THE CANADIAN FORCES EXPERIENCE IN PART-TASK TRAINING

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ABSTRACT

The Canadian Forces experience in the evolution of part-task training requirements is traced through a discussion of systems both in service and under development. These devices provide individualized training without tying up weapon system or full mission simulator resources. This is especially useful in multi-member crews where an intensive effort is required to train new crew members on specific functions. One example of such a system is the Acoustic Positional Trainer which is used to train sensor operators for the CP-140 Aurora anti-submarine warfare aircraft. New technology has recently been applied to this method of training to produce multi-purpose trainers which can be reconfigured to provide training for more than one system.

One application of this concept is the Tactical Procedures Trainer, a device which can be rapidly reconfigured into any one of several sub-systems to provide training for Aurora crew members on the various facets of anti-submarine warfare. Another developmental system is the Naval Tactical Display Emulator which grew out of a program to evaluate multi-purpose trainers for shipborne combat system operators using the latest display technology. The successes of this program and the Tactical Procedures Trainer have demonstrated the advantages of part-task training with low cost, multi-purpose, reconfigurable trainers. The paper concludes with lessons learned and the way ahead for part-task training in the Canadian Forces.

ABOUT THE AUTHOR

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INTRODUCTION

Canadian Forces Training System

Organization - Canadian Forces (CF) training is conducted via a systems approach and is performance oriented and intent on achieving maximum efficiency.

Doctrine - The aim of the Canadian Forces Individual Training System is "to produce for the CF, from the types of training under its control, the right number of people, with the right qualifications, at the right time and at minimum cost."[1]

Evolution of Training Requirements

Definition - The generation of new training requirements can occur either through the acquisition of a new mission vehicle or weapon system or through the update of an existing system. In either case, the Project Director is required to address the question of training equipment and simulation to minimize fleet maintenance and training costs.

Where new training requirements are defined, an analysis is conducted to determine the skills and knowledge needed for the performance of the various tasks by an operator. Performance objectives are derived and organized into a logical sequence for training. Enabling objectives are defined by further refining each performance objective in terms of related knowledge, skills or attitudes.

The list of performance and enabling objectives is then subjected to a media analysis to determine those most amenable to being addressed through training equipment. Part-task trainers which are devices designed to provide training on a specific part of a function (ie. a procedure) are often identified as a cost-effective training media.[2]

Implementation - The technical authority for training equipment in the CF resides with National Defence Headquarters. The acquisition, maintenance and life cycle management of all maritime and air training equipment is delegated to the Director Avionics, Simulators and Photography (DASP).

Once a particular item of training equipment is selected and approved by the operational community, the simulator section, DASP 4, becomes responsible for acquisition. The first step in this process is the generation of a specification for contractual purposes. This involves not only reference to the performance and enabling objectives but also discussion with the operators. This translation of operational requirements into a trainer which provides the right amount of detail and training impact is an iterative process.

Ultimately, a trainer is delivered. Once the operators begin using it, modifications and/or updates are usually inevitable by virtue of experience or changes to the system being simulated.

AIM

This paper's aim is to inform the reader of recent part-task trainer developments within the Canadian Forces.

DISCUSSION

History

Early Trainers - The development of early trainers concentrated on as faithful a duplication of the actual equipment as possible given the technology and training budgets available. A number of such trainers evolved in the sixties and seventies which were successful in providing part-task training in that they enabled individualized instruction without tying up weapon system or full mission simulator resources. The following examples illustrate some of the shortcomings of these early systems:

1) The Yukon Navigation Ground Trainer - The Yukon was a Long Range Transport Aircraft for the Canadian Forces until the late sixties. Given the dire consequences of possible navigational errors over the North Atlantic and/or the Arctic, a requirement was established for a facility in which the intricacies of trans-oceanic track crawling could be practised. The Navigation Ground Trainer was developed to satisfy this requirement.

   It was constructed out of a single sheet of plywood with the relevant navigation instruments installed in holes of appropriate sizes. The student sat in front of this device while the instructor sat behind. Inputs were "manual" as the controls consisted of appropriately designed cranks and knobs on the back of each instrument. Using these, the instructor would change the instrument reading thereby indicating "aircraft" progress to a different "location" which the student would then have to decipher based on the new indications.

