IMPLEMENTATION OF AVIATION INDUSTRY COMPUTER BASED TRAINING (CBT) GUIDELINES INTO NAVAL AVIATION MAINTENANCE CBT

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ABSTRACT

The integration of Computer Based Training (CBT) products, Commercial-Off-the-Shelf (COTS) software products, and training software applications, such as the Aviation Maintenance Training Continuum System Software Module (ASM), into a completely operational training system is complicated enough without the additional burden of having to integrate a unique Computer Managed Instruction (CMI) tool for each CBT product. When CMI tools work only with particular authoring systems, and CBT products are developed on multiple authoring systems, the task of integrating training system components becomes more complex. In addition, the role of system configuration management is intensified by the need to keep track of which CBT product will run with which CMI tool. To address this problem, the Aviation Industry CBT Committee (AICC) developed CMI and CBT "Guidelines and Recommendations" to promote the interoperability of CMI systems. In this context, interoperability means the ability of a given CMI system to manage CBT lessons from different origins and the ability for a given CBT lesson to exchange data with different CMI systems.

In the case of the Aviation Maintenance Training Continuum System (AMTCS) Program, over a period of eight years, multiple courseware vendors will be developing CBT for various aircraft platforms. Portability of courseware between training devices, maintenance of courseware, and collection and management of training data are some of the issues faced by the AMTCS Program. To alleviate these problems the Naval Aviation Maintenance Training community adopted the AICC guidelines for CMI and CBT products developed and deployed by the AMTCS Program. CBT products developed for the AMTCS Program are required to be compliant with AICC guidelines. CMI products used in AMTCS Training Devices (ATDs) also require compliance. This policy has allowed seamless integration of courseware with CMI into ATDs. The process of implementing AICC guidelines into the AMTCS Program occurred in four stages: Definition of Requirements, Implementation of Requirements, Verification of Compliance, and Formal Integration into ATDs. This paper describes the events involved in each stage of initial implementation of the guidelines. This paper also presents lessons learned along the implementation highway and perspectives on a broader implementation of AICC guidelines in the future of the AMTCS Program.

ABOUT THE AUTHORS

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Mr. Jack Hyde has been working in Flight and Maintenance Training for almost 30 years. Mr. Hyde started as a classroom instructor and training developer in Boeing Flight Training. In 1977, he designed and implemented his first CBT lesson using the PLATO system. Later he became involved in several large custom CBT projects for Boeing. Mr. Hyde currently works for FlightSafetyBoeing as Senior Learning Technology Analyst. He is also serving as the chairman of both the AICC and IEEE CMI subcommittees.

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BACKGROUND

In 1994, Chief of Naval Operations and Naval Air Systems Command launched the Computer Based Training Systems Initiative (CBTSI) to establish a centralized and integrated infrastructure to support effective and efficient, acquisition and management of Computer Based Training (CBT) assets for aviation aircrew and maintenance personnel. This initiative provided the momentum to establish the Aviation Maintenance Training Continuum System (AMTCS) Program. The primary objectives of the AMTCS Program are to increase training effectiveness and to enhance the overall quality of Naval Aviation Maintenance training using computer based training technology. The AMTCS Program provides computer based training systems and training management tools to support technical training in the schoolhouse and in the fleet. AMTCS training tools include the AMTCS Software Module (ASM), Interactive Courseware (ICW), Computer Aided Instruction (CAI), and Computer Managed Instruction (CMI).

THE CHALLENGE

The AMTCS Program launched its CBT development efforts in 1996. When the program was launched, AMTCS Program leaders anticipated the need to balance standardization in the program with the flexibility to benefit from increasing capabilities of Commercial-Off-the-Shelf (COTS) CBT technology. Considering the program plan provided for development and deployment of CBT over an eight-year period, issues of interoperability, portability, and maintainability of courseware were of significant interest to the program. In addition, AMTCS requirements included the ability to collect training management information, such as courseware usage data, in a standard format for subsequent processing and analysis. Program leaders identified the following goals for interoperability between CBT and CMI systems.

- Each CBT product must be easily launched from a variety of available CMI systems, regardless of the authoring system used to develop the CBT.
- Each CBT product must be capable of exchanging training management data with a variety of available CMI systems.
- Each CMI system must be capable of exchanging training management data with a variety of CBT products regardless of the authoring systems used to develop the CBT.

These goals intentionally focus on the issue of CMI-CBT interoperability; however, they also relate to portability and maintainability goals of the program. The challenge to Program leaders was to identify and execute CMI and CBT standards in the AMTCS Program to achieve these goals.

