A BLENDED APPROACH TO THE COMPLETE LIFECYCLE OF MAINTENANCE TRAINING

Keith Gladstone, Business Development;
Military Simulation & Training, CAE Inc., Montreal, Quebec, Canada
Keith.Gladstone@cae.com;

Tell me, I forget. Show me, I remember. Involve me, I understand. *Chinese proverb [4]*

Abstract. Maintenance personnel training is typically a mixture of instructor led courses, Computer Based Training (CBT), hardware training devices and on-the-job training. However, because of reduced training budgets, limited access to live equipment, and expensive hard trainers, this training methodology is increasingly failing to meet maintenance training requirements in a cost-effective way. With today's increased pace of operations, training organizations are faced with the challenge of responding rapidly to new training requirements. The current approaches have created a training gap that has become a critical issue with today's increased operational tempo. Promising new technology-based solutions can now provide a blended approach that involves both aircraft hardware, real and representative, and virtual training media that can be deployed within a distributed environment.

1. INTRODUCTION

The aerospace and defense industry's maintenance training paradigm has shifted significantly. The aircraft and weapon systems of today are more technologically complex, fiscal pressures on defense budgets are more acute than ever before, and high operational tempos are placing greater stress on airframes as well as maintenance personnel. These challenges, combined with high attrition rates and a smaller pool of skilled maintenance practitioners from which to draw, is forcing many maintenance organizations to revisit how they approach maintenance training. Some of the major influencing factors are as follows:

- Reduced maintenance experience levels due to maintainers' and subject matter experts' high attrition rates
- The need for standardized yet decentralized training capabilities
- A shift from fixed based to deployed operations
- Continuous training being displaced by operational needs
- The need for real-time diagnostic tools

Figure 1: Military Maintenance Challenge

To address this new paradigm, maintenance training programs must incorporate a varied spectrum of training methodologies, including instructor-led and student self-paced programs that complement each other to guarantee an enhanced level of quality while ensuring training standardization.

2. CANADIAN MAINTENANCE TRAINING – THE CHALLENGE

Many defence departments have a continuing requirement to train aircraft technicians in the repair and maintenance of a wide variety of military aircraft and subsystems. All of this has to be done within a context of diverse missions deployed worldwide under a variety of threat environments. Usually, these aircraft technicians receive their technician ab initio training at central training school.

Similar to many militaries after the end of the Cold War, the Canadian Department of National Defence (DND) experienced a significant reduction in force manning levels that resulted in reduced recruitment rates and a reduction in capacity of training institutions [1]. An Occupational Analysis (OA) completed in 2001 identified a number of shortcomings in Aircraft Technician training, including deficiencies in course content and in the ability of graduate apprentices to progress to the journeyman level in a reasonable timeframe [1]. The OA also highlighted a significant training burden at unit level attributed to the lack of sufficient practical training during the ab initio training. In addition, downsizing created a significant experience gap, which was exacerbated by an anticipated high attrition rate due to civilian industry demand for aircraft technicians and a large number of military personnel approaching the retirement window.

3. WHO IS THE CUSTOMER?

The question "*Who is the Customer?*" is a key one that must be answered correctly if success is to be achieved during training. Historically, maintenance training was based on a more classical approach that tended to be competitive in nature. The training curriculum included theory backed up by some media, such as films and slides, and relied heavily on hardware trainers with little real-time interaction. However, the students in today's classrooms learn in a different way. They tend to lean towards Just-In-Time (JIT) training. Furthermore, any solution must compete with the plethora of electronic gadgets for their attention. Therefore, for the training to be effective and efficient, this new learner has to be considered as the customer for the solution.

This is not to say that this generation, known in some circles as the Millienials [5], is not capable of learning. Quite the opposite is true. Every one can and does learn [2]. The difference is only in which approach works the best. As Scott Carlson points out in his article, The Next Generation Goes to College:

> *Born between roughly 1980 and 1994, the Millennials have already been pegged and defined by academics, trend spotters, and futurists: They are smart but impatient. They expect results immediately. They carry an arsenal of electronic devices -- the more portable the better. Raised amid a barrage of information, they are able to juggle a conversation on Instant Messenger, a Web-surfing session, and an iTunes playlist while reading Twelfth Night for homework. Whether or not they are absorbing the fine points of the play is a matter of debate. [5]*

For training to achieve its goals, it is important that it be applied in the context of this intended audience and that it adhere to the following fundamental principles *[4]*:

- Learning occurs in context. You need to understand the context of the subject being taught.
- Learning is active. Learning involves more than listening. It needs to include participation.
- Learning is social. Learning in groups accelerates the learning process.
- Learning is reflective. Effective learning occurs when there is a real-time feedback loop.