   Updates were not frequent but if the instructor could be equated to a modern CPU, then it could be said that the "software" changed on every trip. Mission fidelity received a major boost one day when a can of surplus paint was found which allowed the plywood to be painted the same colour as the cockpit. Although effective for its time, the lack of flexibility meant that this device had to be discarded with the arrival of the new Boeing 707s - and computers which were smaller than gymnasiums.

2) The Junior MARS* Officer Trainer - This device was acquired circa 1980 for the purpose of providing an introduction to radar for junior naval officers. It is driven by DEC PDP 11/34 technology and provides generic procedural training in radar and voice. It consists of eight bridge mock-ups, each with a student radar display and helm position, and two instructor stations.

   As an introduction to radar, it is a successful trainer. However, it can serve no other training purpose and any upgrade to increase its capability would require complete redesign at great cost.

Limitations - A major limitation in early trainers was their design which was predominantly hardware based with very little flexibility in the computer technology used. If the actual equipment was updated, modifications to the corresponding trainer required major redesign and expense and, if the equipment was replaced, the trainer would also need to be replaced with one designed specifically for the new equipment. This would often be an expensive proposition which occasionally meant that no trainer was acquired because of a limited budget.

Another challenge, in the case of more complex systems, was the time taken to develop a trainer. The translation of training requirements into equipment capable of satisfying them is an arduous process subject to considerable interpretation, the pressure of austere budgets and many well-intentioned agencies trying to achieve their individual goals. The overall impact of these factors has often conspired to cause significant delays between requirement definition and trainer delivery.

The decision to use operational hardware or

*MARitime Surface

simulation in a trainer has also been heavily debated in the past because of the expense of actual hardware on the one hand and the challenges of simulating a complex system on the other.

The military is always interested in reducing training costs. In the past, the search for an adaptable, reliable and effective part-task trainer which would be capable of transcending the inescapable obsolescence typical of military systems has almost been analogous to the search for the Holy Grail. However, in the last few years, the CF has made some progress in this search.

Acoustic Positional Trainer

Background - In 1978, the Canadian Forces replaced the venerable Argus anti-submarine warfare aircraft with the CP-140 Aurora. This aircraft which represented the latest technology was a derivative of the US Navy P-3 Orion and the S-3 Viking. As the Forces acquired only 18 of these aircraft, it was recognized at the beginning of the project that a requirement existed for a sophisticated suite of training equipment which would include a Flight Deck Simulator for the pilots and an Operational Mission Simulator (OMS) for the crew.

While such equipment was a relatively new experience for the Forces, it did not take long to recognize the need for another trainer capable of providing more individualized attention and hands-on time for the various system operators, particularly in the esoteric art of acoustics. Thus was born the requirement for a part-task trainer to complement training received in the OMS and to make time spent in both the OMS and aircraft more productive.

In-service Experience - The Acoustic Positional Trainer (APT) was designed to provide training for the Acoustic Sensor Operator (ASO) with six training positions and an instructor station. A host computer simulates the actions of the Aurora's Acoustic Data Processor and the acoustic data which is used to feed the simulated processor is taped raw data received by acoustic sensors. It is also possible to use tapes produced by the OMS target generation facility. The trainer operates in real time and is successful in satisfying the requirements for which it was designed. Its main advantage outside of providing more individualized training and hands-on time is the high degree of fidelity that is possible since actual targets are used. These advantages have allowed achievement of an across the board increase in the standard of excellence in acoustic data analysis for the ASOs.

The major drawback of the system is, of course, its lack of an interactive capability where the student might be challenged with a reaction to a given tactic by the target. This means that no tactical evolutions are possible and, also, that flexibility is limited. This was acceptable in 1983 when the system was designed since the technology available meant that a more capable trainer would likely have been so expensive that it would have nullified the trainer as a cost effective complement to the OMS. An additional limitation was that only the acoustic operators were able to train on the APT.

