COURSE DEVELOPMENT

8/1/2017

FAA COE TTHP: Project 8

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Course development requirements for NextGen training are evolving. Course objectives, presented by PowerPoint slide, do not engage the learner as well as other tools readily available through the mobile learning environment in a top rated learning management system. This study examined course development in regard to best practices, LMS functionality, the architecture of mobile learning, and competency-based learning.

Course Development

FAA COE TTHP: PROJECT 8

OVERVIEW

Within the AJI COE TTHP, Curriculum Architecture Focus Area, Project 8 was described in this way.

> For modernization of Air Traffic training, this project will demonstrate development of aviation technical courses using current agency practices assessing for efficiencies and innovative instructional systems design practices. This project would also address standardization of contractor course development efforts. Research industry best practices; identify current efficiencies and provide recommendations on innovation w/in instructional systems design (other tool set/technologies).
> **Scope**: Air Traffic Controller and Technician training
> **Schools**: University of Oklahoma, Oklahoma State University
> **Note**: *Description confirmed in e-mail note from April Williams, Dated January 26, 2017*

Although assigned in October 2016, the Project 8 investigators began in earnest in January 2017. Both researchers had full-time teaching, research, and service commitments, before entering in this project. Priorities had to be rearranged, which caused a delay. An extension was requested and approved, which extended the project to September 2017.

Timeframe for Work:

- Official Start: October 2016
- Official End: May 2017
- Actual Start: January 2017
- Extension for completion: September 2017

There were five objectives in Phase 1.

1. Examine current course development protocols
2. Examine current use of eLMS for course development
3. Create a modified ISD protocol that used Design Research features that would be compatible for NextGen courses
4. Develop a modified ISD protocol that use Design Research features that can be used in the eLMS
5. Create a process that all developers can use to develop course using Design Research and ISD methods

Two component elements served by this project are:

Technical Training
Air Traffic Control

In June 2017, after learning of requests from AFS-500, it appeared that work being accomplished on Project 8 would also benefit the Flight Standards office. This extended the number of elements served. Aviation Safety Inspectors became the third element.

Three deliverables were promised:

1. Modified ISD protocol compatible with NextGen courses
2. Modified ISD protocol compatible with eLMS
3. Process for developers

Reports

Monthly and Quarterly reports were uploaded to OMIS, along with reports generated by special meetings with the client.

Final reports are due by July 31, 2017 and September 30, 2017. The July report covers work accomplished during the fiscal year. The September report includes final recommendations for Phase 1 of the Project. A Phase 2 proposal was completed in early July, and pending approval, Phase 2 initiatives should bring the FAA closer to a better, final solution for transformative course development, in light of NextGen requirements.

Note: The more expansive portion of this report can be found after the Executive Summary. However, the reader is welcomed to read the Executive Summary, if wishing to get a gist of the project.

EXECUTIVE SUMMARY

From the start, it was clear that the FAA was aware of problems associated with underutilization of Blackboard 9.1, their electronic Learning Management System. David Palmer confirmed this during a teleconference on July 31, 2017 (personal communication, Todd Hubbard & David Palmer). At a fundamental level, course design and development will have to change. But, by how much? And if course design and development changes, will this require existing Instructional Systems Designers/Specialists to retool and develop new skill sets. This report provides answers to the questions and queries, while also providing a strategic roadmap for how to bring course development into the post-SCORM era.

Course Development (Project 8) is nested within the Content Management and Delivery portion of the FAA COE for Technical Training and Human Performance (TTHP). Other Content Management and Delivery projects, such as Best Practices and Methods for Virtual Training Deliver, Development of Learning Taxonomy, Research Alternative ISD Model, and Development of Learning Taxonomy were also investigated. Some cross-project collaboration was attempted, but during Phase 1, there were few opportunities to truly collaborate. It is envisioned that more collaboration will occur during Phase 2 of any of the projects.

BEST PRACTICES

Although the reader is welcomed to read the report, here are some recommendations to consider from Best Practices

Regis University Recommendations

Recommendation: Develop a better relationship between the ISD/ISS and Instructional Technology, so that the instructor can either follow the Option 1 or Option 2 process.

Recommendation: Provide instructor development workshops, conducted by ISD/ISS and Instructional Technologists, where the focus is on better course development processes and procedures, and where the instructor is made aware of other ways to use technology in the classroom.

Southern Oregon University Recommendations

Recommendation: Ensure that the elements of a syllabus are also in the Course Design Guide.

Recommendation: Expand the types of interactions for students.

Recommendation: Incorporate more of the tools shown in Table 1 in each course.

University of Texas at San Antonio Recommendations

Recommendation: Consider creating an instructional process where re-design is an acceptable outcome to course development.

Recommendation: Think beyond standard course development processes and intentionally incorporate more technology that helps learners engage more with the material in less restrictive ways. Create an opportunity for unscripted, dynamic learning.

Western Michigan University/University of Victoria (BC, Canada) Recommendation

Recommendation: Consider revising or adding to list of instructional methods for ATC and Tech Ops training. Ask yourself the question: does the instructional method used match how the learner assimilates the new material or learning objective?

Texas A&M University Recommendations

Recommendation: Consider using lessons learned in the Dondlinger study for Tech Ops training. Although gaming and simulation would be an effective tool for air traffic controller training, much of their curriculum is based on more realistic simulation, perhaps for good cause. One would not want an air traffic controller to view his or her activity as "one, big game."

Recommendation: The FAA should ensure that ISSs develop skills in gaming and simulation design, not just what has always been done. These new skill sets would be useful in NextGen training.

LMS FUNCTIONALITY

Blackboard 9.1 is sufficient for many of the operations needed to build, deliver, and track training. However, there are some features not available with Blackboard. One of those that we find useful is a Gamification capability. While Blackboard has its own authoring tool, the Blackboard App allows participants to see prioritized events or actions, keep up with assignments and tests, access grades and personal progress, and to stay connected with others in the class.

We recommend that the FAA take full advantage of what it has, before contemplating a migration to another LMS.

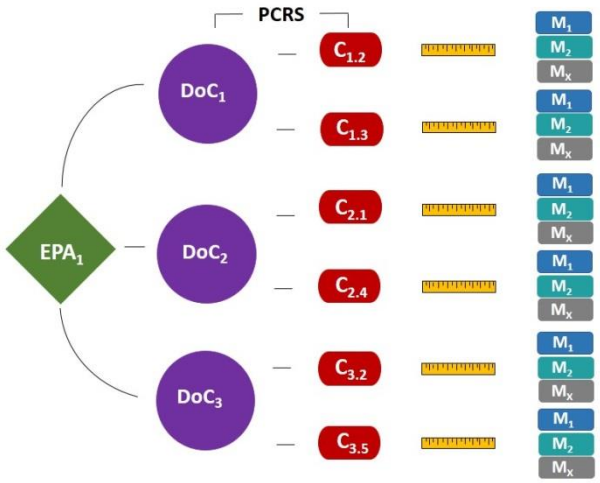
ARCHITECTURE OF MOBILE LEARNING

Mobile learning environments have changed the way we interact with others and the way we perceive education. As the FAA moves forward into the NextGen world, mobile learning and mobile communication will become the norm, not the novelty. As the FAA contemplates which Learning Management System best supports their training, planners and educators need to consider both online and offline learning. Offline learning, through mobile apps, will allow the FAA to stay in touch with training and learning, at anytime and anywhere.

It will be important to the decision-makers, to have those on their staffs who can speak to course development issues where mobile learning is involved. Instructional Systems Designers/Specialists will need to add knowledge, skills, and abilities with education technology to their list of competencies.

COMPETENCY-BASED LEARNING

An excellent model of the competency-based learning process is as follows:



As the FAA transforms its training to competency-based learning, this illustration helps to envision how milestones (perhaps objectives in a course) measure competency building. All competencies (C) belong to a Domain of Competency (DoC), which then bellows to an Entrustable Professional Activity. In the report, Deicing was used as an example of an Entrustable Professional Activity with its own Domain of Competency, and supporting Competencies.

