COMPUTERIZED OPERATIONAL TRAINING FOR AEROSPACE SYSTEMS: AUTOMATED PROGRAMED INSTRUCTION (API)

MR. R. T. MURRAY
Air Operations Division, System Development Corporation

This paper concerns the Automated Programmed Instruction project developed and produced for the United States Air Force Aerospace Defense Command by the System Development Corporation. In 1965, the System Development Corporation commenced a project to determine the feasibility of implementing the concept of computer-assisted instruction into an operational air defense computer. This early research was conducted on the BUIC Air Defense System computer. BUIC, an acronym for Backup Intercept Control System, was then in the BUIC II phase. *This early SDC research culminated in a determination that the concept* of computer-assisted instruction could effectively be implemented into an operational system. In essence, the determination that individualized training based on accepted concepts of computer-assisted instruction could be accomplished, using a military air defense operational computer, as the teaching medium.

Following this feasibility study, the Aerospace Defense Command requested that SDC undertake a project to implement this type of training into the BUIC III advanced air defense system. The Air Force termed this training concept Automated Programmed Instruction, or API. The reason for using the term API rather than the acronym CAI which stands for Computer-Assisted Instruction was that API was totally based on the teaching concepts of programmed instruction, as developed during the 1950's. The SDC Automated Programmed Instruction training vehicle therefore was an application of proven training concepts and advanced computer technology. In API training the computer presents instructional information to the student, quizzes him as to how well he learned the information, presents an immediate feedback as to the correctness of his response, and when he makes an error, provides remedial instructions.

API commenced to be integrated into the BUIC III operational air defense system in 1969. For the next year it was available for use at selected BUIC III operational defense control centers throughout the United States. Before it was fully implemented, however, API was dropped from the BUIC III Operation System due to budgetary and personnel cutbacks in the command. Nevertheless, SDC's preliminary validation tests of API proved it to be an outstandingly effective training tool. Air Force personnel were enthusiastic about this form of training, and validation tests results affirmed criterion tests were met.

API was designed for integration into the system on the basis of several operational criteria. First and foremost, the Air Force specified that API was to run concurrent with live air operations. In other words, live air defense was to be conducted simultaneous with the conduct of API at the BUIC III center. Each BUIC control center has ten consoles, one of which could be placed in the API training format, while the remaining nine were used to conduct live air defense. The API data was thus never mixed with the live data being processed in the center.

Of course the live system had precedence over API training at all times. An example of this is that in the event an emergency occurred in the live system or, when the BUIC control center received an excessive amount of live radar returns, in these and like instances API was terminated and removed from the system automatically and instantaneously. The console assigned to API training was also instantaneously returned to normal live operations.

API, therefore, was gainfully employed concurrent with the center's live air control responsibility but without interfering or impinging on the operational requirements of the BUIC system. Even though only one console was used for API training at each center, approximately 12 hours of each day could be used for API training purposes at each location.

Another functional criteria in the development of API and certainly one of the most advantageous features from a cost-effectiveness viewpoint was that API used existing air defense computer programs. It used the existing tracking program, the existing display program, and the existing tactical weapons program. API, from a computer programming viewpoint, was relatively simple to develop, making maximum use of the existing operational system. The API concept was, therefore, basically cost-effective to develop calling for a relatively small amount of original computer programming. Also, by using the operation computer programs to process the training data, very realistic training situations were achieved. The simulated interceptor was guided to its target in an API training situation exactly as if it was an interceptor on time-division data link, because the operational computer program processed the API data the same way that it processed live data.

