COMMANDERS DIGEST

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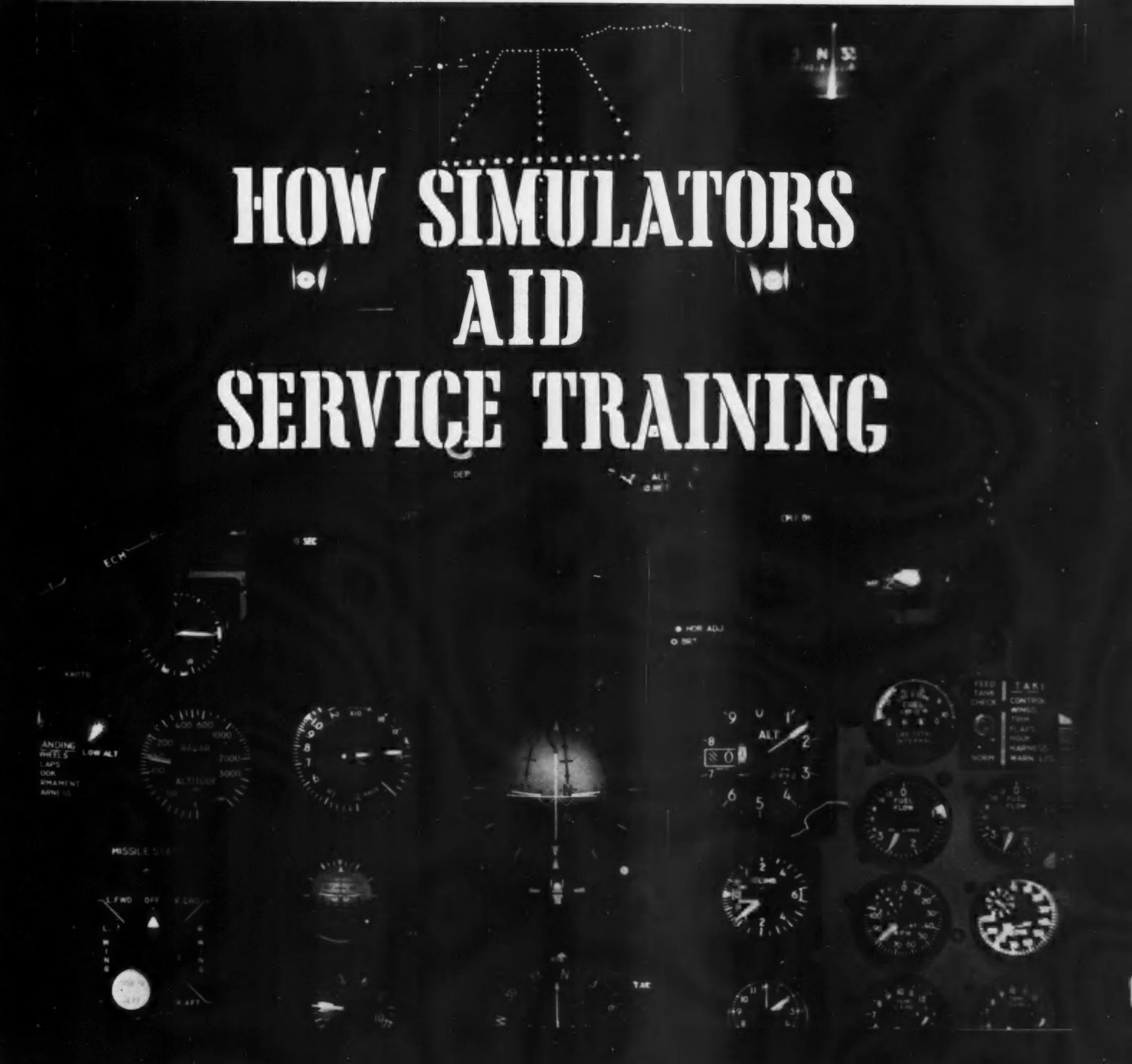