THE SOLUTION

Knowing that various CBT development efforts were occurring outside the AMTCS Program, an analysis was conducted to determine how government and industry organizations were handling interoperability issues. The analysis revealed two very common scenarios. In the first scenario, an organization was committed to a specific vendor's authoring tool and the same vendor's own CMI package. In this situation, the CMI developed by vendor X would only communicate with CBT developed using the vendor X authoring tool; and vice versa, CBT developed with the vendor X authoring tool would only communicate with the vendor X CMI. In the second scenario, an organization developed their own custom CMI and created unique interfaces to CBT to collect desired data. This approach provided the organization with the ability to ensure CMI and CBT were interoperable; however, it required significant effort to maintain unique systems as CMI and CBT requirements evolved. During our investigation into the aviation industry approach to CMI and CBT interoperability we discovered a concerted effort by the Aviation Industry

Computer Based Training Committee (AICC) to address these issues directly and provide a means for escaping the paradigm of stovepipe CMI and CBT systems. The AICC had published and released CMI and CBT standards for interoperability, developed test procedures to check compliance and established a certification program to verify compliance. Seeing that the AICC was a mature standards group for the aviation community with CMI and CBT interoperability goals shared by the AMTCS Program, and after reviewing their CMI and CBT standards document, Program leaders chose to adopt the AICC standard for the AMTCS Program.

AICC ORGANIZATION BACKGROUND

The AICC was founded in 1988. It is designed to address problems in the aviation industry related to Technology-Based Learning. However, the reality is that these problems are not limited to commercial aviation. The problems are universal, and many of the solutions are as well.

The committee includes members from all over the world, although most are from North America and Europe. Membership includes:

- Airplane and airplane equipment manufacturers,
- Airlines,
- Professional CBT developers,
- CBT development toolmakers,
- Government agencies,
- Educational institutions, and some
- Military organizations.

AICC INTEROPERABILITY OBJECTIVES

One of the problem areas that has been addressed by the AICC is in the arena of learning object interoperability, or Learning Management System (LMS) flexibility. The goals of the AICC were to enable learning objects to be mixed and matched in building a course, to allow courses to be moved from one management system to another, and to enable easy analysis of complex student data available from the learning objects. These goals were too comprehensive to be met with the resources of the AICC, so a subset of objectives was developed from these goals. The objectives were:

- To allow a LMS to launch and terminate lessons. Of all the learning objects that may be defined, a lesson is one of the most commonly used. If the goal of allowing lessons to be reassembled into different courses is to be achieved, lessons must be able to launch and terminate under the control of a variety of LMSs.

- To allow LMS/learning object communication. Launch and termination must be accompanied by communication. To have a seamless integration of lessons in a new course there needs to be a persistence of data from one lesson to another and from one usage to the next for a single lesson. The LMS needs to have the ability to determine the learning outcomes of all the lessons under its care; and the lessons themselves need to know something about the student using them. These needs all became communication objectives of the AICC initiative.

- To enable course interchange. The AICC also recognized that not everyone in the world, or even in the aviation industry, would want to use the same Learning Management System. Therefore, it should be easy to move sets of lessons that have been organized into a course from one LMS to another. The interchange of courses became another objective.

- To standardize student performance data. Finally, there was a desire to see extensive and somewhat complex student performance data in a format that could be seen, analyzed, and compiled by a single tool. When you have the ability to mix and match lessons from many different sources, you run the risk of many different forms of student data in many different formats. Attempting to compile detailed student performance records through several lessons in a course can become a nightmare. Having to design a hundred different tools to analyze student data from each of a hundred different lessons is not a desirable outcome of creating courses from disparate sources. So the last objective was to allow the creation of a single set of tools for student data tracking and analysis.

CMI AND CBT INTEROPERABILITY GUIDELINES

To meet the objectives of interchange and interoperability of learning resources, the AICC created a guideline called “CMI Guidelines for Interoperability”. The guidelines do not attempt to standardize all the functionality of a Learning

Management System. They address only a small subset of functions, and only those that relate to interoperability hence, the name CMI instead of LMS.

The guidelines focus on four areas:

- Launch and termination
- Communication
- Course structure interchange
- Student data

Launch and Termination

This is perhaps the simplest, but at the same time most important guideline. By defining how the LMS (or CMI) launches lessons and learns of their completion, lesson mixing and matching becomes possible; and all of the additional objectives become attainable.

Communication

The AICC guidelines define the content and format of the communication between lessons and a CMI system. The content however, is extensible. Additional data can be communicated; however, there is a core of data that supports basic functionality that is carefully defined in the specification. Additionally, the extensions need to follow the same format conventions. This guarantees that lessons can not only be launched but can run well getting needed information about the student entering the lesson.

Course Structure Interchange

In order to move courses from one LMS to another, you need to have a standardized description of the course. This is what the guidelines provide. Format and content guidelines were designed to describe each lesson in the course, to describe the relationship of these lessons (that is the structure of the course), and to describe sequencing the lessons for the learner.

