WRITING AN ISD TRAINING PROGRAM CONCURRENTLY WITH FULL SCALE DEVELOPMENT

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ABSTRACT

Developing a training program concurrently with full-scale development of a new system has been looked upon by several educational professionals as being impossible. The US Air Force desire to shorten the time from drawing board to full operational capability for a weapon system requires combining normal system life phases whenever possible. Therefore, the 4235th Strategic Training Squadron was tasked to develop a training program for the Offensive Avionics System (OAS) and Air Launch Cruise Missile (ALCM) Modifications to the B-52 G and H fleets concurrently with full-scale development of hardware and software for the aircraft. Having written the training program using the ISD approach, the squadron provides insight into the problems of such an effort and the solutions it developed to overcome those problems. Areas addressed in this paper include:

(1) Developing a core of knowledge about a new system without an established working model.
(2) Selecting an organizational method for presenting the training program.
(3) Developing training devices.
(4) Developing technical orders.
(5) Handling of changes to system operation and implementing them into the training program.
(6) Selecting instructional media.
(7) Selecting instructors.

INTRODUCTION

Since 1977 the U.S. Air Force has prepared to integrate the Offensive Avionics System (OAS) and Air Launched Cruise Missile (ALCM) into the B-52 G and H model aircraft. With the date for delivery of the first operational aircraft set for August 1981, preparation for its arrival had to be expedited drastically. To do so several phases of normal system development had to be accomplished simultaneously.

Along with full-scale development and flight testing the prototype system, a training program had to be written for the aircrew member. Despite the fact that many educators believe such a simultaneous effort is impossible it had to be done. The 4235th Strategic Training Squadron (STS) actually began working on the training program using the ISD approach in April 1978. The training program developers have experienced numerous problems throughout their three years of work. However, they have overcome them and are ready to implement their program to the crewmembers for the conversion to the new equipment. The squadron can now provide insight into the problems they encountered, the solutions they used, and additional suggestions to help in similar circumstances.

DEVELOPING A CORE OF KNOWLEDGE

One of the most obvious problems that arises when trying to create a training program simultaneously with full-scale development of the equipment is building a core of knowledge about the system. Early in 1980, almost 8 months before the first OAS/ALCM equipped B-52 flight, seven instructor radar navigators were assigned to the 4235th Strategic Training Squadron at Carswell AFB, Texas to begin preparing the training program.

First, all the training program developers completed an Instructional Systems Development course given by the squadron. This course provided the basic understanding necessary for all the writers to work toward the same goals using the same methods. This proved to be an extremely essential ingredient in developing continuity and uniformity in the various training blocks.

Next, the training program developers began reading the numerous engineering documents published by the contractors. These documents provided in-depth explanations of all the OAS/ALCM operations. However, it must be made clear that it was not necessary to have an engineering degree to understand these documents.

The ISD course proved valuable during this phase also because each training developer was now able to evaluate each bit of knowledge as to its later usefulness to the student. After six weeks of studying documents the next phase began.

A task analysis of each activity the navigators of a B-52 would perform was compiled. This included both the tasks associated with the new equipment and those in which the new equipment did not come into play. This phase of preparation served two purposes. First, it identified the items that had to be taught to the navigators so they could convert to the new equipment. Second, it translated the operation of the OAS from engineering vernacular to understandable English. This phase took approximately four months to complete.

The final source of information prior to the first simulator or aircraft having OAS equipment was the familiarization course and operator's course conducted by Boeing (Type I Training). Although the course that was taught encountered the same problems of not having a simulator or aircraft to verify the system's actual operation, it did provide some additional information. It also allowed the training personnel to meet the engineers who wrote the software. This was important because when questions arose later the training developers knew who to call for a possible answer.

When the aircraft finally made its maiden flight training personnel had already begun the actual development of their program. As the aircraft continued its test program, daily phone conversations with the flight personnel provided constant updates to the training program. Ironically, the information flow was also reversed at times. The training developers having spent so much time preparing to build their program were able to provide flight test personnel with information how the engineering documents said the OAS should operate. This allowed flight test to identify numerous actual system operation errors which needed correction.