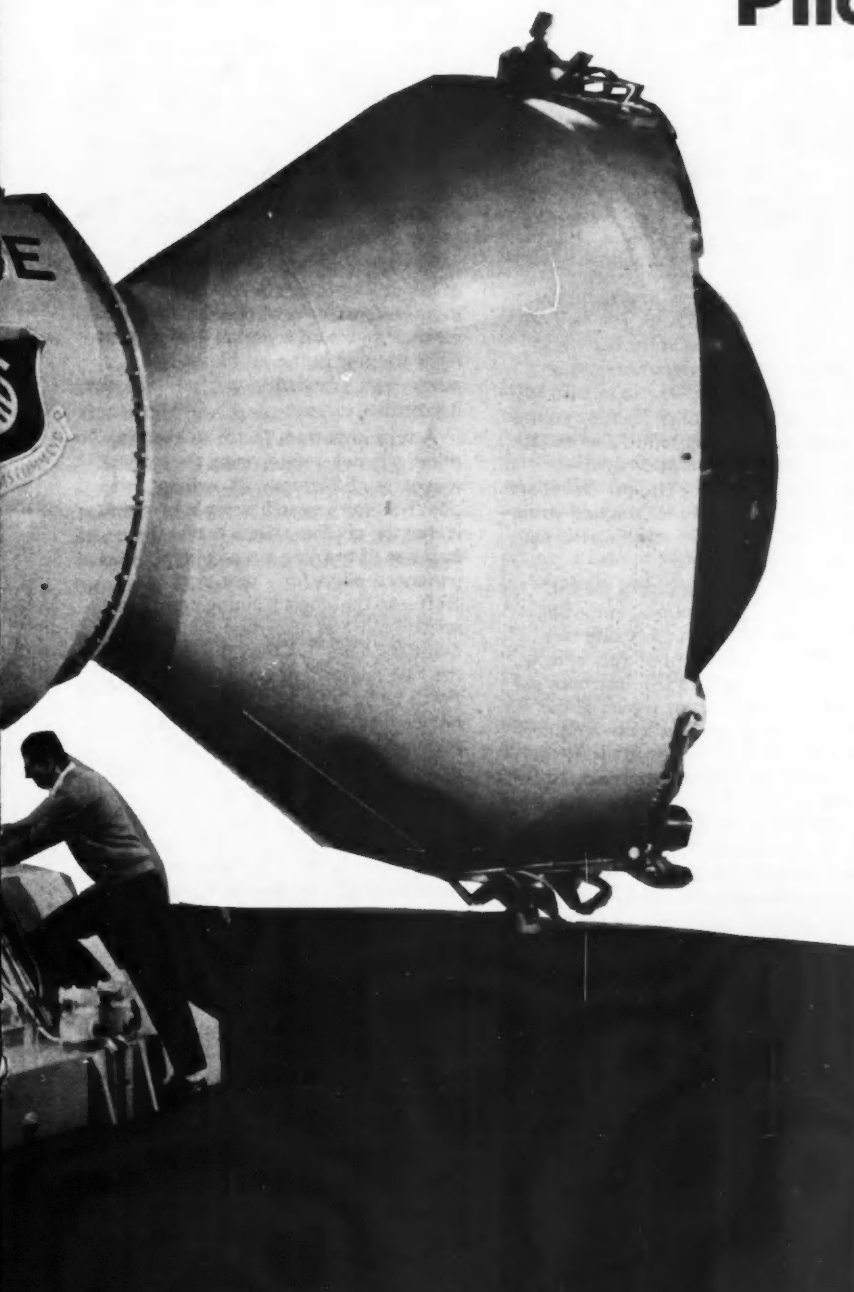
HOW SIMULATORS AID SERVICE TRAINING