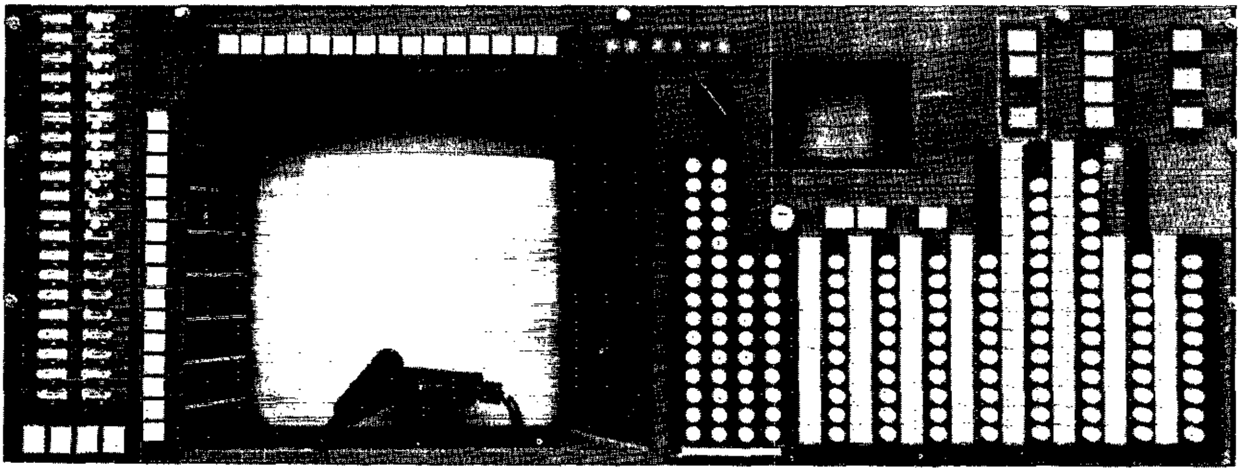

Figure 1. BUIC III Console Picture

Another obvious advantage of the API concept was that it used the same operator console as used in live air defense (see figure 1). The trainee used the identical switch actions and the identical light sensor actions as he did to conduct live air defense. The trainee did not, therefore, have to learn to manipulate a unique teaching machine to be able to take API training. The console was used to train the operator to take the same actions, interpret the same alpha numeric data presented on the situation display or SID and make the same decisions as called for in his particular operational position.

In using the operational Air Defense Program or ADP (see API System Flow Chart), which runs on a real-time basis, prevision was made to "freeze" the API air picture for an indefinite length of time allowing the trainee to self-pace his own response to the training objective being presented. (See figure 2.)

Generation of API course material was also done from existing computer programs. In this case API courses were produced using the BUIC Exercise Preparation System or BEPS. With minor modification to the BEPS program, eight different API courses were generated at SDC's Santa Monica facility accounting for approximately 24 hours of concentrated site specific training materials. In addition to modifying BEPS and ADP the BUIC Operational Recording Tape (BORT) and the BUIC Analysis Reduction System (BARS) were also slightly modified to accept, record and printout data concerning student progress, errors, time latencies, and box scores.