Combining their early efforts in learning the engineering documents and the updates from flight test, the training program progressed on schedule. Having almost completed the training program several recommendations can be drawn from the 4235th STS experience:

(1) All training program developers should use the same basic instructional approach within a program.

(2) The training program should start as early as possible so personnel can develop a sound knowledge of the system to be taught.

(3) Training program developers should attend all available contractor training but only after they know a good deal about the system operation. This provides a framework for understanding the system rather than mere acceptance of the contractor's claims.

(4) In the case of simultaneous accomplishment of several phases of system development it is essential that the test personnel for the system be highly qualified and knowledgeable in the expected system operation prior to the actual test phase. Since the engineering documents are the only basis for training programs development, test personnel must be intimately familiar with them. Then they can not only identify system errors and shortcomings but also provide timely information to training personnel about discrepancies from the documents. Early identification of such discrepancies can be handled by changes to the training program or by placing the demand on the contractors to correct the problem. If a strict deadline is set for bringing the system on line, it becomes more difficult to make such changes to the equipment. Therefore the equipment is delivered with less than the original capabilities and/or the operator must use workaround procedures to achieve his objective.

(5) When descrepancies are identified by the test or training personnel the system manager must support the effort to rewuire the correction of the deficiency. If it is not required that all deficiencies be corrected, a weekly report of such deficiencies must be published. This provides all other agencies with data to modify their efforts.

SELECTING AN ORGANIZATIONAL METHOD

After developing a core of knowledge about how the OAS and ALCM operated the training program developers had to choose an organizational pattern for the training program. The decision came down to two alternatives - the systems approach and the phase-of-flight approach. Traditionally, the Air Force has used the systems approach for most aircrew training programs. Using this approach the training program breaks the large system into subsystems (radar, doppler, heading, etc) and then teaches the student all he needs to know about the subsystem.

After all the subsystems are explained the student is expected to have an understanding of the overall system operation. However, more often than not this approach leaves the student with fragmented system knowledge and requires a lengthy period of time for complete knowledge of the system to be obtained. The other alternatives phase-of-flight provided a much more task-oriented approach for the training program. Beginning with mission-planning the student would proceed through preflight, enroute procedures, descent, landing, and post-flight. This approach allowed the program developers to concentrate on developing procedures and checklists as well as transmitting knowledge to the student. Therefore, the student left each segment of training knowing both the knowledge he needed and how to use it. Because the conversion of each crew member to the OAS/ALCM was to be done in only three to four flights, the task-oriented phase-of-flight approach was selected for the training program organizational pattern.

As was stated earlier the initial step in actually writing the training program was completing a task analysis for each activity

EXAMPLE TASK ANALYSIS

T	N	ENRUTE	AA	XXPPXX		F	I	4		PERFORM ENRUTE PROCEDURES
T	N	ENRUTE	AA	XXPPXX		O	I	4A		Perform General Navigation
T	N	ENRUTE	AA	XXPPXX	MFD IKB RN MGT RADTILT RADPRES	R	I	4AA		Perform radar position fix
	N	ENRUTE	AA	XXPXXX	MFD	R	I	4AA	1	The AP will automatically position the crosshairs on that point which is: 1. Closest to the aircraft, and 2. Within the field of view
T	N	ENRUTE	AA	XXPXXX	IKB	R	I	4AAA		Select the MFD supporting radar
T	N	ENRUTE	AA	XXPXXX	RN MGT MFD IKB RADTILT	R	I	4AAB		Perform altitude calibration

T=Task
Blank=Knowledge item

N=Non critical
C=Critical

Phase of Flight
M PLAN
PRETAK
T/ODEP
ENRUTE
PDLAND
POSTFL
ALERT

E=EWO C=Contingency T=Training A=All
Trng Reqred;B=Conversion only A=All

Plt, Coplt, RN, Nav, EWO, Gun

Crew member role
P=Primary
I=Interaction
B=Backup
X=NA

Panel used

Media
C=CPT
R=Text
O=OSMT
W=WST
L=Lecture
T=Tape/Slide
V=Videotape
S=Seminar
F=Flight

I=Introduction
R=Reinforcement
T=Test

Task ID

Knowledge Code

Task

FIGURE 1

accomplished by the crew members. Formatted and entered in a word-processor this document formed the skeleton for the body of the training program. Figure 1 shows a task analysis for one of the tasks during preflight. The key explains how this document was used for the conversion training and how it will be used for the Combat Crew Training School curriculum which must be developed. The phase-of-flight approach was especially well-suited for organizing this task analysis which now could be used as an outline of the training program.