END OF EXECUTIVE SUMMARY

FAA COE TTHP

CMD COURSE DEVELOPMENT

PROJECT 8

FINAL REPORT

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BEST PRACTICES

Regis University. Dynamic course development must be supported by a fusion of instructional designers and instructional technologists. Regis University (n.d.) gives their faculty two options, when it comes to course development. Option 1 is total course development support.

> This option provides full collaborative support for faculty who desire a more controlled development process. Working as a team, faculty meet regularly during course development with an Instructional Designer and Instructional Technologist to develop their course from inception to ready-to-deliver. This option is best for faculty who are new to course development, or simply prefer a guided process.

Over the eight years Dr. Hubbard spent as an instructional systems designer at the FAA Academy in Oklahoma City, instructors and ISDs worked together to ensure that the course materials included learning objectives and outcomes, and that the objectives were related directly to what was testable. It was a method to standardize training, but it also relieved instructors from the lengthy process of course development. Instructional Technology was limited to videos, PowerPoint slides, and some part-task instruction with either mockups or some other hands on experience. Labs usually followed classroom instruction, and it was there that the students were immersed in the near-actual environment. Course development for air traffic controllers and tech ops were very similar, although the fidelity of the lab experience was different between the two groups.

Regis University's (n.d.) Instructional Design and Technology (ID&T) support group also offer an Option 2 where there is a range of support for course development consultation.

> This option provides the opportunity for the faculty to select those aspects of course development that they want or need consultation and/or support with from ID&T. This option is best for more experienced faculty who desire help with specific elements of their course development, but prefer to guide the development process themselves and work independently.

Option 2 might not be an attractive option for the FAA. Within the COE for Tech Training and Human Performance, under Curriculum Architecture, there is a project looking at standardization across all the FAA facilities. If instructors are allowed to create on their own, the FAA would unable to determine if instructional design standards were met. Without assurances that objectives and testable items were linked in every course, course managers could not adequately manage training. Moreover, the FAA has an ethical responsibility to ensure a safe flight environment, which can only be realized if air traffic controllers and tech ops have been adequately trained.

The following depicts the Regis University (n.d.) approach to course development.

1. The school or college conducts pre-work, including:

- Confirming the delivery methods of the course and what term it will be offered.
- Determining what faculty will be involved in the design and development of the course.
    - Does faculty have available time to support the course development effort?
    - Does faculty have appropriate skill set for course development?

2. Point of contact from the school or college submits service request form to ID&T.
3. ID&T review form.
4. For Option 1 request, ID&T notifies point of contact that resources have been allocated or that additional discussion is needed.
   For Option 2 request, schedule a meeting with point of contact to identify the nature and scope of the project, and to allocate appropriate resources, or ID and/or IT meets with content authors to determine support needed and then meets with the ID and IT managers to allocate appropriate resources.
   Option 3 – No ID&T support—if this is selected, the only support will be providing a shell in the LMS.
5. Reporting will show status of all courses active in the course development process.

If one converts faculty member to instructor, in the materials from Regis University, we are still not matching their program to the way the FAA conducts course development process, at least at the FAA Academy. ISDs and ISSs have a separate function from Instructional Technologists. And instructors are rarely ISDs or ISSs in the FAA. Instructors in the FAA are practitioners, with years of experience to make them credible. An instructor can be a Subject Matter Expert, but is not asked to create all the features of a finished course.

Recommendation: Develop a better relationship between the ISD/ISS and Instructional Technology, so that the instructor can either follow the Option 1 or Option 2 process.

Recommendation: Provide instructor development workshops, conducted by ISD/ISS and Instructional Technologists, where the focus is on better course development processes and procedures, and where the instructor is made aware of other ways to use technology in the classroom.

Southern Oregon University. Like most universities, the course syllabus expresses not only the content of a course, but also instructional methods and the use of technology. Southern Oregon University uses a Distance Education Center to standardize online course development. Like Regis University, faculty members (similar to FAA instructors) are directly involved in the development of the course. Southern Oregon University Distance Education Center [SOU DEC] (2009, p. 2) ensures that every online course has the following elements.

- Detailed syllabus
- Course content
- Opportunities for interaction
- Opportunities for feedback
- Assessment
- Accessibility

A good Course Design Guide (CDG) should have the same elements that SOU DEC requires in each syllabus (SOU DEC, 2009, p. 3).

1. Course Title and Identification
2. Instructor Contact Information
3. Course Description
4. Course Goals or Outcomes
5. Required texts and materials
6. Recommended texts or readings
7. Class format or outline
8. Assignments and expectations
9. Attendance policy
10. Grading policy
11. Academic honesty statement
12. Academic support/ADA statement
13. Other policies as needed
14. Course plan
15. Disclaimer

SOU DEC (2009, p. 5) also provides their instructors with a table, which lists Instructional Methods, Techniques, and Online Tools/Resources, which is reminiscent of the three-column format used in FAA Academy training before 2000, and which may still be used in some course guides at the FAA facilities. There are some tools and resources in Table 1 that were not available to ISDs or ISSs at the FAA prior to 2000, and which may not be used even today.

Table 1: Online Instructional Method and Tools Matrix

Instructional Method	Techniques	Online Tools/Resources
Cooperative Learning	Multimedia Presentations Research Project Student-Led Instructions	Windows MovieMaker, PowerPoint, Audacity, or Garage Band Blogs, Wikis, Group Pages Discussion Board or Web Conferencing
Demonstration	Video Clips Text and Images	Streaming videos, YouTube PowerPoint Presentation
Discovery	Research Projects Web Quests	Wikis Internet/Library Searches
Discussion	Asynchronous Discussion Synchronous Discussion	Blogs, Course E-mail, Discussion Board Chat, Web Conferencing
Drills	Exercises featuring multiple choice, fill in the blank, crosswords, matching/ordering, short answer, jumbled sentences Self-tests	Hot Potatoes Quizzes
Presentation or Lecture	Narrated Slides/Images Podcasts Video Clips Written Lectures/Lecture Notes	PowerPoint Presentations Streaming Audio/Video Files YouTube Videos Word/Rich Text/HTML files
Problem-Solving	Problem-based Learning	Word/Rich Text/HTML files Group Pages
Simulations and Tutorials	Animations Self-Paced Modules Video Clips	Flash HTML files MERLOT, WikiMedia, Wisc-Online, World Lecture Hall

Recommendation: Ensure that the elements of a syllabus are also in the Course Design Guide.

Recommendation: Expand the types of interactions for students.

Recommendation: Incorporate more of the tools shown in Table 1 in each course.

University of Texas at San Antonio. McGee and Reis (2012) performed a study of "publically available guides, documents, and books that espouse best or effective practices in blended course design to determine commonalities among such practices" (p. 7). In Bonk and Graham (2005, p. 4), three blends are listed.

> Enabling blends - Enabling blends primarily focus on addressing issues of access and convenience. For example, enabling blends are intended to provide additional flexibility to the learners or attempt to provide the same opportunities or learning experience but through a different modality.
>
> Enhancing blends - Enhancing blends allow for incremental changes to the pedagogy but do not radically change the way teaching and learning occurs. This can occur at both ends of the spectrum. For example, in a traditional face-to-face learning environment, additional resources and perhaps some supplementary materials may be included online.
>
> Transforming blends - Transforming blends are blends that allow for a radical transformation of the pedagogy, a change from a model where learners are just receivers of information to a model where learners actively construct knowledge through dynamic interactions. These types of blends enable intellectual activity that was not practically possible without the technology. (McGee & Reis, 2012, p. 8)

The FAA has a number of blended courses, but the author is uncertain if the FAA has defined what they mean by blended. Vaughn and Garrison (2005) suggested that a blended course

> [I]ntegrates the best of face-to-face and online learning while significantly reducing traditional class contact hours (p. 1). When the strengths of each approach are integrated in an appropriate and creative manner, the possibility to become fully engaged in a sustained manner is increased exponentially. In this way, blended learning designs reach beyond the benefits of convenience, access, and efficiency. (McGee & Reis, 2012, p. 9)

McGee and Reis (2012) synthesized their findings of instructional strategies into three, major areas: process-driven, product-oriented, and project-oriented.