Tactical Procedures Trainer

Requirement - The Tactical Navigator, Navigator/Communicator and Non-Acoustic Sensor Operators on the Aurora's tactical crew had to get all their training in the OMS which meant a lack of sufficient, individualized hands-on training. Work was therefore begun on a trainer specification that would utilize newer technology to provide the required training.

The specification focused on the latest in technology (circa 1988) with the intention of developing a system which might escape the drawbacks inherent in previous part-task trainers. Based on the lessons learned up to that point, it was decided that a PC based system with reprogrammable touch-sensitive flat panel displays would provide the flexibility, versatility, real-time capability and reconfigurability desired.

Progress of the project - A contract was issued and the Tactical Procedures Trainer (TPT) resulted. The PC design allowed the Forces to take advantage of a universally available technology which easily allows for future growth

and gets away from the "orphan" aspect which occurred so often with custom-built task specific trainers.

The touch-sensitive flat panel displays were specified in lieu of keyboards because their programmable feature made it possible to design the display to look like the one used on the aircraft.

Although the requirement is for a part-task trainer, the computing capabilities of PCs have permitted the inclusion of some advanced features normally only found on full mission simulators. Incorporated, for example, was a sophisticated ocean model with multi-layers and boundary conditions.

Other advantages included the modelling of air and surface environments as well as reactive targets in all three environments. Tactical systems such as Electronic Support Measures and radar are also included and modelling was possible for the Directional Command Activated Sonobuoy System. Although the TPT was designed primarily for the Tactical Navigator, these features and a minimum of reconfiguration mean that some training is already possible for other operators on the crew.

Implementation - Eight systems have been ordered and the Forces have now taken delivery of four. A full training configuration for all of the Aurora's tactical operators is planned.

Naval Tactical Display Emulator

Origin - The Canadian Navy is faced with the challenge of several major training equipment replacement requirements. This has been driven by a number of modernization and equipment replacement projects which are now in various stages of delivery. In the interest of achieving maximum efficiency, a study was done which provided a definition of the ideal characteristics that a part task trainer might possess. To achieve efficiency and effectiveness in both development and life cycle costs, the following characteristics were found to be desirable:

1) high fidelity;

2) reconfigurability/flexibility of use;

3) ease of authoring to adapt the device for different uses;

4) ease of use in conjunction with existing trainers and simulators.

As a result, an intense effort was initiated to determine if the technology existed which might enable these characteristics to be combined in the form of a single trainer. Virtual prototyping technology emerged as a likely contender and, to prove the concept, the Naval Tactical Display Emulator (NTDE) project was initiated.[3]

The essence of the NTDE project was to determine whether emerging technology based on software reconfigurable graphics simulations of real equipment could be used to provide a viable and cost effective alternative to traditional training technology and, most importantly, whether such a trainer would be acceptable to the user community, in this case the Canadian Navy which traditionally uses only real equipment for training.

The Technology and Applications - The design was based on a relatively new product called the Virtual Application Prototyping System developed by Virtual Prototypes Inc. of Montreal and augmented to provide a suitable training platform called the NTDE. Virtual prototyping is a design tool that enables the user to customize graphic replications of real equipment using object primitives such as knobs, dials and switches which can be driven by a simulation programme. Naval display objects such as generic radar and sonar displays were also added along with the capability for dynamic game scenarios complete with numerous targets and instructor interaction for game control and monitoring.

The key point is that this approach enables users to create graphic simulations that are suitable for training purposes without programming.

As a proof of concept, the NTDE was designed with a simulation control computer and two generic consoles that could be reconfigured at will to represent virtually any naval console of choice with the capability of operating

independently or interactively. For the project, an instructor console and a number of ship display consoles including a sonobuoy processor (SPS 503), a surface weapon controller, a sonar (SQS 505) and a radar fire control were created using the NTDE's generation capability.

Upon initialization the instructor could configure the system for a one or two game mode and reconfigure either station to represent any of the displays implemented. By initializing both consoles within the same game, student interaction was possible thus providing a team training capability.