4. FLEXIBITY IN DELIVERY

There are several approaches to hard skills training today, in addition to hands-on, live equipment training. Text-based and 2D multimedia, while relatively cost-effective, offer limited learning effectiveness when applied to maintenance training, where "hands-on" proficiency is an essential requirement. Hardware-based trainers provide students with the necessary hands-on ability to practice procedures and troubleshooting; however, they are expensive and difficult to create, update, and maintain. As well, hardware trainers are usualy only available within a school and cannot easily be used in a distributed learning environment or in the field. Consequently, the current approaches have created a training gap that has become a critical issue for many military forces.

Figure 2: Training Gap

This training gap can now be addressed by combining the capabilities of high fidelity distributed simulation-based maintenance training with interactive 3D virtual equipment. These capabilities can deliver a comprehensive end-to-end blended maintenance training solution that provides virtual synthetic training equipment and system maintenance trainers for familiarization, procedural, troubleshooting and maintenance repair and overhaul training in a cost effective, deployable package. When blended with innovative hardware trainers and simulation based courseware, the turnkey package provides a dynamic and effective solution to today's maintenance training challenges.

As dictated by organizations such as Canada's DND, training content needs to be reusable, distributable, and adaptable, and encompass different delivery mechanisms, described as follows:

- **Self-Paced Training**. This is typically delivered in a distributed learning environment via the internet or a network. Student performance is often monitored, with the results being integrated with a Learning Content Management System.
- **Instructor-Led Training**. The focus is typically on learning by watching and doing using simulation based training or hard trainers. A collaborative environment (i.e., virtual classroom) can support instructor led distance learning.
- **Free-Play Training**. With interactive training enablers, free play can allow personnel to explore the various aspects of system in an unstructured manner based on interest, thus enhancing student engagement. When augmented by Self-Pace and Instructor Led training, it can be an effective training approach.

5. PROTOTYPE MAINTENANCE TRAINING MODULE (MTM) – CASE STUDY

5.1 Problem Definition

To address the current challenges associated with the conduct of air maintenance training within the Canadian Air Force, the Canadian DND decided to commission the development of a prototype MTM for an element of training that could not be executed at the ab initio training center due to the unavailability of effective training aids. Furthermore, they had an interest in ensuring that it was capable of supporting the entire Air Force training system. This meant that it would not only encompass ab initio and Technical Training Establishments, but would also be accessible to Weapon System Managers, Wings and Squadrons, so that a user is never far from the knowledge they need to perform their job tasks.

The intent of the project was to make the training tool available to the ab initio student as well as others throughout the organization who may make use of this capability for reasons that extend beyond training. For this to work, the information would need to be not only modular but also accessible from a central repository via a distributed network. This knowledge base would consist of first hand information, animations, technical orders, publications, a collaborative environment, and be focused on achieving interoperability, reusability, and commonality in training and simulation.

5.2 Objective

The objective of producing the MTM was to use the Federation Development and Execution Process (FEDEP) as a methodology to be used in defining and implementing the learning environment, in which an air technician student could successfully achieve a training course enabling objective (EO).

Figure 3: C130 Propeller System

The platform chosen to illustrate the required propeller system components and functionality was the C130H Hercules aircraft.

5.3 MTM Design

The resulting MTM consisted of various components that would allow the conduct of training using three different learning methods: student self-paced instruction, instructor led instruction and student practice (free-play). The intent was to provide the student with the ability to prepare for the lecture, be guided through the learning material, practice the essential elements and be tested to confirm the degree of understanding. As indicated in Figure 4, these levels were related to each other with the first, Free-Play, forming the building block for the next two.

The design was based on the concept that the core elements would nominally be available from a central repository from which the instructors could draw for use in the lesson.

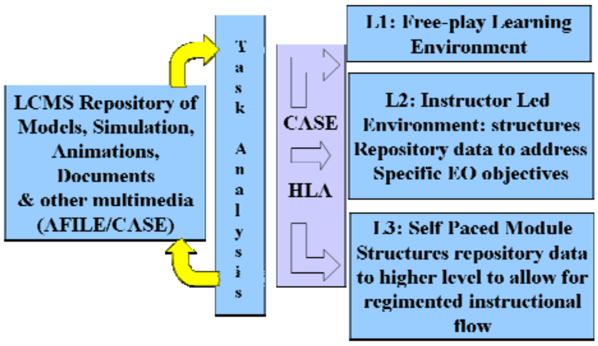

Figure 4: MTM Design Concept

This repository, although not implemented as part of the MTM development, would consist of text, animations, 3D models, simulations and video. Based on the task analysis for that prospective EO, the selected items would then be imported into the lesson utilizing the HLA based Canadian Advanced Synthetic Environment (CASE), a network that is designed to include the infrastructure and management system to enable modelling and simulation resources to be used for CD&E, R&D, Requirements Definition, OT&E, Mission Rehearsal, and Training within DND.