> Process-driven: a focus on practice through isolated or progressive activities (typically completed by the individual rather than a group) that culminate in a performance or an objective assessment. Examples include: Audio recordings, brainstorming, document analysis concept mapping, fieldwork, gaming, peer review, problem solving, listen, read, write, reflect, self-testing exercises, simulations, synchronous discussions and tutorials.
>
> Product-oriented: assignments and activities support the development of a well-defined product that documents and illustrates the learner's mastery of course content. Often these are the result of a process-driven approach where students understand that the end product is the outcome of course work. Peer reviews are often a part of a product-oriented approach. Examples include: art projects, essays, case briefs and podcasting.
>
> Project-oriented: assignments and activities support an ongoing step-by-step set of activities and assignments with benchmarks so students know they have accomplished

> objectives. Projects are cumulative in that they require completion of assignments over time. Unlike products, projects involve more than an end result. Examples include: debates, group reports, case studies, blogs, interactive web activities and online group collaboration. (p. 14)

McGee and Reis (2012) said that

> the 'best' and 'effective' practices reported here touched upon each of these facets (learner, learning objectives, the content, instructional strategies, and results of instructional interventions) to varying degrees without prescribing a lock-step process. A loosely articulated design process allows variability and flexibility in the design of blended courses. Overall, the process of design is emphasized as one of re-design, implying that those involved in the design process are willing and able to see beyond what has been done in the traditional classroom and re-conceptualize what can be done in multiple delivery modes. (p. 17)

Recommendation: Consider creating an instructional process where re-design is an acceptable outcome to course development.

Recommendation: Think beyond standard course development processes and intentionally incorporate more technology that helps learners engage more with the material in less restrictive ways. Create an opportunity for unscripted, dynamic learning.

Western Michigan University/University of Victoria (BC, Canada). McIver, Fitzsimmons, and Flanagan (2016) argued that "current frameworks, including the dominant Bloom's taxonomy, usually end with learning objectives, a step prior to the final step of choosing instructional method" (p. 48). They likened this shortfall to the delivery of a package to one's home. If the package were delivered to within a mile of your home, it would still be insufficient. This is how they look at the selection of an instructional method. "Instructional methods ought to be applied mindfully, based on an understanding of each method's appropriateness with respect to the intended learning objectives, yet frameworks give minimal guidance on how to make these decisions" (p. 48).

Instructional method is an integral part of course development; however, its importance is sometimes overlooked. Once the course objectives are matched to test items, how the course is delivered to the learner will often resemble how it has always been done. With the more mobile features available in modern learning management systems, an instructor should not feel confined to only lecture or online delivery, or a blend of both. "Instructional methods refer to teaching and learning techniques, such as lecturing, the case method, simulations, homework problems, or assignments" (McIver et al., 2016, p. 48).

"Instructional design theories are both prescriptive and probabilistic, meaning they propose how to increase the chances of achieving desired learning objectives" (p. 49). McIver et al. (2016) created a process model for choosing instructional methods.

Step 1: use board course learning objectives to identify specific granular learning objectives
Step 2: classify the underlying knowledge structure of each learning objective by its knowledge-i-practice
Step 3: map knowledge-in-practice of learning objective to learning processes
Step 4: choose instructional methods to trigger the learning process identified in step 3 (p. 50)

As a way to compare what these authors are suggesting with what the FAA currently does in their Course Design Guide, consider FAA Course 60004552, Weather—Controller Responsibilities, Recurrent Training. The CDG, dated February 2012, lists the following items as being part of the document.

Management Summary

- Training outcomes for the course
- Major topics covered
- Technical approach, including instructional methods and media used and assessment design
- Deliverables to be developed
- Course length
- Key personnel

Course Design Data Sheets

- Lesson name/number
- Duration
- Enabling objectives
- Outline of technical content
- Method/media
- Test type
- Development notes

Cross Reference Matrix, which includes a list of all training outcomes and enabling objectives for the course and the job tasks and/or knowledge topics to which they correspond from the AIR Job Task Analysis completed in October, 2011.

For this training, there are three methods of instruction listed.

Instructor-Led Training (ILT)
Simulation Training (ST)
Web-Based Training (WBT)

There is no mention of how only these three methods were considered. It is likely that they were selected, because that is the way it has always been done. Mobile methods, in 2012, were only vaguely available in some corners of academe and business. However, FAA training had been using these methods early on, and they seemed to be effective. Indeed, they are. Yet, perhaps it is time to transform learning by upgrading to the newer technologies available. Augmented and Virtual Reality are two of those instructional technologies that would enhance training for air traffic controllers and technicians.

One of the issues needing to be addressed is how one creates a user-centered design, as a part of instructional method. For example, in Tech Ops training, problem solving is part of what technicians do. So how do we help people imagine? If the solution to the problem is unknown, and we wish to enlist the help of the technician to solve the problem, how do we motivate the person to imagine possible solutions? One method might be through the use of Augmented Reality. Part of the solution team could be at a different location, but part of the solution through the camera mounted on the AR eye glasses.

Koskinen, Zimmerman, Binder, Redström, and Wensveen (2012) said that constructive design researchers have had good reasons to go back to contemporary art and design in search of more design-specific methods and ways of working (Loc 882). "Several research groups have begun to address the problem of creativity with methodic, conceptual, technological, and artistic means" (Loc 882). If an air traffic control developmental is allowed to imagine how aircraft are separated and controlled, using a game to allow participation, would that not allow the participant to go further in learning before the lab? The same rationale would work for Tech Ops as well.

Recommendation: Consider revising or adding to list of instructional methods for ATC and Tech Ops training. Ask yourself the question: does the instructional method used match how the learner assimilates the new material or learning objective?

Texas A&M University. As the FAA contemplates its place in NextGen training, instructional systems designers and specialists will need to retool, in order to adapt to changes in mobile learning environment. Moreover, FAA instructional systems specialists will need to add gamification to their skill set.

> Research on games and simulations for learning in the last decade has expanded the instructional design knowledge base to such an extent that degree programs in instructional design and technology are beginning to develop and offer courses on games and simulations as learning technologies. (Dondlinger, 2015, p. 54).

It is ironic that major movements among those developing a mobile learning environment through Tin Can occurred at the same time that Educational Technology faculty were exploring changes in instructional design that incorporated games and simulations. At Texas A&M, their "program focuses upon the development of a philosophy of educational technology that incorporates literacy, integration, and research related to best practices in the use of current and emerging technological trends" (p. 55). The department expects their graduating students to be able to:

1. Develop a philosophy of educational technology that shapes their vision reflected in a variety of areas from the role of technology in personal and professional settings.
2. Utilize best research practices in order to make informed decisions regarding the effectiveness/impact of technology integration.
3. Demonstrate an effective integration of communication, media, information, and technological literacy skills.
4. Effectively design, develop and integrate a variety of technological applications that are appropriate within professional settings. (p. 55)

In the initial analysis phase of Dondlinger's study, traditional ISD methods were compared to those more relevant to design games and simulation. The ADDIE process (analysis, design, development, implementation, and evaluation) for gaming and simulations is modified slightly. For the gaming designer analysis includes foundations of the field; design, includes learning theories, methods, and models; development includes tech apps and tools; implementation/integration includes issues and considerations; and, evaluation includes research.