Regardless of which pattern was chosen the simultaneous accomplishment of full-scale development and writing a training program would have caused problems. The systems approach would naturally be more suited to handling the constant changes of the OAS software. A training program developer could simply find the training block devoted to the changed equipment and make the required changes. The phase-of-flight approach on the other hand required locating all the tasks involved with a particular change and making the corrections. Although the task analysis format used in this program aided in the change process, corrections did take more time to insure all tasks were correct. However, once made, the change helped stimulate reexamination of checklists and procedures. These crosschecks aided in delivery of a training package that agreed with checklists and the operator manuals.

The problems of handling the constant changes to OAS software required flexibility in curriculum development. As each change notice arrived the appropriate task analysis and training lesson was updated. However, it surfaced that just teaching the basic tasks to the crew members failed to give him the "big picture" of managing the navigational computers. To provide this insight required a departure from the task-oriented format. After the functional descriptions of the switches and equipment used during preflight and before takeoff, the student needed an understanding of what he was trying to achieve in programming the navigational computers and the best way to go about doing so. Therefore, a lesson was written which explained the techniques and theory of inertial navigational equipment. However, this theory was extremely limited in scope and operator oriented. Collecting the data for such a block proved difficult because empirical data did not exist due to the limited experience of flight test. Instead, the procedures for basic management of the system had to be derived from software documents and telephone conversations with Boeing programmers and engineers. The important aspect of this effort was not the magnitude of the work involved but the realization that training personnel must be flexible. The objective should be to make the student as capable of performing the desired task as possible. With limited time to achieve this objective willingness to depart from standard procedures must be present. If a systems approach is more suitable for a training block then it must be used. If theory must be taught in a task oriented program - do it. The student performing the task is the ultimate. To argue over educational concepts or delay completion of a training program to spend excessive time to maintain purity of the training approach is inexcusable. In the OAS/ALCM training program this flexibility saved invaluable time in meeting the deadline set for aircrew training. It also provided a period of time to review the program and publish last minute errata.