AIR FORCE

The Dynamic Environment Simulator at the Aerospace Medical Research Laboratory, Wright-Patterson Air Force Base, Ohio, was designed to study a number of stresses on the human body simultaneously.

Simulation in Undergraduate Pilot Training



By
LT. GEN. WILLIAM V. McBRIDE, USAF
Commander, Air Training Command

Air Training Command (ATC) is responsible for most of the training which is conducted in the Air Force—a really diverse task that covers recruiting, basic training, technical training, and both navigator and pilot training.

Even though the undergraduate pilot training program is only one part of ATC's mission, it's certainly of key importance to the primary mission of the Air Force, and as such we must see that the program operates at maximum efficiency, both from the standpoint of turning out a quality product, and in terms of cost effectiveness.

During fiscal year 1974, 2,450 pilots were produced, including some Reserve and Air National Guard pilots as well as some from other nations under the Security Assistance Training Program. The current fiscal year pilot production goal is 2,587. The program has considerable flexibility built into it—necessarily so because of occasional "surge" requirements—such as the Vietnam conflict, which saw USAF pilot production soar to 4,400 in fiscal year 1971.

The student pilot, over a span of 49 weeks, spends 267 hours in the classroom, covering 16 academic courses. During his training, he will accumulate 210 flying hours—90 of those hours in the Cessna T-37, a twin-jet primary trainer featuring a side-by-side seating arrangement, and 120 hours in the Northrop T-38 Talon, our advanced trainer. The student's time in the air is divided among contact, instrument, formation and cross-country navigation missions, dual or team (with an instructor or another student), and solo.

In addition to his academic workload and his flying time, the student also spends a portion of his time in instrument trainers. At the time they were pro-

cured by the Air Force, some 14 years ago, these devices represented the state-of-the-art in simulation technology. We presently have 81 T-4 trainers for the T-37 aircraft, and 101 T-7/T-26 trainers for the T-38. These trainers, which duplicate the aircraft cockpit, are fixed-base devices with no visual or motion cues. These devices are the primary means of teaching cockpit familiarization, use of checklists, emergency procedures, and instrument procedures.

Within the limited context I have described for these trainers, the devices have served us well. But the simple fact is that their design and utility have been surpassed by current technological advancements.

Teaching technology in general has advanced rapidly, as well. For several years now we have been formally and informally applying the principles of Instructional System Development (ISD) to many of our technical training courses. ISD is essentially a systematic method of finding the answers to basic questions: What should be taught? What are the most cost effective techniques, strategies, and resources for teaching the material?

We are currently applying the ISD process to our pilot training program. The process includes a complete task analysis—establishment of very precise, job-relevant objectives and instructional methods—validation or tryout of the instruction to insure it works—and continuous evaluation to insure update as necessary. We systematically determine the mix of instructors, facilities, materials, processes, and students and the appropriate integration of these elements to insure student mastery of job-essential skills and knowledges.

It is possible that we could have moved more rapidly in applying formal ISD principles to flying training and in seeking a more advanced simulator. Whatever reasons for the apparent delay in moving toward advanced simulation capability during the sixties—whether because of preoccupation with the Vietnam war, budgetary restraints, maintenance problems on the few experimental models which had been purchased during that period, or possibly because of sheer human reluctance to adapt to new techniques—much of the civilian airline industry did press ahead with its incorporation of simulation advancements in its training programs and with a considerable degree of success, as indicated in several studies and observations by Federal agencies.

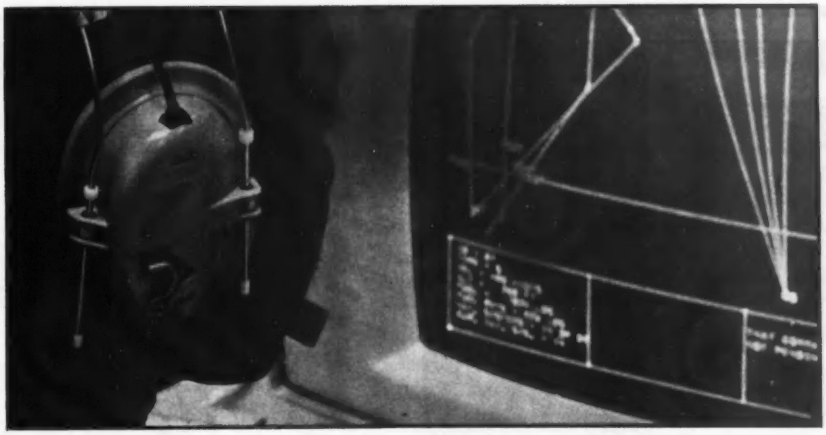
A General Accounting Office (GAO) report to Congress last year noted that for two representative civilian airlines, 75 to 89 percent of total flight training time is accomplished in simulators. While this may seem a considerable amount contrasted with instrument trainer time of about 23 percent in ATC's pilot training program, some of the airlines have set their sights on a goal of 100 percent flight training in the simulator when advances in simulation technology make it possible.