Program Results - The observations in terms of the ideal characteristics mentioned above were as follows:

1) Fidelity - Comment on functionality was very positive. Physical fidelity did not fare as well because of lags in the response times for some of the input devices and system simulations used. These discrepancies led to an operational recommendation that tactile feel and simulation response times are critical if negative training is to be avoided. Acceptable solutions were subsequently identified.

2) Reconfiguration - Switching between the various display/panel simulations was achievable in three minutes. In other words, a lesson on radar operation could be discontinued and three minutes later, a lesson could begin on a sonar system trainer.

   The device was found acceptable for independent training of students and also for team training in which two or more students interact to acquire and track a target on one console and hand it off to a second console for gun or missile engagement. The instructor's control console was locatable at either work station and ship's course and speed changes were also tracked on the consoles.

   Finally, the Data Base Editor received excellent marks for its capabilities which allow an instructor to build, customize and control scenarios without having to do any programming. In addition to the high degree of realism possible, parameters can be changed while a game is in progress and it is possible to build scenarios and platforms which react to certain tactical situations without instructor input.

3) Generation Capability - This aspect received high praise. NTDE delivery coincided with the Gulf Crisis when there was an urgent need to train operators on the Harpoon Fire Control Panel. Using the NTDE, a fully functional Harpoon Panel Trainer was designed, tested, redesigned, retested, and available for training within four weeks at no additional cost.

   This is considered a major breakthrough in part-task training as traditional methods would have required months or years to produce at high cost.

   In another instance, a marine technician with a computer background was able, after 10 hours of self-instruction, to generate, in 18 hours, a program of sufficient fidelity to train technicians on the basics of the Integrated Machinery Control System used to operate the gas turbines on the Canadian Patrol Frigate.[3]

4) Interoperability - As a final test, the NTDE was used by Fleet School Staff to create a simulation of the Canadian Navy Electronic Warfare System operator console which was then connected to an existing multi-threat procedural trainer. The test was conducted to assess the ease with which school staff could use the NTDE to design new displays, the degree of difficulty in connecting it to other hardware, the ability of the system to augment the simulation provided by an existing trainer and its ability to display the results in a manner consistent with the real equipment.

   This portion of the project took three months from start to finish and was an unqualified success judging by the

comments from operator staff who assessed it.

5) Cost - Savings achievable through an NTDE-like approach to training are estimated at 10:1 using commercial equipment and virtual display software to replace military equipment and command and control subsystems.[3]

Current Status - The NTDE is not a trainer; it is a concept. As a result of the experience gained with the NTDE, the Canadian Patrol Frigate Project Management Office initiated the procurement of three Marine Systems Trainers each of which will have eight student stations plus one instructor station and will be used to provide operator training on over 40 different console displays. The hardware and software involved are basically the same as that trialed on the NTDE project except that the input devices have been expanded.

The most noteworthy aspect of this acquisition is that the display simulations for these systems are being provided entirely by Canadian Forces subject matter experts at the Canadian Forces Fleet School in Halifax. In other words, a powerful user-friendly tool has been placed in the hands of the instructor who can now directly implement the solution to his trainer deficiencies without the need for outside assistance.

CONCLUDING MATERIAL

Lessons Learned

The requirements for part-task training in the Canadian Forces are becoming ever more important because of continuing fiscal austerity and reductions in Force size. With fewer resources, the military must continue to maximize the value of training while minimizing the dollars spent.

In terms of the Canadian Forces Individual Training System's goal of maximum efficiency, progress has been achieved. In the evolution from the Acoustic Procedures Trainer to the Tactical Procedures Trainer and through the results of the Naval Tactical Display Emulator project, the main lesson learned is that current technology is indeed capable of allowing the design and development of trainers which can be reconfigured as operational equipment is replaced.

The Way Ahead

The Navy has solved part of the requirement for marine systems operator training with the definition of the Marine Systems Trainer. With the training community of the Canadian Forces becoming increasingly impressed with these latest developments in capability, a similar approach may be used for other training requirements. The challenge now is to ensure that future part-task trainers are designed with open hardware and software architecture so that the trainer itself does not have to be replaced as computer hardware and software components become obsolete.

Once this is accomplished, the era of ageless part-task trainers will have arrived.

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