DEVELOPING TRAINING DEVICES

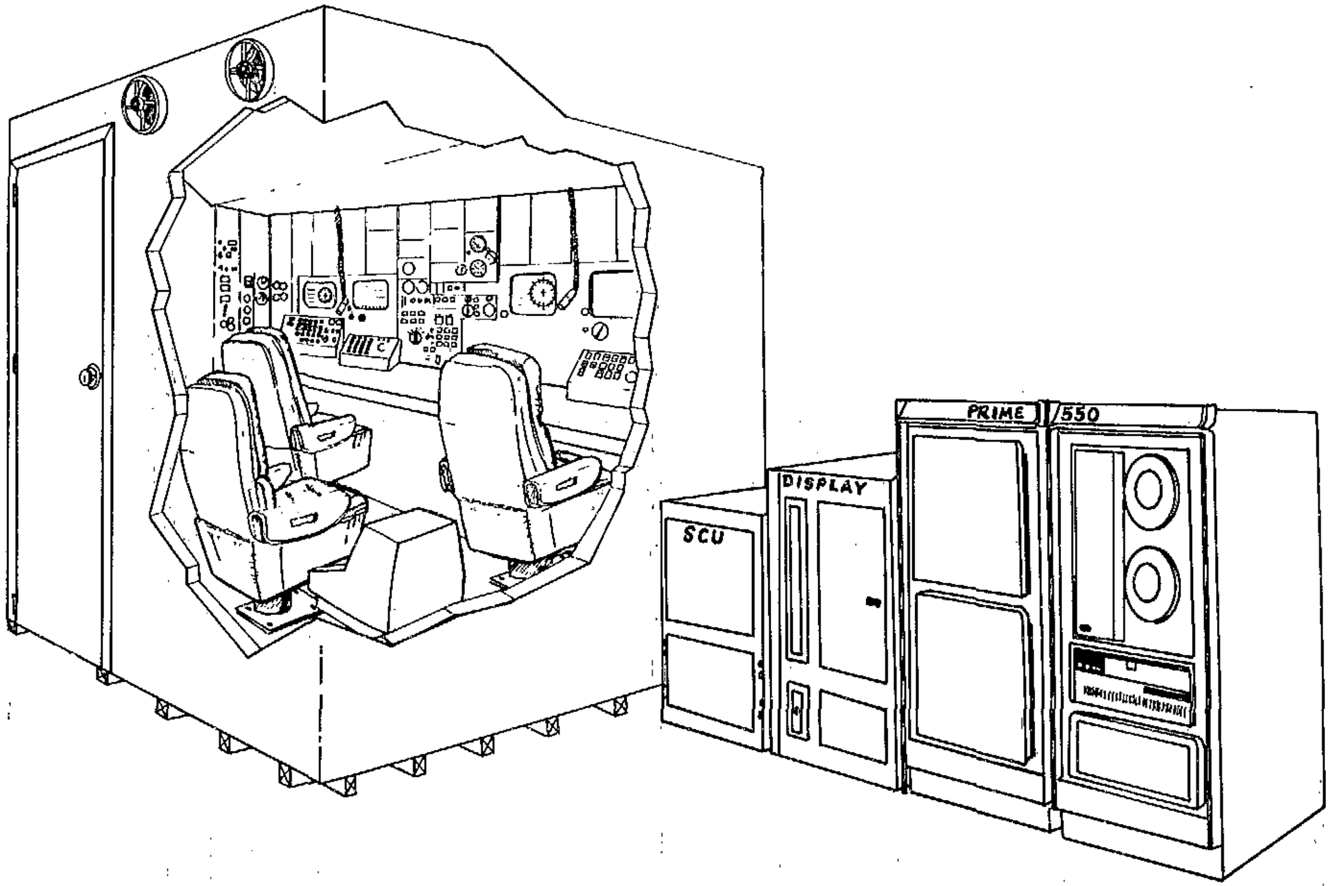
As the training requirements for the OAS and ALCM were developed, it became apparent that lower level tasks and systems functions would have to be trained in a ground simulator. The first question that arose pertained to what simulator could be used. The WST designed for the B-52 would not be ready for the OAS conversion and the present T-10 could not be modified due to current training requirements. Using the ISD approach, the 4235th STS developed a list of tasks which required training in this ground simulator. These tasks and trainer requirements were determined with both the OAS conversion program and the Combat Crew Training School program in mind. The tasks were prioritized from simple to hard. A simple task consisted of anything from knowledge of switch locations to a 3 - 5 step system operation proceudre. The hearder tasks consisted of weapons supervision and OAS system management. Investigation of these tasks determined that a series of training devices could be developed. For the OAS/ALCM program two devices were necessary. The first device would be used to train simple tasks or lower level objectives. The second device would be used to train simple tasks or lower level objectives. The second device would be quite sophisticated and would train higher level objectives. The two devices would compliment each other and the weapon system.

The OAS training managers decided to use a Cockpit Familiarization Trainer (CFT) for lower level objectives and a Part Task Trainer (PTT) for the higher level objectives. As the requirements and designs of the devices began to take shape, it became readily apparent, that these devices would be the backbone of the OAS Conversion Training Package.

The CFT was designed as a wooden mock-up of the B-52 OAS/ALCM modified Radar Navigator and Navigator stations. All the panels in the CFT are inoperative with visible pushbutton switch legends. Two of the four multifunctional displays are also inoperative; however, two are replaced with Singer Caramate II Tape/Slide Projectors. As stated before, this device will be used to teach switch locations and minor procedures.