A very important factor to keep in mind, whenever comparing the techniques/methodologies of civilian airline pilot training and military pilot training, is that the civilian arlines are in the business of training already highly experienced pilots for a new type of aircraft—so that their training can be described more as transition than as basic flying training. On the other hand, in the vast majority of cases, we in the Air Force begin training with a relative novice—and we have the task of transforming him into a pilot capable of flying high-performance, sophisticated aircraft designed to accomplish a variety of military missions, in an environment which is not always friendly. And in many cases he must do this solo. This makes it difficult—maybe impossible—to make valid comparisons with the airline industry.

Nonetheless, it is now clear that the advances which have been made in simulation technology have very definite application to undergraduate pilot training.

We in the Air Force initiated steps to procure a new Instrument Flight Simulator in 1973. The procurement action will provide us with 136 simulator student stations—16 to be installed at each of our eight Undergraduate Pilot Training (UPT) bases and eight simulator stations to be used at our instructor pilot training base. Half of the simulators will be an exact duplicate of the T-37

Lieutenant General William V. McBride, USAF, is Commander of Air Training Command at Randolph Air Force Base, Texas. Training Command is responsible for most training conducted in the Air Force.



An Air Force sergeant operates an enroute/return operator control console on the remotely piloted vehicle (RPV) control center at the Aerospace Medical Research Laboratory at Wright-Patterson Air Force Base, Ohio.

cockpit, with the other half duplicating the T-38 cockpit.

As the name implies, the Instrument Flight Simulator will be designed to provide instruction in the instrument phase of training.

This instrument phase comprises a significant percentage of our flying time now—a total of 48 hours, which amounts to 23 percent of the total 210 hours of flying training which the student currently receives.

Contrasted to the current fixed-base trainers, the new simulator will have a motion system that will impart to the student a realistic sensation of aircraft flight. The student will sense the motion cues that are so important to the understanding of flight dynamics and a feel for the precision required in the performance of his tasks and responses. The motion system will provide cues indicating climbs, descents and turns—and the rate at which those maneuvers are accomplished.

The new simulator will have a six-degrees-of-freedom motion base, and a forward visual display depicting an airfield and its surrounding terrain, including variable cloud conditions. This visual capability is a major step toward realism. Even though the device is an Instrument Flight Simulator (IFS), one of the most difficult tasks for the student to master is the transition from flying "head-in-the-cockpit" instruments to obtaining external visual references for final alignment with the runway. This is extremely difficult to teach in the aircraft itself—because of many factors ranging from aircraft and flight restrictions to weather conditions and the inexperience of the student.

Despite these highly beneficial advantages of the new simulator—onset motion cues and a visual display—both aspects have limitations which require further development of the state of the art prior to full application of simulators across the spectrum of flying training. The visual display of the simulator will project a field of view that is 48 degrees horizontally and 36 degrees vertically. This limited field of view will not permit us to attempt simulator accomplishment of other phases of student training, such as visual traffic patterns, formation flying or aerobatics. Training for all of these tasks, so necessary for an accomplished military flyer, requires some degree of extended horizontal visual reference—the ultimate objective being a full visual scene in the simulator—just as in the aircraft itself.

The second limitation is the fact that the IFS motion base will provide the proper cues for the pilot entering a sharp turn—but it is incapable of providing the cues for maintaining the rapid rate of turn for an extended period. This problem is presently under study by the Air Force as part of a simulator research and development project.

Despite these limitations and drawbacks, we believe the simulator will help us in the pilot training business—for several different reasons. One of the reasons is safety. There are maneuvers which require much practice, although to do so prior to obtaining flying proficiency requires activity in excess of that which is considered safe.

Another factor that affects the quality of training is the effective use of time. Because of today's congested airways, our practice areas are usually a considerable distance from the base. In the simulator, there is no time lost proceeding to and from a practice area. Another advantage with simulators is that a turn of the dial sets the simulator as appropriate for either day or night flying.