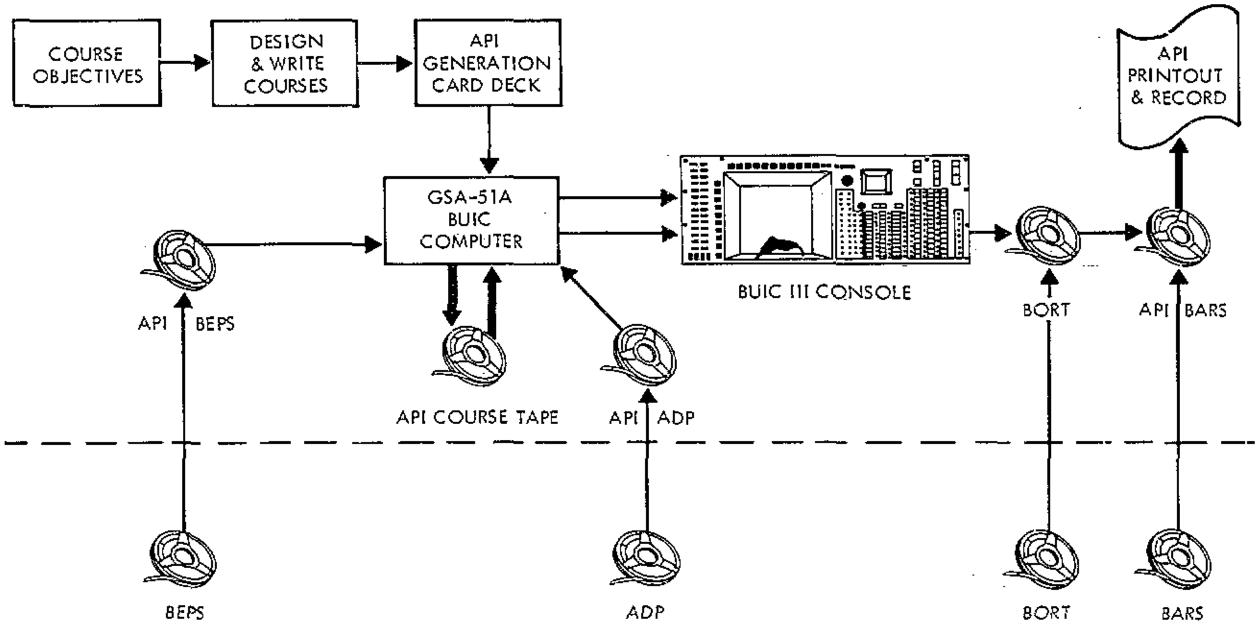

Figure 2. API System Flow Diagram

Each course was stored on an individual computer tape. The courses were broken into 15 to 30-minute lessons so the student would have logical break points, thereby, avoiding long attention-span problems. Because of the self-pacing feature of API, a trainee working at an API console could stop his API training lesson at any point to accomplish other tasks, such as answering a phone, and then return to the console, take a continue action and without further adieu go right on through the training program.

All courses were based on a 3-part mixture. First, basic instructional information was presented to the trainee. Secondly, the trainee was asked to take operational switch actions identical to those found in live air and third, the trainee was presented multiple choice questions. The method of presenting this information was done on an individualized basis with regard to the position being trained.

A Weapons Director trainee was taught weapons direction, an Air Surveillance Operator was taught air surveillance operations, and so on. Remedial training loops were built into each course as determined necessary by field trials conducted by the course designer. If a trainee made a critical error, while going through an API course, remedial training was automatically given to clarify the point being taught and to help assure that the trainee would benefit from the rest of the course.

Now that the basic objectives and methods of operation of automated programmed instruction have been presented, let's take a look at it from the viewpoint of the trainee.

The BUIC III console is a rather complex piece of equipment to master. The SID picture shown here (see figure 3) is taken from the Weapons Director Course and is providing the trainee information regarding the Selective Identification Feature (SIF) number switch action. This example is taken from the Cape Code environment where BUIC III site Z10 is situated. Once the trainee has read this information he will take the "continue" action which is a single button switch action. The continue action will force the API course into the next frame of instruction. The English text that is displayed on the scope is unique to API. The operational display does not have English textual information on it.

Following the reading of this information the trainee will continue on to the next frame of instruction.