Student Data

The CMI guidelines provide a standard way for describing and storing a broad range of student activities. A standard format is set for these student interactions, so tools can be designed to import the data from any lesson following the guidelines.

IMPLEMENTATION OF AICC CMI GUIDELINES

AMTCS training tools are integrated with COTS software and hardware components and delivered in the form of Electronic Classrooms (ECRs) and Learning Resource Centers (LRCs) for formal schoolhouse training, and Fleet Training Devices (FTDs) for in-service training. Training device development follows a typical development cycle of requirements definition, design, build, test, deploy and support. Implementation of AICC CMI guidelines followed a similar path with requirements definition, implementation of requirements, verification of compliance, and formal integration into AMTCS Training Devices (ATDs). The following paragraphs describe the events that occurred during each stage of the implementation process.

Requirements Definition

Once the AMTCS Program had adopted the AICC guidelines, AICC CMI and CBT requirements were incorporated into AMTCS requirement documents. The ATD System Specification describes functional, physical, and performance requirements for ECRs, LRCs and FTDs. Language to articulate CMI requirements was placed in the ATD System Specification. The language states that CMI software shall provide the capability to develop course structures, provide roster operations, and administer testing. The ATD System Specification specifically states that CMI software shall comply with the AICC CMI guidelines. Similar language was placed into contracts to develop CBT courseware, informing developers of the requirement to design ICW to integrate with an AICC compliant CMI tool.

Implementation of Requirements

The AICC CMI guidelines describe core and optional parameters for CMI-CBT launch and communication. For the initial implementation of the AICC guidelines only the core fields were required of CBT and CMI. In our initial implementation of the guidelines, we found that courseware developers often required assistance with interpreting how to apply the guidelines. During this time, the AICC CMI Subcommittee was very helpful with providing assistance on the interpretation of the CMI guideline. Earlier versions of the guideline left more to interpretation however, newer releases more clearly define CMI-CBT interoperability requirements. COTS and Government-Off-the-Shelf (GOTS) products were researched and evaluated for

their ability to satisfy AICC CMI guidelines. Since only one product on the market had achieved AICC CMI certification, this product was used to verify CBT compliance with AICC CMI-CBT launch and communication requirements. Once the AICC certified CMI tool was provided to the CBT developer, the developer was generally able to proceed without further assistance.

Compliance Verification

CBT was tested with the AICC certified CMI to verify AICC compliance. Testing involved the following checks and verifications:

- Verify each lesson can be launched from CMI.
- Verify student course completion data is transferred between CBT and CMI.
- Verify student bookmark data is transferred between CBT and CMI.

Testing was limited to these checks as only the core data communication requirements were implemented in CBT. In initial courseware deliveries, a few lessons failed the tests when they could not be launched from CMI. These failures were later found to be the result of minor oversights such as missing files and incorrect addressing, and not indicative of a larger technical problem.

Formal Integration

Formal integration involves verifying that CBT and CMI work together on the intended hardware platform with the other software tools residing on the system. On ATDs, the AMTCS Software Module (ASM) is used to launch CMI, which in turn launches CBT. Essentially, ASM provides CMI with the student and lesson identity then CMI launches the lesson and collects student data as it would normally. Students are able to complete training without having to exit ASM. When finished with the lesson, the student is returned to ASM. Formal integration verified a seamless interface between ASM and CMI in the proper operating environment.

LESSONS LEARNED

The following are lessons learned during the initial implementation of the AICC guidelines:

- Clearly state in requirements documents the level of AICC compliance that the CMI and courseware are expected to comply with. Also, specify core fields only or provide specifics on optional fields that CBT and CMI must be able to support.
- Provide developers with a copy of the CMI tool early on so they can perform their own CBT/CMI interoperability checks.
- Do not wait until the final CBT is delivered to test and verify AICC compliance. Test at appropriate intervals in the development of the CBT such as at the completion of a group of lessons.
- Verify that each lesson is compliant. Just because one lesson in a course works with CMI does not mean all of them will work.

FUTURE DIRECTIONS

Two facts evidence the success of the AICC guidelines. The first is that many software companies are building or have built Learning Management Systems adhering to the guidelines. Two CMI tool vendors have received AICC certification and several others are waiting for the AICC to begin certification of Web-based CMI tools. The second is that these guidelines are now moving through the IEEE standards process, which may lead to an ANSI, and perhaps even an ISO, version appearing as standards in the near future.

At a time when no other widely supported standards were available the AICC guidelines provided a much welcome resolution to CMI-CBT interoperability issues. The AICC guidelines provided a simple and effective means to satisfy the CMI-CBT interoperability goals of the AMTCS Program. As the AMTCS Program enters into the Web-based training arena, AICC guidelines will continue to provide a means for accomplishing interoperability goals.