Another factor is weather. While practice in adverse weather conditions (instrument flying) is necessary for pilot qualification, it obviously needs to be controlled carefully from a safety standpoint. A simulator that will allow us to establish specific cloud heights and varying degrees of visibility will serve to greatly enhance our capabilities.

As I mentioned earlier, cost factors in these days of reduced budgets are an increasingly important part of the training equation. In ATC, we fly approximately one million hours per year. It follows that consequently, what may appear to be a minor change of one flying hour in the course of instruction can mean a significant change when considering overall UPT program costs, realized simply through the transfer of flight instruction from the aircraft to a flight simulator. In addition to dollar savings —the program also has the very important advantage of easing the fuel shortage.

Nevertheless, further experience needs to be gained prior to a full commitment to substitution. Direct training costs still remain only a partial factor, and all factors must be weighed carefully in the light of training quality.

Whatever the degree of substitution that is achieved, we believe the benefits to be derived from our new simulators will be considerable. The added features of onset motion and visual cues—now lacking in the current instrument trainer —will enhance our capability for duplicating in-flight sensations and perceptions, for recreating the same environment the student will encounter in actual flight . . . at least to the extent feasible in the current state of the art.

An instructor pilot sits in the right seat of the Advanced Simulation in Undergraduate Pilot Training (ASUPT) cockpit. The right seat enables the instructor to interact for the student all malfunctions, performance demonstrations and training capabilities of flying. Two Air Force officers—an element leader and instructor—operate the simulator, which has made "no fly" training a reality.

What's a
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The installation of one of the world's most advanced flight simulators recently at Williams Air Force Base, Arizona, marks a major milestone in current attempts to advance the state of the art in simulation as applied to military flight training.

Williams Air Force Base is the largest of the eight Air Force undergraduate pilot training bases, all located throughout the southern United States.

The Advanced Simulation in Undergraduate Pilot Training (ASUPT) system consists of two T-37B flight simulators. Extensive studies in the role of simulation in Air Force pilot training will begin early in 1975.

Research using the system will eventually lead to savings in aircraft operations costs (including fuel) far exceeding the initial investment, by limiting flying time to the minimum essential requirement through substitution of simulation for flying time.

The studies will be conducted by the Air Force Human Resources Laboratory's Flying Training Division (AFHRL/FT), located at Williams. The unit is one of seven divisions of the laboratory, which is responsible for research and development in personnel, training, and education for the entire Air Force.

The Flying Training Division is working to improve pilot, navigator, and combat crew training programs for all major commands with achievements being measured in terms of more proficient aircrews as well as in dollar savings.

Several features make the simulators at Williams Air Force Base unique.

The six degrees-of-freedom motion system, provides "onset" cues during simulated aircraft accelerations. Since such motion cannot continue indefinitely, the pilot sits on a "G-seat" which simulates sustained sensations experienced during aerobatic maneuvers. Individual air cells in the pilot's seat cushion and backrest inflate and deflate under computer control, and his lap belt tightens or relaxes to vary the pressure it exerts on him.

Each cockpit will be surrounded by a visual dome with seven television tubes providing nearly a complete visual field. The TV tubes (black and white cathode ray tubes) will be driven by a computer image generation system which creates what would be seen in the cockpit from a digital data base stored in the computer memory. No models or film are used in this visual system.

The cockpits and motion systems are being provided by the Singer-Link Corporation at a cost of approximately $12.5 million. The visual system is being manufactured by the Apollo and Ground Systems Organization of the General Electric Company and will cost about $9 million. Integration of the two systems is the responsibility of the Singer-Link Corporation and adds $1 million to the total contract cost.

The first demonstration of the fully integrated system is expected to begin at Williams in December 1974.

SEWT

A highly sophisticated new simulator for electronic warfare training (SEWT), designed to train navigators as electronic warfare officers (EWOs), is being employed at Air Training Command's Mather Air Force Base, California, where all Air Force navigators receive their initial Undergraduate Navigator Training (UNT). EWO trainees are graduates of that course, qualified navigators who have been selected for this advanced training.

The simulator—referred to as the SEWT or T-5—is officially described as a general task, eight-student-position, digitally controlled electronic warfare simulator. In it the trainees learn basic skills, operational techniques and tactics in a realistic and dynamic electronic environment.