It appears that the use of games and simulations has its theoretical support from constructivism. Dondlinger (2015) posited that "constructivist learning theories uphold the following primary principles:

- Learning results from a personal interpretation of experience
- Learning is an active process occurring in realistic and relevant situations
- Learning results from an exploration of multiple perspectives (p. 57)

A course given at Texas A&M on games and simulations, had as its "umbrella topic" theories regarding learning and play. The syllabus included the following student learning outcomes:

- The learner will apply defining characteristics to distinguish games from simulations and other virtual learning environments.
- The learner will analyze instructional needs and create a learning game or simulation design.
- The learner will reflect on and discuss relationships among theories of learning and play. (p. 59)

Recommendation: Consider using lessons learned in the Dondlinger study for Tech Ops training. Although gaming and simulation would be an effective tool for air traffic controller training, much of their curriculum is based on more realistic simulation, perhaps for good cause. One would not want an air traffic controller to view his or her activity as "one, big game."

Recommendation: The FAA should ensure that ISSs develop skills in gaming and simulation design, not just what has always been done. These new skill sets would be useful in NextGen training.

OBJECTIVE 1: CURRENT COURSE DEVELOPMENT PROTOCOLS

The first objective of this project required an examination of current course development protocols. Rather than ask Instructional Systems Designers/Specialists how they currently develop a course, we looked at the evidence of development. The obvious place to look is the Course Design Guide.

Courses Examined. We looked at the CDGs for many courses, but decided upon the following courses as being representative of what we observed:

55109	Airspace and Procedures for AMA 500 (Feb 2002)
57047	DBRITE (May 2015)
60004552	Recurrent Training (Jan 2012)
57838	IFR Approaches (April 2010)
55092	Electronic Flight Strip Transfer System (EFSTS) Air Traffic Training (April 2003)

Course 50019/55092

The CDG for these two courses was clear, concise, and accurate. The format fully explained how the course was designed and developed. The follow table of contents indicates the type of format for both courses (See Figure 1).

FIGURE 1: OUTLINE OF A GOOD CDG

Table of Contents

A proper CDG walks the reviewer through all the steps taken to develop the course. The following example shows how the developer laid out the course. The method is straightforward, and this design will allow assessment experts to easily assess learning outcomes (See Figure 2).

FIGURE 2: EXPLANATION OF METHOD

2 CURRICULA DOCUMENTS

2.1 Curricula Documents Format

The Curricula document contains the curricula for the each job category identified in the TASA.

Part 2.2 contains the Curriculum Document for the Ocean 21 course for Air Traffic Control Specialists

Part 2.3 contains the Curriculum Document for the Ocean 21 course for Air Traffic Training Specialists.

The Curriculum document format is as follows:

Header information:

Course Number: The number assigned to the course by the FAA's Consolidated Personnel Management Information System (CPMIS).

Lesson Number: Lesson number assigned to identify the module and sequence.

Date: Date Curriculum Document was prepared

Course Title: Title of course.

Lesson Title: Title of the lesson.

Training Outcome: Contains the expected outcome of the course.

Associated Tasks: Provides a reference to the TASA duty, task and/or subtask

Terminal Objective: Provides the expected outcome for this lesson.

Time: How long it takes to teach this terminal objective. Time to complete includes administrative functions, presentation of subject matter, knowledge assessment. Laboratory exercises and performance assessments time to complete should be a separate line item but associated with the lesson.

The table contains 6 columns.

1 **Enabling Objectives** contains the Enabling Objectives. Since the conditions and standard are, for the most part the same they will not be repeated throughout the document. When the condition or standard is different a three part objective has been written.

2 **Content Outline** contains the content outline. unless the corresponding lesson objective makes the content outline self-evident.

3 **Mode** contains the instructional method and media. The method and media is consistent throughout the course. **Lec** is used to indicate lecture, **Lab** is used to indicate a demonstration on the and/or practical time on the Ocean 21 simulator

4 **Test Type: C** indicates cognitive. **P** indicates performance.

5 **Estimated Time:** contains the estimate in minutes of how long it will take to complete this enabling objective.

6 **Developer Notes:** this area is to provide information helpful in developing and maintaining the training curricula.

The following example shows how Training Outcomes, Enabling Objectives, and Content are combined to give the reader a snapshot of learning integration (See Figure 3).

FIGURE 3: COURSE 55019 COURSE DESIGN, LEARNING INTEGRATION

Course Number: TBD		**Lesson Number:** ATCS-2			**Date:** 02/15/02
Course Title: ATOP ATCS Course		**Lesson Title:** Workstation Display Windows			
Training Outcome A: Given an Ocean 21 system and simulated air traffic situations, the student will perform all air traffic tasks without error, in accordance with the Ocean 21 AT Operators Manual, FAA Orders 7110.65 and 7210.3.					**Associated Tasks:**
Terminal Objective 2: Given an overview of the Ocean21 system, the student will correctly locate and open the workstation display windows necessary to provide air traffic control services in accordance with the Ocean21 AT Operators Manual.					**Time:**
Enabling Objectives	**Content Outline**	**Mode**	**Test Type**	**Est Time**	**Developer Notes**
a. Given an Ocean 21 system, the student will correctly open and locate the workstation display and task windows in accordance with the Ocean 21 AT Operator's Manual and facility oceanic procedures.	1. Workstation Window				
	a. Locate the visual indicators of the Workstation windows buttons	Lab	P	20	
	1) Color				
	a) Red				
	b) Yellow				
	c) Green				
	d) Grey				
	2) Numerals				
	b. Locate the system status.	Lab	P	10	
	1) DOWN				
	2) INIT				
	3) START				
	4) OPER				
	c. Demonstrate the functions of the Workstation buttons.	Lab	P	20	
	1) Sector Queue				
	2) Coordination Queue				
	3) Error Queue				
	4) Sysop Queue				
	5) Supervisor Queue				
	d. Access the options available from the Workstation window menu bar				
	1) Open	Lab	P	30	
	a) Aircraft message window				
	b) AFN window				
	c) Clearance window				
	d) FPEA window				

Another great feature of a good CDG is the traceability matrix. This also helps the assessment expert, because in a very straightforward way, training outcomes, TASA Task numbers, terminal objectives and training outcome labels are shown in table form (See Figure 4).

FIGURE 4: TRACEABILITY MATRIX

ATCS Course			
Training Outcome	**TASA Task Numbers**	**Terminal Objective Number**	**Training Outcome Label**
At the completion of the course the trainee will be able to manage the data display in order to deliver an air traffic control service	1.1, 1.2, 1.3 1.4	A.3, A.4, A.4 A.4 G.4	A
At the completion of the course the trainee will be able to manage the aircraft situation display in order to deliver an air traffic control service	3.1 3.2 3.3 3.4 3.5	B.2, B.3 B.2, B.3 B.2 B.3 B.2, C.2, E.1, G.2	B
At the completion of the course the trainee will be able to manage the clearance window in order to deliver an air traffic control service	5.1 5.2	C.1, C.2 C.3	C
At the completion of the course the trainee will be able to manage the sector window and strips in order to deliver an air traffic control service	2.1 2.2 2.3 2.4 2.5 2.6 2.7 2.8 2.9	D.1 D.1, B.1 D.1 D.1 D.1 D.1, H.3, C.2, G.2, I.1, E.1, A.3 D.1, E.2, E.3 D.1 D.1, C.1, C.3	D
At the completion of the course the trainee will be able to manage coordination and transfer of control in order to deliver an air traffic control service	6.1 6.2 6.3	E.3, E.4 E.2, E.1 E.2	E
At the completion of the course the trainee will be able to manage conflict detection and reporting process in order to deliver an air traffic control service	9.1 9.2	F.5, B.1, F.1, F.2, F.3, F.4, F.6, G.2 F.7, F.6	F

The course developer had completed a Task and Skills Analysis (TASA) Report in the year before the CDG was completed. Rather than being an example of course design, it is a better example of curriculum design. An educator views the curriculum much like we view competencies. The following example (See Figure 5) shows the Task Analysis Methodology. Notice that the designer used multiple sources to identify and analyze tasks.