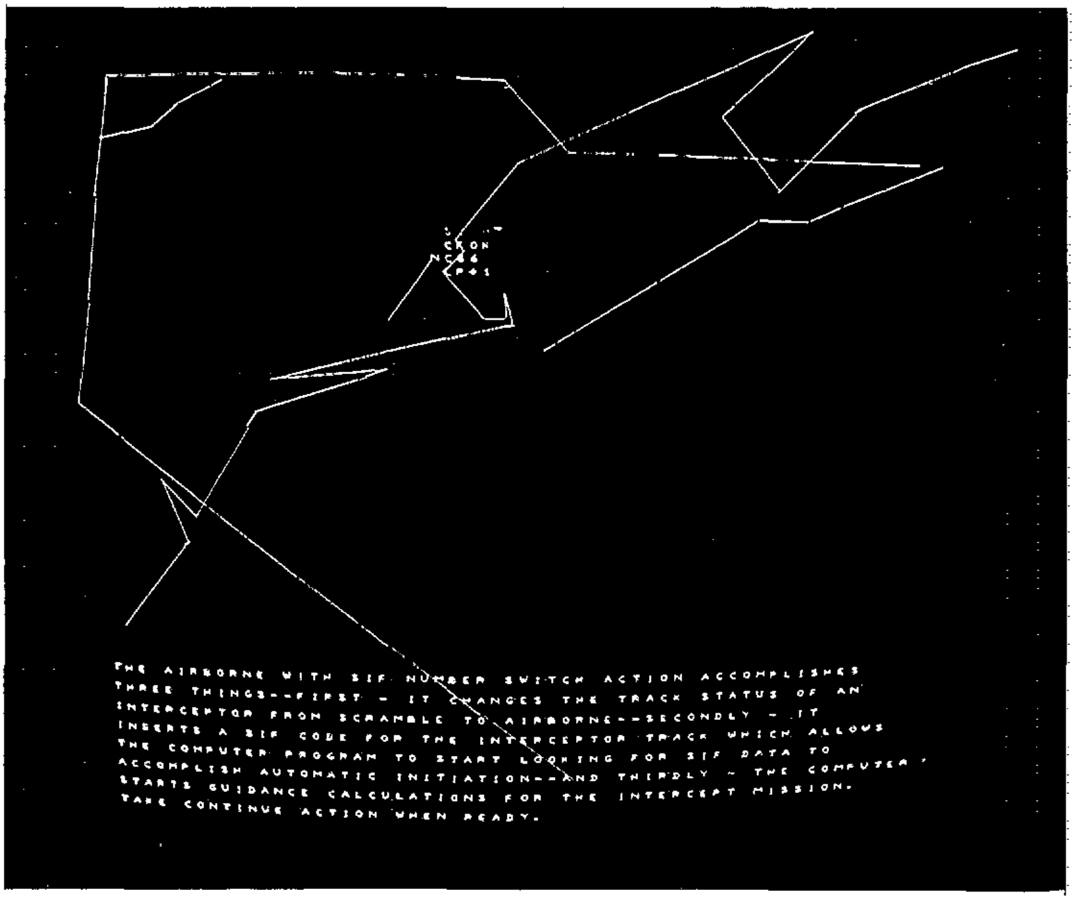

Figure 3. BUIC III SID Picture - Text Display

In this case (see figure 4), the next frame of instruction is a multiple choice question based on the information just provided to the trainee. Once the trainee has read the question and selected the answer he thinks is most appropriate he will light sensor the dot to the left of that answer.

Once he has light sensored his answer he will be provided with feedback as shown here at the top of the scope indicating whether he was right or wrong and informing him to continue on in the course.

In this case the trainee answered correctly and he is informed that the system will now explain how the action is taken.

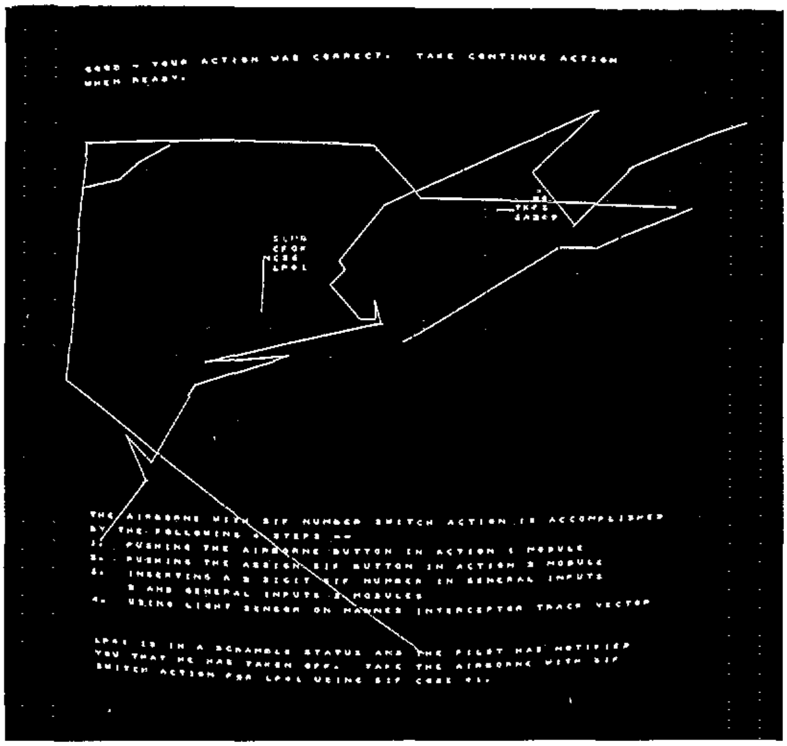

Figure 4. BUIC III SID Picture - Multiple Choice Display

The airborne with SIF number switch action is accomplished by several steps. These steps are pointed out on the scope (see figure 5), the trainee will take his time to read these instructions then insert into the console keyboard the proper button actions which constitute the operational action.