The student will select a tape/slide program and view it on the projector in the CFT. As the program directs him to a certain switch or series of switches, he is able to locate them in a more real environment. The student can run checklists and even take step by step actions necessary to perform minor OAS procedures.

The design of this device is simple but the training impact is great. Another important



B-52G/H OAS/CMC PART TASK TRAINER

Figure 2

design feature in the CFT is mobility. This device must be capable of being moved to the various sites where the OAS/ALCM training program will be conducted.

The B-52 OAS/ALCM Part Task Trainer is a sophisticated device that addresses some of tasks, procedures and conditions the crew members must handle with the actual weapon system (see FIGURE 2). Because the aircrews receiving training will be highly experienced with B-52 navigational functions, the focus of the PTT will be on procedures training; specifically, those procedures unique to the new OAS. As an example, the PTT must respond exactly as the OAS would to all commands (button pushes, switch activations, etc.), but only those features used directly in navigational and weapon procedures need be displayed in radar video.

The physical layout of the, the PTT provides stations for the two crewmembers required to operate the OAS, as well as for an instructor. The PTT is a physical mockup identical to the OAS layout. The mockup is comprised of 16 operational panels, two of which include a keyboard and trackball (one for each crewmember). Four monochromatic display monitors provide up to 33 different display formats, three of which include synthetic radar imagery. The instructor's position is equipped with a CRT console for setup and monitoring of the training sessions.

The only problems in training device development occurred when changes were made to the OAS hardware (panels/aircraft configuration) and software (program and system operation). Since the CFT was being constructed locally, any changes that were received were incorporated directly to the design. The panels being static could be changed or rebuilt with relative ease. Any change in cockpit configuration could be done easily. Software changes did not effect the CFT.

The PTT with its full-working mockup was effected greatly by both software and hardware changes. A system to handle these changes was established between the 4235th STS and the other agencies involved in the project. As in the CFT, the PTT crewstation was constructed locally so changes could be implemented with minor coordination efforts. The software changes had a much greater impact on the PTT design. A change in the OAS operational system put the PTT software one step behind the aircraft.

To handle this problem the simulator manager set up coordinated communication between all agencies to determine how the changes impacted the software design. The 4235th STS received changes from Boeing and determined what impact they had on the PTT and the training program. If the change was significant, a written change request was forwarded to the other agencies involved. The software specialist would act on the request and forward a yes/no proposal for implimentation. For the prototype software a freeze date finally had to be established. All software changes were accepted until this date. After this date, all changes were held at the 4235th STS for further evaluation. After completion of the prototype software effort, any remaining changes would be implemented in the baseline software effort for the first production device. By developing a prototype and a baseline software a minimum number of crews would be effected by differences between the PTT and the aircraft.

The software design of the PTT was based on the modular design concept which made software changes easy. This gave the PTT the flexibility necessary to incorporate changes.

DEVELOPING TECHNICAL ORDERS

One of the associated items involved with bringing any system into operation is the development of manuals (tech orders) for the operator. Recognizing that manuals written for other aircraft systems often became bogged down in engineering jargon and a conglomeration of useless facts, Air Force personnel involved in the early stages of the OAS/ALCM integration insured training personnel would play an important role in the new manuals. Even before a working model of the OAS was available or the ALCM had flown, meetings were held to organize the development of the aircrew manuals.

These meetings were essential for several reasons. They established that the books were to be written for the OAS/ALCM operator not the staff planners or weapons officers. Therefore, extraneous material was deleted or placed in other manuals used by those individuals. Readability and functionality of the manuals was also stressed to Boeing writers. This ensured the engineering language would not be present since most crewmembers lacked such backgrounds. Also important was the fact that the books would be used by the fully-qualified crewmembers. Therefore, the books did not have to take a tone of training documents. This eliminated the need for repeated explanations of basic operations such as keyboard entries. Through the meetings these cosmetic changes became easier to make as Boeing writers learned the desires of the Air Force. Each published change underwent editorial and technical reviews by Air Force and Boeing personnel. As each change was published these reviews required less time due to the parties understanding each others problems and desires.