FIGURE 5: TASK ANALYSIS METHODOLOGY (COURSE 55109)

1.5 Task Analysis Methodology

Multiple sources were used to identify and analyze the tasks and skills that will be required to operate the Ocean21™ ATC system. Operating skills and tasks, and supporting knowledge to enable the performance of these tasks were identified from Airways Oceanic Control System ATC operational and training experience and documentation, and Ocean21™ ATC Operator's manual. These findings were augmented through observation of New York and Oakland Center's oceanic operations and discussions with current Oceanic ATC Specialists at both facilities, identified below.

Documentation used in the analysis:

- ATOP Air Traffic Controller Operators Manual (CDRL A011A)
- Airways Corporation of New Zealand Cognitive Task Analysis of the Oceanic Control system (high level)
- Airways Corporation of New Zealand ADS rating training course.

Subject matter experts assisting in the analysis:

- Mark Goodall Airways NZ, author of the Airways Manual of Air Traffic Services: Oceanic Services.
- Grant Dowie, Airways NZ, Oceanic Training and Procedures Specialist
- Lance Cameron, Airways NZ, Air Traffic Management Specialist
- Brian Hay, Airways NZ, Educational Specialist.

Course 57047

We included this course, because it represents all courses needing revision. In the storyboard folder, one can find notes left by an assessment expert. The course needs to be revised. It has no CDG or TASA. We did not determine how many courses needed revision, but we added this example to let the reader know that the FAA does review their courses and determines to keep them update. This one is in the long queue of other courses needing work.

Course 60004552

This course was used as an example earlier in the report. Under the best practices from Western Michigan and University of Victoria, the CDG organization for this course was shown. We have included it again here, so that the reader can see that not all CDGs are the same. When compared to 55109, 60004552 is a much shorter, less detailed CDG (See Figure 6). It is likely written in this way, because it is a recurrent training course.

FIGURE 6: COURSE DESIGN GUIDE DATA SHEET (COURSE 60004552)

COURSE TITLE: Weather-Controller Responsibilities
COURSE NUMBER: FAA60004552 Block I DATE:

TRAINING OUTCOME:

Lesson Number, Title & Duration	Enabling Objectives	Technical Content Outline	Instructional Methods/Media/ Test Type	Development Notes & References
FAA60004552	• List controller weather responsibilities. • Determine when to disseminate severe weather information. • Determine when to solicit pilot reports (PIREPs). • Determine when to provide weather deviation guidance. • Use correct weather phraseology.	• Intro • Scenario • Objectives • Controller weather responsibilities • Severe weather information dissemination • PIREPs and weather • Weather deviation guidance • Correct weather phraseology • Summary	WBT	• SME input

Course 60004552 is a newly designed course. Therefore, one can anticipate a much different view of the CDG after the first course conduct. This is explained in the course report (See Figure 7).

FIGURE 7: COURSE 60004552 COURSE REPORT FORMAT

2.2 Course Report

A course report will be prepared within a determined number of calendar days of the completion of the first class to summarize the results of the first class conducted. The contents of the course report will include, at a minimum, the following:

When the course report is completed, it will have course data, class data, test data, comments, planned revisions, and supporting documentation.

Course 57838

In 55109, we found a very complete CDG. In 57047, we did not find a CDG. In 60004552, we found a CDG in the first course conduct version. In 57838, the CDG lacks any outline of what is to come. It also does not integrate training objectives with enabling objectives and learning outcomes. It is merely an outline.

MODULE 1: Approach Clearances
Objectives - Identify *the purpose of Instrument Approach Procedures and why they are important for En Route Controllers. Identify the difference between Precision and Nonprecision approaches and examples of each. Identify when to issue standard, special, contact, visual, and cruise approach clearances. Identify the proper phraseology for these clearances. Identify when to issue detailed approach and altitude information and know the correct phraseology. Recognize a missed approach.*
Identify the requirements for issuing an approach clearance.

- Introduction
  - Introduction
  - Topics
- Instrument Approach Procedures
  - Definitions and Purpose
  - IAP Charts
  - Progress Check
  - Types of Approach Procedures
  - Approach Categories
  - Examples of IAP Types
  - Three Classifications of Approaches
- Standard Approach Clearances
  - Definition
  - Clearance for Standard of Special IAPs
  - Inbound Aircraft on Unpublished Route
  - Progress Check
- Detailed Approach Information
  - Phraseology
- Specifying Altitude
  - When to Specify
  - Omitting the Altitude
- Missed Approach
  - When to Execute
- Approach Clearance Requirements
  - Conditions
  - Progress Check
- Other Approach Clearances
  - Three Alternatives
  - Contact Approach Definition
  - Conditions for a Contact Approach
  - Visual Approach Definition
  - Conditions for a visual Approach
  - Pilots & Visual Approaches
  - Cruise Clearance Definition
  - Conditions for a Cruise Clearance
  - Progress Check
- Module Summary
- Reference
  - AIM (5-4)
  - FAA Order 7110.65 (4-5), (4-8), (6-6), (7-4)

MODULE 2: Instrument Approach Procedure Charts
Objectives - *Recognize the key elements of the IAP chart.*
Interpret and relay the information contained in the IAP to pilots.

Introduction
- Introduction
- Purpose
- U.S. Terminal Procedures

Approach Plate Sections
- Five Sections

Margin Information
- Margin Components

Planview
- Planview Components
- Communications Information
- NAVAID Information
- MSA Information
- Obstructions
- Approach Procedure Layout
- Progress Check

Profile View
- Definition
- Non-Precision
- Altitude Indicators
- Precision Profile View
- Progress Check

Minimums Chart
- Components
- Approach Types
- Progress Check

Aerodrome Sketch
- Purpose
- Progress Check

Module Summary
AIM (5-4)
FAA Order 7110.65 (4-5), (4-8)

MODULE 3: End-of-Lesson-Test
Introduction
Exercises

FAA Order 7110.65 (4-8)
FAA Order 7110.65 (4-8)
FAA Order 7110.65 (4-8)
FAA Order 7110.65 (4-8)
FAA Order 7110.65 (4-8)
FAA Order 7110.65 (4-8)

Click on the correct phraseology for a specific approach type when more than one of that type of approach is published. *FAA Order 7110.65 (4-8)*
"November two six alpha, cleared runway one eight, ILS approach."
"November two six alpha, cleared ILS runway one eight approach."
"November two six alpha, cleared ILS approach, runway one eight."
"November two six alpha, cleared approach ILS, runway one eight."

Click on the correct phraseology for clearing an aircraft for approach from an unpublished route. *FAA Order 7110.65 (4-8)*
"King Air four zero four papa, cross RICH VOR at or above three thousand. Cleared VOR runway two three approach."
"King Air four zero four papa, hold at RICH VOR at or above three thousand. Cleared VOR runway two three approach."
"King Air four zero four papa, cleared approach VOR runway two three."
"King Air four zero four papa, cleared VOR runway two three approach at or above three thousand."

Click on a portion of the detailed approach information and move it to the correct position. *FAA Order 7110.65 (4-8)*
Final Approach on (name of NAVAID) - **4**
INITIAL APPROACH AT (altitude) - **1**
(specified) COURSE/ALTITUDE/AZIMUTH AT (altitude) - **5**
(number) MINUTES/ MILES (direction) - **3**
PROCEDURE TURN AT (altitude) - **2**

Click on the Approach type described in this scenario:
You have issued a clearance to Fed Ex 20 which authorizes the pilot to conduct flight at any altitude from the minimum IFR altitude up to and including the altitude specified in the clearance. It also allows the pilot to make an approach to the destination airport.
FAA Order 7110.65 (4-8)
Contact Approach
Visual Approach
Cruise clearance

Weather is VFR. N2323P reports the destination airport in sight. ATC may initiate this type of approach. *FAA Order 7110.65 (4-8)*
Contact Approach
Visual Approach
Cruise Clearance

King Air 9572C does not have the destination airport in sight; however, it is able to maintain one mile visibility and remain clear of clouds. The pilot may request this type of approach. *FAA Order 7110.65 (4-8)*
Contact Approach
Visual Approach
Cruise Clearance

Click a label and move it to the correct altitude indication.
FAA Order 7110.65 (4-5)
Recommended Altitude
2000

Mandatory Altitude
_____
2000

Minimum Altitude
2000

Maximum Altitude
_____
2000

What is the minimum safe altitude in the southern sectors?
3600

Question 10
What is the height of the highest obstruction within 10 miles of the VOR?
1429

What type of altitude is shown for the procedure turn?
Minimum
Mandatory
Maximum
Recommended

What is the distance from the final approach fix to the missed approach point?
4

What is the minimum descent altitude for a category "D" aircraft executing a circling approach?
1300

What is the field elevation?
677

Exercise Summary

This completes our examination of courses, and fulfills our obligation to examine courses and determine the current course development protocols. The courses examined are indicative of the varied types of CDG and course development protocols.