An interface between computer and electronic equipment creates actual radar or other signal characteristics in a wide range of frequencies. Using electronic warfare receivers, transmitters, analysis equipment and expendable systems installed in each of the eight student stations, trainees are taught to recognize, analyze and counter these signals.

A digital system using computer control, the SEWT can modify missions while conducting a variety of preprogrammed training exercises, and its automated monitoring, scoring and evaluation capability improves training cost effectiveness: Instead of one instructor monitoring one student, he can monitor four.

The SEWT has several attractive economic aspects. One has particular significance in these times of energy shortages: the SEWT has been a significant factor in making "no fly" Electronic Warfare Officer Training (EWOT) a reality, leading to the retirement of a fleet of 12 ET-29s previously used in the program. And since instructors won't have to wait for landings or takeoffs before beginning instruction, more training can be accomplished than in the same period of time in the aircraft training program. Also, SEWT will permit the present course length of 28 weeks to be shortened by two to three calendar weeks. Most important from a learning standpoint, the student can proceed at his own pace, which is not possible in an airborne situation.

The EWOT non-flying course is the outgrowth of an earlier ATC reevaluation of its electronic warfare training. Based on the findings, Headquarters, United States Air Force approved an ATC proposal to test a non-flying concept, using the existing T-3 and T-4 simulators. The asumptions underlying the proposal were that basic airmanship skills had been acquired by electronic warfare officer trainees during their original navigator course; secondly, flying training had not kept pace with the state of the art and a simulator could provide equivalent—if not better—training with improved cost effectiveness.

Results of the test were evaluated by ATC and the operational commands—Aerospace Defense Command, Strategic Air Command, Tactical Air Command and Pacific Air Forces. In July 1972, Headquarters USAF approved the evaluation and ATC's recommendation that a simulator no-fly program be implemented in conjunction with employment of the SEWT.

At present, Air Training Command instructors train several hundred electronic warfare officers a year. Some of these are from the Air Force Reserve, Air National Guard, the U.S. Marine Corps and the Canadian Armed Forces.

The first class to use SEWT convened January 18, 1974.

SCOPES

New Squad Training Method

Streaking may be the in-thing for school students today, but in the 82d Airborne Division as well as other units, worldwide, attention is on "scoping."

SCOPES or Squad Combat Operations Exercise (Simulation) is a new training technique developed over the past several months.

The system consists of a six-power telescope, mounted on each man's M-16 rifle; each squad member also has a number pinned on four sides of his helmet. As the attacking squad nears its objective, the defending unit attempts, by means of the scopes, to read the numbers on the helmets of the advancing wave.

Controllers with radios accompany both the attacking and defending units. If a trooper's number is sighted, the controller designates him as a casualty and he must drop out of the problem. The officer-in-charge records the numbers of the fallen troopers and, after the attack is complete, supervises a critique at which soldiers are encouraged to suggest improvements to each other's movements and technique.

The concept was initially designed by the Army Research Institute in Washington, D.C. Further testing has been carried out by the Combat Arms Training Board and the U.S. Army Infantry School at Fort Benning, Georgia.

A total of 3,000 SCOPES sets (six-power scope, rifle mount and numbered patches) have already been distributed. In the next several months an additional 30,000 sets are scheduled to be in troop unit hands.

Troop reaction to the new training technique is extremely favorable. 82d Airborne Division Sergeant Jesse G. Laye says, "The SCOPES training increases both morale and interest in basic squad tactical exercises."

Smaller training budgets, restricted supplies of fuel and ammunition and limits on use of land and air space for training purposes are a few of the challenges facing the Army Training and Doctrine Command (TRADOC).

These challenges are being met by improving existing training simulators and developing others which are more effective and can result in economical ways of teaching the soldier how to operate equipment.

As the command charged with determining what is taught and how to train, TRADOC is working with Army Materiel Command to design better simulators to assist units in conducting training in the field. Utilizing improved technology such as computers, lasers and the latest instructional methods, TRADOC seeks not only to meet the training challenges but to make simulators more effective training devices than the equipment they represent.