However, the largest pay off from these meetings came from the communications established between the Boeing writers, flight test personnel, and the 4235th STS. Sometimes bordering on harassement, the interplay caused several hundred questions to arise about the system's operation. Procedures and checklists were developed which would have otherwise taken months to evolve without the collective knowledge of the groups. However, despite the success brought by early efforts there is no denying that simultaneous accomplishment of several phases of system development created problems.

Software implementation of the OAS/ALCM did not proceed as easily as anticipated. Daily changes to the software programs became commonplace. This caused changes to the engineering documents. The lag between actual change of operation of the OAS and changes to the engineering documents required tech order development to be extremely flexible. To keep up with these changes not only in the training program but also in the manuals required almost daily telephone communication between the three groups. Without this constant conversing, an OAS would have been delivered that bore little resemblance to the engineering document, the training program, or the tech orders.

In addition to the meetings to establish the early groundwork for communications, several other actions could ease the task of developing operator tech orders. First, tech order writers, test/test flight, and training personnel should all become extremely knowledgeable concerning the information in the engineering documents. Then they all should attend contractor training for the new system (Type I Training in Air Force terminology). This allows them the opportunity to ask questions concerning unclear areas and to be questioning students rather than naive listeners *during the training*. *Once having* completed the contractor training all individuals involved in testing, training, and publication writing are on equal ground and can be valuable inputs at subsequent meetings.

Finally, tech order witers, training program developers, test/test flight personnel, and a system engineer should meet as often as possible to discuss how the system is actually working. In the case of an aircraft, this should be required after each flight. This provides the forum for discussion of system operation of the engineering documents. It also provides feedback to all parties from the system engineer concerning any changes made or to be made to those documents, on a more timely basis than normal printed distribution which normally takes weeks.

HANDLING SYSTEM CHANGES

Ideally training programs written after a system is developed do not encounter serious problems with changes in system hardware or software. This luxury does not exist in a training program developed simultaneously with the full-scale development of the system. The daily changes in the Offensive Avionics System had numerous effects on the training program.

Anticipating a system resembling the engineering documents, personnel of the 4235th STS had written a task analysis, lesson outlines, and simulator mission profiles based on those documents. Each change called for adjustments to all these efforts. The changes initially caused consternation and frustration in the training program developers. However, when it became apparent that changes would be part of the daily routine, the developers learned to adapt more quickly.

A few suggestions to minimize the problems associated with the handling of changes to the system follow:

(1) Prepare all individuals involved with the training program for the changes that will more than likely evolve. This means not only the actual writers for the training program but also the instructors who will teach it; the graphics people who must prepare new slides for what seems to be a miniscule change; the individuals who are building trainers, etc. This preparation lets everyone know that the changes are not generated by the training developers' errors but by actual changes in the system. This understanding not only leads to increased credibility for the training developers but also unites everyone into the challenge of preparing a quality program within the time constraint imposed.

(2) Establish communication lines between all parties involved in the program. The system manager, system test personnel, training personnel. system engineers, manual writers and any other groups concerned with system operation must meet often to resolve how the system is operating and how it will operate once in the field. Communications lines must also be *established to allow more rapid reaction to* problems if it is required between such meetings. In its program the OAS training developers conducted numerous telephone conferences with any agency that could provide up-to-date information concerning OAS/ALCM.

(3) The use of a word processor was essential in keeping the training lessons up-to-date. When a writer changed a lesson it was immediately put into the word processor. This provided a current printout of any lesson when an instructor asked for it.

(4) Realizing that it is often easier and cheaper to change an engineering document rather than hardware and/or software, curriculum developers must develop the flexibility to change any lesson. However, at some point a "freeze" must be implemented on courseware changes. At this point coursebooks or multi-media programs should be completed and all changes should take a form of errata. This prevents "the last minute" publication of courseware. If such last minute efforts are allowed editorial and reproduction errors will create the appearance of lack of professionalism. As was said earlier - changes due to system development can be explained. Sloppiness in controllable areas can not be excused.