OBJECTIVE 2: LMS FUNCTIONALITY

To quote the grant proposal, "The FAA faces a dilemma. Apparently, the current eLearning Management System (Blackboard 9.1) used by the FAA is being underutilized. Reported as being a way to take online courses, Blackboard can be used to standardize classroom-delivered course as well." In fact, Blackboard 9.1 has the following features. To add to the experience, Blackboard offers Ally, Analytics, App, Collaborate, Instructor, Learn, Mass Notifications, Mobile Learning, Moodlerooms, Open Content, and Transact for Government.

Blackboard 9.1 Features

Supported Learning Types	**Activity Grading**
Asynchronous self-paced	Gradebook
Asynchronous instructor-led	Gradebook comments
Synchronous Virtual Classroom	Gradebook audit trail
Blended Learning	Multiple grading scales
	Manual Grading ("marking")
	Course History
User Roles	**Compliance Management**
Define roles	Soft/Hard Stop Due Dates
Role Assignment	Certification Expiration Management
System Permissions per role	Due Date Notification
Teams and Team hierarchies	Certificate expiration notifications
Course Creation	**Customization**
Built-in authoring tool	Mobile Learning Support
Changing course default settings	
Upload courses	**Mobile Learning Support**
Can reuse PPTs, PDFs, Videos	Online (Internet connected)
Consume online video content	Offline (disconnected Mobile app)
Tests engine	
Survey Engine	**Course Categories**
Assignments Engine	Create new categories
Course backup options	Assign courses to categories
Scheduling LIVE events	Manage Categories
Learning paths (curricula)	Priced categories (Bundle)
User Authentication	**Gamification**
Self-Registration	Blackboard does not seem to incorporate gamification into its capabilities, which could be a drawback.
Self-Registration w. Admin Confirm	
Manual Accounts	
Active Directory/LDAP Integration	
Custom User login page	

Certificate Management	User Enrollment
Unique certificate by course	Guest Access Settings
Unique certification by curriculum	Manual Enrollment
Predefined certification templates	Self-Enrollment
Manage certification templates	Self-enrollment (with PIN #)
Certification life-cycle	Survey enrollment (based on a response)
	Automated Enrollment (based on User data
	Attendance Tracking

User Accounts	Course Format
Browse list of users	Social format
Bulk user actions	Weekly format
Add a new user	Topics format
Custom/Mandatory User profile fields	Gamification
Upload users	LIVE Videoconferencing/Webinar
Archive users	LIVE Chat Option
	Course Discussion
	Learner Upload

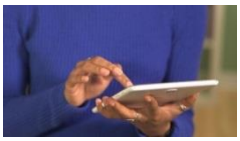
Reports	Interface Options
Grading report settings	Ready-made Themes
Training record maintenance	Block management
Exporting reports in variety of formats	Additional external pages
Canned reports	Location settings
Automated Report Scheduling	Calendar settings
Email delivery of reports	Language settings
	Multilanguage support

System Reports
Live logs
Email notification settings
Automatic email reports in predefined intervals
Custom reports generator

If bundled appropriately, the FAA training system can be transformed without needing to migrate to another LMS. Since 2012, Blackboard has made all the right changes, to make their product readily useful to the mobile consumer. There are many learning management systems, and the authors invite the reader to ask for the full review of LMSs. Twenty-one LMSs were compared along 106 possible features.

The following scenario was provided to AFS-500, as a means to illustrate how Aviation Safety Inspector training could be revitalized. The reader should be made aware that AFS-500 asked proposal writers to focus on five areas: (1) Adaptive Testing, (2) Course Development and Delivery, (3) Adaptive Content; (4) Managing Training Content, and (5) Transfer of Information.

The Aviation Safety Inspector at Anchorage, Alaska needs a refresher on her "deicing management and evaluation" competency. She picks up her Smart Tablet, goes to the "Competency App," finds the directory of competencies, and selects "deicing management and evaluation." The menu allows her to immediately take the end of course test, since, by record, she already had achieved competency. She makes a good score in most areas, except one. The prompt sends her to the module "environmental concerns when applying deicing at various temperatures." She quickly runs through the module, successfully answers the end-of-module questions and is awarded an updated competency for deicing management and evaluation. Before leaving the competency site, she selects, "Ask the Expert," and asks the expert her question. An immediate answer is posted to her, along with justification for the answer and other documents that would provide helpful advice about the subject of her question.



She leaves the competency site open on her table, as she goes to the flight line to monitor deicing operations. She points her tablet's camera at the deicing operation, captures the image, and with her finger, she draws an arrow at a point of interest and writes a comment. She sends her picture and message.

In real time, every Aviation Safety Inspector, with the "deicing management and evaluation" competency, can access Ms. Manchester's picture and message through the "Competency App." A text prompt was also sent in real time, which directed all ASIs with deicing competency to review new information on the App. Scrubbed of her identity/location, Ms. Manchester's weak area on her test shows up as a trend item for all other ASIs with the same competency to see. They also see the question she posed to "The Expert."

Meanwhile, an FAA Academy training manager on travel to Atlanta, Georgia, sees a prompt on his Smart Phone, signifying that Clara Manchester refreshed her "deicing management and evaluation" competency. He pulls up the "Competency App," and accesses "deicing management and evaluation." He notices Clara Manchester's name with a link attached. He accesses all the Connect Learning Analytics in the Learning Management System for Clara Manchester's competency refresher. He sees that Ms. Manchester took the competency test, failed in one area, accessed the corrective action module, spent 20 minutes reviewing the module before testing, retook the test on that area, achieved 100%, and was notified that she was now fully competent to manage and evaluate deicing operations. He also sees the question to "The Expert," and the reply. Using his "Competency App," he accesses a special area for Training Managers, and see a map that shows all those with the deicing competency. They show up as dots. When the dots turn blue, it means that all those people have received Ms. Manchester's picture and message, as well as trend data on test outcomes in their competency area.

All of these things features, except for the Competency App that must be developed by an FAA-industry-university working group, are available now. However, to be adaptive and distributive, you must have the right programming in the background.

The following LMSs were compared across 106 possible features.