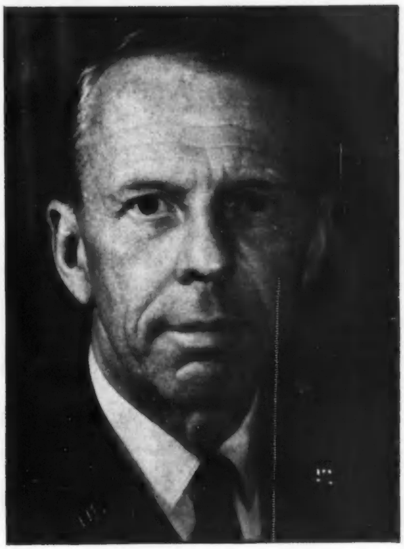
The importance of potential savings in training time, manpower and money associated with the use of training devices is fully recognized. However, the Army remains fundamentally interested in improving the effectiveness of its training. Each training device is evaluated according to its benefit to the trainee and the way it lends realism to combat training.

Soldiers at Fort McPherson, Georgia, practice unloading techniques from a mockup of a C-5 aircraft.

ARMY

Simulators Speed Training, Reduce Costs

By
GEN. W. E. DUPREY, USA
Commanding General
Training and Doctrine
Command



Does the simulator provide more realistic high quality training in less time? That question must be answered in the affirmative prior to the developing of any simulator.

There are now more than 30,000 training devices, worth almost $51 million, being used by the Army in the Continental United States, and many others are being developed.

Some of the new devices now or soon to be available include:

- A flight training system incorporating use of a motion platform and a computer to teach basic and advanced instrument flying, emergency situations, and proficiency and transition training.
- A simulation of the CH-47 Chinook helicopter incorporating a visual system so that both contact and instrument training can be conducted.
- A representation of the AH-1Q Cobra helicopter for contact, instrument and gunnery training.
- A NAP-of-the-earth navigation trainer.
- A Combined Arms Tactical Training Simulator.

The Multiple Integrated Laser Engagement System (MILES), a family of laser devices being developed to simulate the firing and kill capabilities of direct fire weapons.

Performance simulators which are general purpose trainers providing adaptive training features. These simulators are capable of being programed into many different training situations in order to simulate the use of military hardware where progressive, sequential step by step procedures are involved.

Through the use of the simulators and other improved training techniques, TRADOC seeks to provide our soldiers with the most modern, realistic, thorough tactical and technical training possible.

NAVY

New Simulator Methods Vital to Training

By
VADM M. W. CAGLE
Chief of Naval
Education and Training

In its simplest form, simulation means "copying." Simulators are used to copy conditions and phenomena likely to occur in actual performance. The use of the simulator as a training tool has increased proportionally with the increase in our technology which enables higher fidelity "copying" of actual operational conditions. This has been publicly demonstrated in the space program, commercial aviation and is an integral part of many military training programs.

The ability to train personnel under safe, realistic, controlled and closely monitored conditions provides the "experience" factor to personnel which is normally obtained only by facing these conditions and phenomena under actual operating conditions. These normal environmental and combat conditions, coupled with multiplex adverse situations, can only be provided cost-effectively through simulation.

Consumption of fuel, ordnance and other materials and the effort required to manage that consumption can be reduced significantly through increased emphasis on simulation; thus, the shortfall in energy sources has accelerated military interest in simulation and it is being looked upon to at least partially relieve the fuel demands of the military. Simulation will provide some relief, but more importantly, it will increase our forces' operational readiness at a substanial savings in dollars, time and safety.

Why does the Navy use simulation? The answer to this question has several facets; however, the main reasons fall into one of the following areas: cost effectiveness, training effectiveness, safety and more recently fuel conservation.

In spite of the high cost of many individual trainers, simulators are a great dollar saver. Not only because a trainer is cheaper than a nuclear submarine, but also because of the fact that the trainer versus the ship is available for full time use as a trainer. No time needs to be set aside for the many other functions which must be performed at sea, like meals, routine cleaning and maintenance time. Simulators can and are used up to 24 hours a day to train successive individuals or ship teams.