SELECTING INSTRUCTIONAL MEDIA

Using the ISD concept, the curriculum development manager usually has a number of instructional media choices to deliver his training course. In selecting the proper instructional media, the curriculum manager must select the media that is the best to convey his subject matter to the student.

In developing the OAS/ALCM Conversion Training Program, the selection of instructional media was limited by certain constraints. Many media options were not available, became to complex, or were not flexible enough to handle program changes. Because the curriculum was being written and produced during system full-scale development, the instructional media had to be simple and easy to update. The training manager had to anticipate system changes and be able to update the courseware quickly. If the media chosen for a lesson was to complex, it became costly in both time and dollars to change. The curriculum development managers of the OAS/ALCM program used simple but effective instructional media. The three forms of media that proved flexible enough to use were tape/slides, coursebooks, and trainers (CFT or PTT). All three of these proved effective and withstood the constant change of a developing system.

SELECTING INSTRUCTORS

As the OAS specifications and system requirements were completed the 4235th STS established an initial cadre of instructors. These seven instructors were to function as both Subject Matter Experts (SME) and Curriculum Development Managers (CDM). Once assigned, the instructors began to establish a core of knowledge by studying the OAS/ALCM specification and Boeing documentation. Using the ISD approach, the seven instructors were tasked to develop the entire OAS/ALCM Conversion Training Program. In the program plan, additional people were to be added to the OAS program and with the original seven instructors these individuals would form a "road show" instructor team. The teams would travel to each SAC base and conduct the conversion training. They would provide both the ground and inflight instruction.

Due to assignment priorities for fliers and shortages of qualified instructors, the above concept did not develop. The 4235th STS and SAC were faced with the problem of conducting extensive training with minimum instructor resources. A new concept of training was developed which created a less then optimum situation. The responsibility of the curriculum development remained with the 4235th STS but the responsibility of the "road show" was given to the 4017th Combat Crew Training Squadron (CCTS), Castle AFB, CA. The problem arose that a training program was being produced in one organization but the instructors to conduct that training would come from another.

A three step solution was formulated to eliminate this problem. First, a channel of communication was established between the OAS project officers at the 4017th CCTS and the 4235th STS. Boeing documentation, task analysis, and system specifications were sent to the 4017th CCTS to establish a core of information for the initial instructor team. This improved the communications between the two organizations since the 4017th CCTS now knew something about the OAS/ALCM.

The second step to solve the problem fell on the 4235th STS. A training program for the initial "road show" instructors was established. In this class, the 4017th CCTS instructors would take the entire conversion course. Doing this, the 4235th STS was able to perform validation on the curriculum and the 4017th CCTS instructors were able to learn the system plus see how the course was produced and delivered. 4017th CCTS instructors also completed a course in ISD so the philosophy of the courseware was more meaningful to them. Both organizations became confident that the other was doing its job.

In the third step, the 4235th STS established a procedure to have at least one CDM present at each base for the entire length of the conversion. This individual would be there to oversee the training program and to make note of valid changes. He will not be an instructor but an evaluator of the curriculum presentation. The 4235th STS three step program has thus far been successful. These efforts have averted a potentially serious situation. However, future programs requiring simultaneous curriculum development and full-scale development should make every effort possible to use the curriculum developers as the initial cadre of instructors. They have the most current knowledge of system operation and courseware. Serving as instructors they could also discover changes between system operation and courseware more readily due to the longer amount of time they have been involved in the system.

CONCLUSION

The 4235th STS has produced a training program simultaneously with full-scale development of the system requiring the training. Is has certainly not been as easy as conventional training program development; however, it is possible. Evaluations of the OAS/ALCM training program by Strategic Air Command's 1st Combat Evaluation Group and the Griffiss Air Force Bass staff have been highly complimentary. With the long lead times required to bring todays'sophisticated systems into operation, the combining of full-scale development and training program development might become a common occurrance. Hopefully the suggestions made in this paper to solve the typical problems of such an effort will help in the devleopment of future training programs.

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