Blackboard 9.1/Ultra
Bridge
SAP SuccessFactors

SABA
Adobe Captivate Prime
Docebo
TalentLMS

ExpertusONE LMS
Administrate LMS
PROPEL Enterprise * Distribute
LearnUpon LMS
WiZDOM Enterprise
GnosisConnect
Agylia

Absorb LMS (Open Source)
Eliademy (Open Source)
Forma LMS (Open Source)

Opigno (Open Source)
NEO LMS
The Academy LMS

These LMSs were **not** compared by cost. There were many that would do the same job as what Blackboard does. The future of learning will most likely incorporate gaming. Blackboard does not appear to support gamification. However, **Absorb** has all the features that Blackboard has, except it's ready for gamification. If gaming is not an important element in training, then Blackboard might be sufficient. Other LMSs that support Gamification are:

- Adobe Captivate Prime
- Docebo
- TalentLMS
- The Academy LMS
- ExpertusONE LMS
- LearnUpon LMS
- WiZDOM Enterprise
- Agylia
- NEO LMS
- Opigno

Typically, if an LMS offers Gamification, then it has all the other important features as well. Another important feature for an LMS is **Course Creation**. LMSs that have their own **built-in authoring tool**, are perhaps more helpful than those without it. LMSs that have a **built-in authoring tool** are:

- Blackboard
- Bridge
- SAP SuccessFactors
- TalentLMS
- The Academy LMS
- PROPEL Enterprise + Distribute
- NEO LMS
- Eliademy
- Opigno

Under the major feature heading **Course Creation**, there are some other features that the FAA will find very useful. Here are some of those features:

- Changing course default settings
- Upload courses
- Can reuse PPTs, PDFs, Videos
- Consume online video content
- Tests engine
- Survey engine
- Assignments engine
- Course backup options
- Scheduling LIVE events
- Learning paths (curricula)

In light of work being done to transform Aviation Safety Inspector training, the category Compliance Management, with its features would be very helpful to track user compliance. Here are some of the features within this category.

- Soft/Hard stop due dates
- Certification expiration management
- Due date notification
- Certificate expiration notifications

After chatting with Dr. Robert Dionne, he said that the Tech Ops folks at the FAA Academy were content with their system. After they certify a person as competent to perform at job task, they do not have to refresh their training (personal communication, August 1, 2017, Todd Hubbard and Dr. Dionne). However, as is true with pilot competencies, critical competencies have an expiration date. Air traffic controllers also take recurrent training in various areas where knowledge, skills, and abilities are critical to flight safety. With a good Compliance Management System, training managers at all levels can be assured that their workforce are current on all tasks in all competencies.

Most of the more up-to-date LMSs support the mobile learning environment. A mobile learning environment allows participants to use an array of Smart devices (mobile telephones, tablets, laptops, desktops) and also allow the user to switch between and among these devices. Cloud technology is most likely the key to a better mobile experience. Of all the LMSs examined, all have online (internet connected) mobile capability. The better LMSs also support offline (disconnected mobile app). These are:

Blackboard
Bridge
Adobe Captivate Prime
TalentLMS
The Academy LMS
ExpertusONE LMS
Agylia
Absorb LMS

Our recommendation is to select an LMS that supports both the online (Internet connected) and offline (app-driven) capabilities. If the FAA wants to control training, no matter when or where it is given, then these offline applications will prove to be beneficial. In addition, these offline apps have the ability of keeping everyone within the same competency connected.

OBJECTIVES 3-5: ARCHITECTURE OF MOBILE LEARNING

Gagnon (2010) provided four key takeaways in his article, Mobile Learning Environments. The reader is cautioned that information within Gagnon's work understates the present state of mobile learning environments, but one must start somewhere, and we start with Gagnon. These key takeaways are:

- With one billion devices expected to have mobile broadband Internet connections, the impact of mobile communication cannot be underestimated.
- With this growth in mobile devices, it seems appropriate to ask what completely new things might be afforded by mobile media for learning.
- The discussion of learning environments and mobile media grants educators an opportunity to adopt methods of situated, contextual, just-in-time, participatory, and personalized learning.
- Theory aside, it seems common sense that instruction should be performed in the most authentic context possible to practice and demonstrate useful learning, which mobile learning environments can facilitate.

Gagnon (2010) also helps us understand how far we have come in our understanding of mobile communication. Here are some characteristics of communication that compare FM Radio with Mobile Phones.

Characteristics	FM Radio	Mobile Phone
Network model	**Centralized**	**Peer-to-Peer**
Content customization	**Uniform**	**Personalized to context**
Information distribution	**Just-in-case**	**Just-in-time**
Role of audience	**Consumer**	**Equal participant**
Reliability qualifier	**Authority**	**Social capital**
Governance	**Institutional**	**Relational**

In light of NextGen requirements for training, this table makes the case for mobile learning environments more succinct. All effective learning environments in higher education, and in government training as well, will need to have the communication features of peer-to-peer, personalized context, just-in-time, equal participation, social capital, and relational interaction.

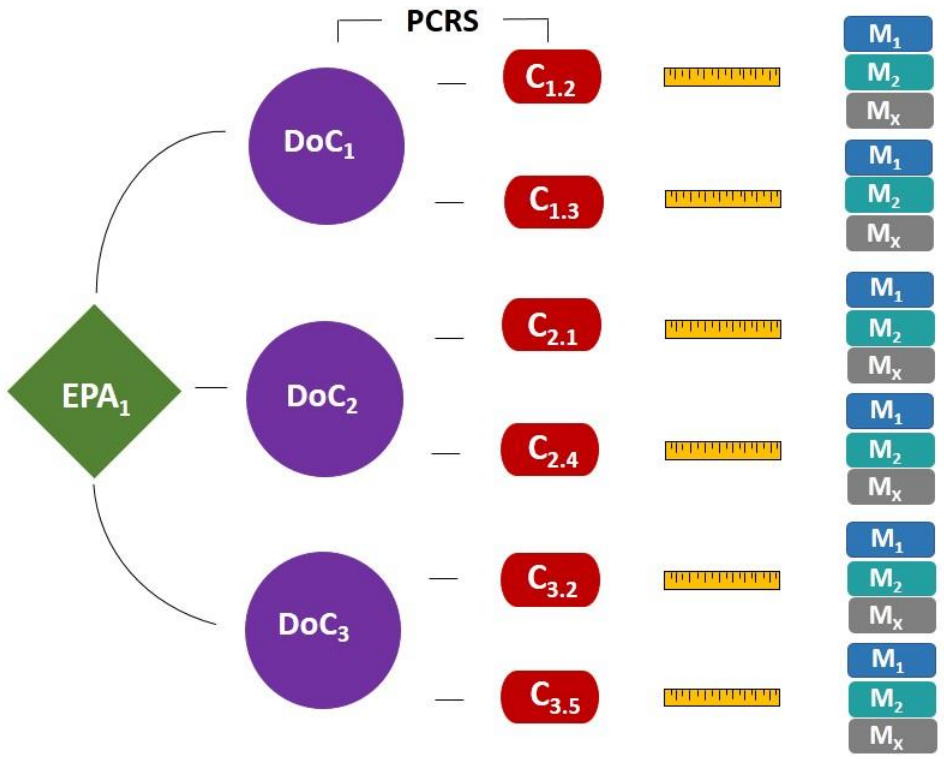
Sølvberg and Rismark (2012) explained mobile learning (m-learning) with these descriptors. "Within the m-learning field, such terms as mobile, spontaneous, intimate, situated, connected, informal, realistic situation and collaboration are used to characterize these learning environments" (p. 24). They went on to say, "Mobile learning also envisions learners who are continually on the move and learn across space and time" (p. 24). Because we tend to be more mobile these days, our communication devices must keep pace. Mobile phones are only one device that keeps us connected. But what about the place where we communicate? In years to come, the traditional classroom will be an archaic notion. With offline apps, students can access their mobile learning environment at the train station, in the taxi, on the airplane, and in the coffee shop. And the learning made available in these locations is just as meaningful as if participating in person in the classroom. And in some ways, participating asynchronously is less threatening to students who find it difficult to express themselves face-to-face.

If the FAA desires to stay relevant in their educational experiences, they will need to take steps to embrace mobile learning. "Mobile learning technologies offer teachers and students a more flexible approach to learning" (Wylie, 2017). "In 2001, Marc Prensky warned us, 'Our students have changed radically. Today's students are no longer the people our educational system was designed to teach" (Wylie, 2017). Students are not viewed as "digital natives." In the college classroom, if the instructor asks the students for the definition of a term written on the whiteboard, no one has to guess at what the term means. In this author's classroom, if a new term is shared, I say, "In 15 seconds you can be brilliant. All you need to do is pick up the Smart device in front of you and do a keyword search and start reading. You don't even have to know what you're saying to sound brilliant."