5.4 MTM Training Enablers

For the purposes of this specific module, the following training enablers were included in the MTM design.

- Original course curriculum instructional material from CFSATE that included text descriptions, diagrams, video, and photos;
- NGRAIN-based high fidelity, interactive, 3D virtual models of equipment sub-systems and assemblies to provide part and component familiarization, and to learn and practice installation, inspection, assembly, disassembly, repair, and overhaul procedures;

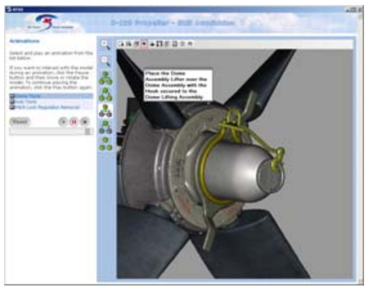

Figure 5: NGRAIN 3D Interactive Model

- CAE Simfinity's Virtual Maintenance Trainer (VMT) that leverages FAA Level D full fidelity simulation software to provide a "virtual aircraft" for training context, familiarization, procedural and troubleshooting training.

- CAE Virtual Maintenance Trainer (VMT)

5.5 MTM Course Elements

The objective was to use the course elements in the following order, in conjunction with any available hardware trainers, to achieve the objectives of the EO:

- Pre-Course Study using the Self-Paced Content;
- Confirmation of understanding through an exam after the conduct of the Self-Paced Content;
- Actual course instruction using instructor led material, which was a combination of the various electronic media co-displayed with the instructional text;
- The administering of an exam based on the course instruction;
- Synthetic environment structured content to familiarize the student with propeller removal sequence, and subsequently testing their knowledge of that sequence;
- The use of free-play content for use by both the instructor and students to further enhance the level of understanding of the course material; and,
- Lastly, the final confirmation of understanding by requiring the students to perform assigned tasks working the actual hardware.

6. MTM USER TRIAL

To confirm the validity of the approach, a user trial was conducted at CFSATE. This included actual technician students taught by a qualified instructor. Two separate test groups were used consisting of eight students each, all of whom had not yet had the benefit of formal maintenance training. The group studied the propeller module in three steps: self-paced CBT, instructor-led training, and a practice session. This was followed by a multimedia based multiple choice exam, identical in content to that used by the school, and a virtual practical exam. At the end of the training session, the students were given a questionnaire. The questionnaire and student exam results were the prime indicators of success for this trial. All students but one passed the theory exam with the average scores on the tests being 17% below those received by previously trained students. However, they all passed the virtual practical exam with an average of 94%. It is important to note that the previous students had more instruction on the subject matter, more study time and already had 12 months of prior maintenance training, while the test students had had no training prior to the trial. Therefore, the results clearly showed the benefit of using this approach to training. The questionnaire validated the heightened level of student interest and acceptance, which was evident during the trial.

> *"We need to increase our throughput in maintenance training. This trial showed that students can acquire training faster than using traditional methods."* LCol R. Thompson, Director Air Requirements 7, Canadian Air Force.

7. MTM NEXT STEP

Following delivery of the MTM and user trial, an evaluation involving the training community that will include elements from academia, industry and government. This evaluation will be led by the Society for the Advancement of Modelling and Simulation (www.advancingsimulation.org) and will give representatives of the industry, academia and government training community an opportunity to evaluate the MTM.

8. CONCLUSION

Most maintenance training organizations are faced with the growing need for highly trained individuals in an environment of increasingly technological complexity, reduced resources and a diminishing pool of expertise. To successfully address this challenge, training must also be addressed within the realities of the changing work environment and the attitudes and training aptitudes of a new generation. Training in general, and maintenance training in particular, must be designed to educate in an interactive, entertaining and effective manner. The MTM represents a significant step towards this objective.

REFERENCES

1. Canadian Department of National Defence, W875-05 ATTR/A RFI Air Technical training Renewal 2005-12-23.

2. On Purpose Associates, Funderstanding, Brain Based Learning http://www.funderstanding.com/brain_based_learning.cfm

3. Renate and Geoffrey Caine, Making Connections: Teaching and the Human Brain.; http://www.funderstanding.com/brain_based_learning.cfm

4. Driscoll, Marcy P., Source: ERIC Clearinghouse on Information and Technology Syracuse NY. , How People Learn (and What Technology Might Have To Do with It). ERIC Digest. http://www.ericdigests.org/2003-3/learn.htm

5. SCOTT CARLSON, The Net Generation Goes to College, The Chronicle of Higher Education, 7 October 2005 Issue, http://chronicle.com/free/v52/i07/07a03401.htm