Cost effectiveness of simulators is increased by the fact that although a sim-

Device 14A2—Surface Ship ASW Attack Trainer—(above) duplicates the physical configuration of major operational compartments and equipment of surface ship ASW attack weapons and simulates their functional operation. The simulator is currently in operation at San Diego, Newport, Key West, Charleston, Long Beach, Pearl Harbor and Etajima (Japan). Training Devise Computer (TRADEC) Cockpit, Motion System and Control Console is a major research tool being used by the U.S. Navy. The cockpit is designed to accommodate a tandem seating arrangement. This simulator is configured like the interior of an F-4 Phantom.

MARINES

Simulators: Unlimited Potential

Simulation equipment used in both ground- and aviation-related training has unlimited potential and provides an innovative and cost-effective teaching tool. This equipment employs the latest state of the art in educational technology and methodology.

Although ground-related simulation equipment has not yet been developed to the high state of sophistication of aviation-related simulation equipment, ground-related simulators are designed to improve the learning process and to assist in producing a better trained individual. They are neither designed nor intended to replace hands-on training, but rather to make the hands-on training more meaningful and effective. Aviation simulators are considered an invaluable training tool which supplement flight hours without the requirement for additional fuel.

It is readily apparent that the use of simulation equipment in ground and aviation training can and does enhance training in a cost-effective manner and provides a tool to produce a more professionally trained Marine Corps.

The U.S. Navy's 21B20 simulates the submerging, submerged, and surfacing performance of the Trigger (SS-564) diesel electric submarine.

ulator may be quite complicated, its maintenance costs are lower when compared to an actual ship or airplane. This situation is enhanced by the fact that we can keep the trainer housed in a climate-controlled facility away from the harsh realities of the environment.

Finally, in a trainer, many functions are performed electronically which must, in the real world, be accomplished in other manners, i.e., the manufacture of feed water in a trainer costs a fraction of a cent as a computerized function whereas, in the real world steam would need to be generated, fuel used, etc. Therefore, simulators are a cost effective way to decrease the cost of Navy training.

Training effectiveness is a second valid reason for the use of simulator training. As mentioned before, the number of hours a simulator can be made available for training is high. In addition, a student may, in literally minutes, be subjected to problems and stress situations that would take extended experience in the real world to meet. A case in point could be a simulated training flight. The pilot could take off on a short runway under marginal weather conditions, be diverted to a new destination causing navigational problems, suffer a variety of material casualties and be forced into an emergency landing in an hour or two's flight. To experience all of these problems in the real world would require substantially longer periods of time and correspondingly higher costs.

Additionally, experience has shown that training transfer is high. Commercial airlines now transition pilots from one aircraft to another with as much as 80 percent simulator and only 20 percent actual flight time. Although the military has not reached this level, we are constantly increasing the percentage of training accomplished by simulators. Many other examples of training effectiveness could be cited, but essentially, in many situations, far more training can be accomplished in a given time frame by use of simulators than by use of its operational counterpart.

Safety is another factor to be considered in the use of simulators. A young pilot, ship conning officer or engineer can be subjected to many "hazardous" conditions in the simulator and allowed to solve the problem himself with no hazard to life, limb or property. The student actually attempts to solve the problem and lives to learn what he did wrong and how never to do that again, but it lets him build confidence that he can handle himself in the real environment when transitioned to it.

Finally, the Navy is using simulation to assist in solving the Nation's energy problems. Every simulated flight or ship cruise saves precious fuel. One program already implemented will save 9 million gallons of jet fuel in 1974 alone.

The emphasis placed on simulation requires expansion of the present Navy inventory of 1600 simulators to support the reduction goals in flight hours and steaming time. In order to meet these goals, an inventory increase of approximately $60 million above these previously identified for FY 74 and 75 must be provided. The present plan for use of these additional funds is as follows:

a. Update and modernize existing flight and other weapon system simulators and procure new simulators for high fuel consuming weapon systems in the Navy/Marine Corps inventory. This includes, but is not limited to the following programs:

(1) Flight Training System

(2) ASW Surface Ship System

(3) Submarine Attack System

(4) Amphibian Warfare System

b. During FY 75 the program is primarily geared to the procurement of new simulators with some update and modernization of existing trainers. This includes, but is not limited to the following programs:

(1) Submarine Ship Control Trainer

(2) Surface Team Trainer

(3) New Submarine Combat System Trainer

(4) Steam Propulsion Plant Trainer

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