, the bug in the Army LMS could have taken months to correct and integrate into the Army LMS. Having a contingency plan for these bugs or breaks will reduce anxiety and reassure the team that even without the target system, courses will be available to learners and learners will not lose their scheduled training time or fail to complete certification courses before they deploy.

LL #2: Work Closely and Directly with LMS Operators

Before beginning any migration effort, it is critical to work closely and directly with the other organizations involved in the migration, particularly those who operate and support the target LMS or other systems that integrate with the LMS. Obtain contact information for all parties who will be involved in the process and fully understand everyone's role and who reports to whom in the event that you need higher-level authorization or intervention in a situation.

Initially, the team communicated the requirements and migration plan through the LMS vendor to the Army LMS support staff. This resulted in slower response times, confusing communications, and an excessive amount of unnecessary email traffic. Going directly to the Army LMS support staff and obtaining their documentation before beginning the migration would have saved time and frustration and would have significantly streamlined the initial process. It is important to work directly with the LMS operator to

understand their complete processes and dependencies before finalizing the migration schedule. This will ensure there is ample time in the schedule for any additional measures, such as acceptance testing or records cutover. For the Army LMS migration, the Army LMS support staff required about two weeks to complete acceptance testing and the ATRRS staff required two full weeks for records setup and cutover before the courses could go live on the Army LMS. To account for these additional time requirements, it was necessary to expand the migration team and work extended hours to meet the unanticipated deadlines of the other organizations involved in the migration.

LL# 3: Communicate, Communicate, Communicate

Distributed teams are an ideal way to prove the advantages of distributive learning technologies. All of our team members were able to access the files and systems they needed because of web-based technologies including virtual private network (VPN), file transfer protocol (FTP), and web-based file storage. However, distributed teams also present unique challenges, especially on a project this large with such an inflexible deadline. Accidentally leaving one name off of an important project email occasionally resulted in confusion or miscommunication. Scheduling weekly meetings for the extended team to touch base and regroup proactively saved countless hours. Even a fifteen minute call will keep everyone in the loop and avert situations where vital information isn't communicated to all parties.

LL#4: Test to "Break" the New System

Another issue that resulted in a major revision to the migration plan and cost the team several months of time was limiting initial testing to "it works correctly in the new system" and not pushing the testing to "how can we break this in the new system." Since the SCORM 1.2 content packages worked correctly in the Army LMS, we built a migration plan around a deployment of half of the courses as SCORM 1.2 content packages. At the point we discovered that SCORM 1.2 would not deliver an acceptable learning experience in the Army LMS; revising the plan and redoing work resulted in extended work hours, additional programming costs, and increased stress and anxiety for the team. Before anyone on a team begins a testing activity, it is critical to assign a group of potential testers to develop a detailed testing plan to account for all possible ways of "breaking" the course in the target system. Our team member who "broke" the new system did so unintentionally while trying to access other system features, so allow your team members to "play" in the system enough to be able to break it before developing the formal testing plan and beginning formal testing.

LL# 5: Use SCORM 2004 3rd Edition or Higher

While the migration team was aware of many of the limitations of SCORM 1.2, we were trying to cost-effectively migrate a large volume of content quickly and easily. When the SCORM 1.2 content appeared to work acceptably in the Army LMS, it seemed like an ideal solution for many of the courses. However, based on the team's experience, we strongly recommend that any SCORM content migration project use SCORM 2004 3rd Edition, at a minimum, and rely on sequencing and navigation to control the learner experience, not the LMS. There are far too many levels of conformance and too many unknown variables, and occasionally undocumented variables, in different LMSs to achieve more than the most basic interoperability in SCORM 1.2. SCORM 2004 3rd Edition conformance guarantees a better level of interoperability and a much more stable learner experience. To be successful with sequencing and navigation, it is important to identify a strong programmer with specific experience writing complicated sequencing and navigation rules for SCORM 2004 3rd Edition content.

CONCLUSIONS

This migration was only possible through the efforts of a strong, cohesive, multi-organizational team committed to the success of this migration effort through long hours of planning, testing, programming, and retesting. The savings achieved exceeded expectations and allowed DAC to reallocate funds for the design, development, and implementation of more web-based training courses for DAC learners around the world. The lessons learned from this project will not only benefit potential future migrations, but have actually changed DAC's processes and procedures to result in better and faster implementation of web-based training content.

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