There is a reluctance of many Millennials to initiate their own learning. They will chat, text, post on Facebook, talk to friends on Face-Time, send a Tweet, or send a SnapChat post, but they do not see their devices as a means to explore in an educational sense. However, regardless of the challenges, it is important to help students of all kinds realize the power of the devices they carry.

COMPETENCY-BASED LEARNING

Englander, Cameron, Addams, Bull, and Jacobs (2015) illustrated the relationships between Entrustable Professional Activities (EPAs), Domains of Competence (DoC), Competencies (C), and Milestones (M). The following figure shows these relationships.



Their illustration is absolutely vital for those who desire to translate course objectives into meaningful competencies. As one can see, competencies are never disconnected from their Entrustable Professional Activities, but what is intriguing here, is the connection between EPAs and Domains of Competence. This suggests that single competencies are connected to domains, which then provide the proper connection between professional activities and the accomplishment of daily tasks. The milestones help us measure learning until a competency is achieved. And then this competency is reinforced by connecting it with its domain. For example, Deicing is a Doman of Competency. There are many sub-competencies in the work of deicing, both as practitioner and as manager/evaluator. If the manager/evaluator sees that the participant is not performing as he or she should, that awareness is derived from an understanding of the Professional Activity and the Domain of Competency.

As the FAA works toward transforming objective-based learning into an alternative of both objectives and competencies, they will need to harness their work to a workable process. This process by Englander et al. (2015) is that workable process.

In Objective 3, we were to create a modified ISD protocol that use Design Research methods. The methods we have chosen can best be supported through a nimble, mobile learning environment. Some of the better research designs incorporate the imagination of the participant. And indeed, some of the more recent instructional designs have solicited the help of the participant in an unscripted way. In other words, no one can forecast what might happen. This is a foreign idea to the FAA, mostly because training is tied to regulatory requirements and a higher degree of care for the flying public. However, when we examine how gaming might be used in the classroom, we must be less restrictive in how the learner gets to the educational destination.

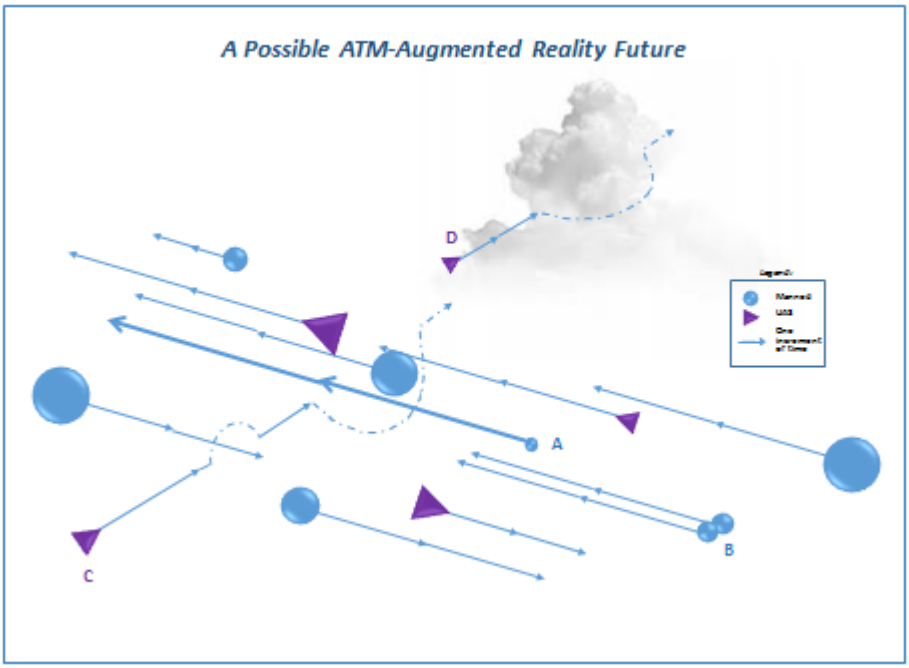
In Objective 4, we were to develop a modified ISD protocol that uses Design Research. This, we must complete in Phase 2, or possibly in the time remaining in Phase 1. More needs to be known about the FAA's existing LMS (Blackboard 9.1). We have been corresponding with David Palmer from Blackboard, and we are continuing to chat via teleconferences. Once we have a better idea of where the FAA is at present, we can provide better recommendations for where to go from here.

In Objective 5, we were to create a process that all developers could use to develop courses using Design Research. The process we have chosen at present is closely aligned with Table 1 from SOU DEC (2009). But we also liked what McGee and Reis (2012) were doing at the University of Texas at San Antonio. Certainly, blended learning is part of the mobile environment. In Phase 2, we feel we can flesh this out better.

CONCLUSION AND RECOMMENDATIONS FOR FURTHER STUDY

We started with best practices, because we wanted the FAA to understand where others are in their development of new ways to educate students of all kinds. It should be quite clear now that Smart device technology is driving how educators educate their students. And, the student that is going through air traffic controller training or tech ops training these days is a much different kind of student than the one of 20 years ago. Expectations are higher, and available of knowledge is more accessible.

Matt Vance, the Co-PI for the project, helps us to visualize what the future might hold for air traffic control and for tech ops. The following illustration, created by Dr. Vance, with its explanation, will help the reader understand some of the challenges facing course designers in the NextGen environment.



This figure shows a schematic of a possible airspace of the future with a diversity of air vehicles sharing the airspace in a free navigational flow. In this depiction of the future, the air vehicles must be capable of self-separation and trajectory de-confliction with each other and obstacles. For simplicity, the graphic suggests a predominately bi-directional flow of opposing traffic with a significantly reduced volume of orthogonal, crossing flow.

The future system, however, must be able to simultaneously accommodate any air vehicle direction and velocity. Augmented reality could enable humans in an Air Traffic Management future to immerse themselves in real-time airspace conflicts and assist in the redirection of air vehicles to avoid each other and obstructions, man-made and natural, such as structures, airspace restrictions, and severe weather. The future airspace must be equitably shared by a diversity of manned and unmanned air vehicles differentiated in size and speed but significantly not in capability. To facilitate safe self-separation, each must communicate their precise location and trajectory intent, have the same ability to sense a conflict with other air traffic network participants and obstructions, as well as compute and execute de-confliction actions.

The spheres represent manned aircraft and the triangles represent UAS. The size of the sphere or triangle connotes the air vehicle's mass. Each air vehicle communicates their trajectory in equal time increments, represented by the dissimilar length arrows projecting ahead of the air vehicles. A minimum of two, equal-time increments are shown by two, collinear arrows for each air vehicle. The direction of the arrows shows intended travel while the magnitude of the arrows shows speed. Note there are differing size manned and unmanned air vehicles with different velocities sharing the airspace. In the center of the figure, immersed in the bi-directional/opposing flow among numerous manned and unmanned air vehicles traveling at similar rates of speed, is a small manned aircraft (A) traveling at a high rate of speed, shown by the thicker, longer time increment arrows. A slower, manned, formation flight is following behind and slightly to the left (B). The UAS in the lower left crossing flow (C) is shown de-conflicting its trajectory/yielding the right-of-way to the manned air vehicles obstructing its path. The UAS in the upper center of the figure (D) is shown

circumnavigating threatening weather. All network participants must be able to autonomously execute the same, predictable de-confliction actions.

This report clearly explained how that course design and development for future courses will be decidedly different from course development at present. While it is important that training is supported by an adequate learning management system, it will become even more important in the future that we make better decisions about those systems, and that we fully use the capabilities of those systems, rather than use only a portion of them.

Recommendations for further research

The investigators of this project believe that we have arrived at the end of what we promised for Phase 1 in Course Development. Although more work can be done before the end of September, particularly in looking at more courses to determine needs, as we anticipate Phase 2, we will be looking at actually using what we have learned in this Phase to create Prototypes. We also look forward to collaborating with other groups, so that the FAA has the best product, and not just individual efforts. It has been our privilege to serve the FAA as we have.

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