Lima Papa 01 is the interceptor he is working with in the center of the scope. The airborne with SIF number switch action combines the keyboard and the light sensor action. Here the trainee has just light sensored the track. He has received feedback telling him once again good, he took the proper action. When the trainee takes the proper action the aircraft symbology goes airborne, exactly as it would in live operations. After taking the continue action the next frame of instruction asks the trainee to take this same action on a new interceptor without the cues present. He will do this purely by recall to reinforce the training he just received. If he fails to remember the proper actions, he will be recycled to the previous frame which contained the cues.

Following this sequence the trainee is once again provided information of a textual nature.

The eight API courses produced by SDC covered the areas of weapons direction, air surveillance, passive tracking, radar input countermeasures, and identification. Weapons, air surveillance and passive tracking each had elementary lessons for newly assigned personnel and advanced lessons built to stress experienced personnel who were classified as operational ready. The countermeasures and identification courses were both elementary courses.

The API concept of using operational computers, programs and data bases is still new in the world of training. Most computer based systems are designed for workloads which are seldom reached. The BUIC III system as an example is designed to combat a massive air attack. During daily operations the computer is no where near being saturated in its workload. API took advantage of this fact and therefore extended the usefulness of the computer system while simultaneously assisting on-site training personnel in their task of ensuring effective operational status among all crew members.

Due to its individualized approach, API proved to be a very powerful training tool. Unlike a lecture, a movie, or a text book API forced the trainee to physically respond to instruction and immediately informed him of the correctness of his response. Only after the trainee has completed the lesson does he receive a box score on his SID and an off-line hardcopy printout of his performance in the course. This automatic printout was proof of the trainee having taken the course and proved useful to the on-site training officer in determining future training assignments.

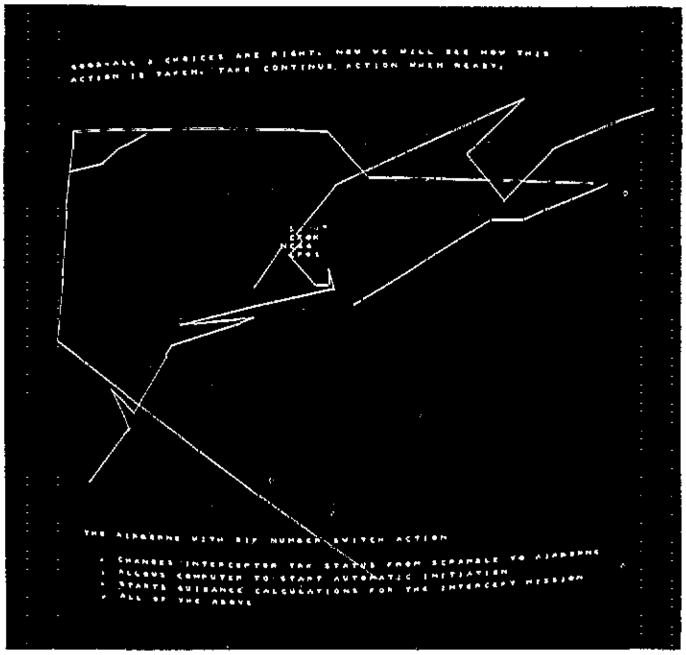

Figure 5. BUIC III SID Picture - Operational Action Display

The courses were system engineered to the point of teaching only those subjects which were critical to effective and efficient operator performance. No frills or attempts to use the computer as a replacement for a text book were included in our training course development. Because of this fact, and the subsequent direct carry over to live operations of the skills taught, all Air Force trainees exposed to SDC's validation runs of API expressed enthusiasm for this unique form of training. It's application to other operational settings seems evident.