REPORT TO THE CONGRESS

Greater Use Of Flight Simulators In Military Pilot Training Can Lower Costs And Increase Pilot Proficiency B-157905

Department of Defense

BY THE COMPTROLLER GENERAL OF THE UNITED STATES

AUG. 9, 1973

COMPTROLLER GENERAL OF THE UNITED STATES
WASHINGTON, D.C. 20548

B-157905

To the President of the Senate and the
Speaker of the House of Representatives

This is our report entitled "Greater Use of Flight Simulators in Military Pilot Training Can Lower Costs and Increase Pilot Proficiency."

We made our review pursuant to the Budget and Accounting Act, 1921 (31 U.S.C. 53), and the Accounting and Auditing Act of 1950 (31 U.S.C. 67).

We are sending copies of this report to the Director, Office of Management and Budget, and to the Secretaries of Defense, the Navy, and the Air Force.

Elmer B. Staats

Comptroller General
of the United States

Contents

ABBREVIATIONS

DOD Department of Defense

FAA Federal Aviation Administration

GAO General Accounting Office

COMPTROLLER GENERAL'S REPORT TO THE CONGRESS

GREATER USE OF FLIGHT SIMULATORS IN MILITARY PILOT TRAINING CAN LOWER COSTS AND INCREASE PILOT PROFICIENCY

Department of Defense
B-157905

D I G E S T

WHY THE REVIEW WAS MADE

Since costs of operating military aircraft are rising rapidly and procurement costs of aircraft are rising even more rapidly, GAO reviewed commercial and military uses of simulators for flight training to find out if greater use of simulators would reduce Department of Defense (DOD) costs without weakening pilot proficiency.

GAO reviewed the pilot training programs of the Air Force and the Navy because they fly the most fixed-wing aircraft.

FINDINGS AND CONCLUSIONS

Advancements in technology are continually improving flight simulators' ability to duplicate the operating characteristics of flying and flight environment. Without the cost and risk of actual flight, pilots can "fly" takeoffs and landings, hear engine noise, and feel the pull of gravity from sharp turns or other maneuvers. Similarly, without leaving the ground, military pilots can practice radar-controlled bombing and missile firing. (See pp. 5 to 10.)

Commercial airlines have taken advantage of breakthroughs in simulator technology since the mid-1960s. Beginning in 1967, the Federal Aviation Administration allowed commercial airlines to replace various phases of flight training with training in improved simulators. Two airlines conduct 75 to 89 percent of their pilot transition training (teaching experienced pilots to fly new airplanes) on the ground in simulators. The commercial airlines plan to do all such training in simulators. (See pp. 8 to 10.)

The Navy and the Air Force fly approximately 8.4 million hours a year in all types of aircraft. Hourly operating costs for fuel, maintenance, and spare parts range from less than $50 an hour for light trainers and utility aircraft to more than $1,500 an hour for operational combat aircraft. (See p. 15.)

Much of the military's flying time is for training, especially in combat aircraft, such as fighter and attack planes, patrol planes, and bombers. Except for combat missions, virtually all flying in these aircraft is for training. (See pp. 15 to 17.)

The military services have not always purchased improved simulators, although the technology has been available. This was due in part to operational requirements and priorities created since 1965 by the Southeast Asia conflict. (See p. 8.) As a result, sufficient priority and emphasis were not placed on developing sophisticated simulators which could satisfy more of the complex military training needs. (See pp. 8, 10, 11, and 12.)

Both services, but especially the Air Force, have begun to study their pilot training programs in order to reduce training costs through increased simulator use and better training methods. More money has recently been spent to develop better simulators, particularly to provide wider view visual simulators needed for the military's complex training in visually oriented combat maneuvers. (See p. 12.)

Navy and Air Force studies completed in 1972 predicted that, with better simulators and improved training techniques, flight time at basic pilot training schools could be reduced in the mid-1980s by about 46 to 49 percent, depending on the type of airplane involved. (See p. 12.)

The potential net savings available through the use of simulators depends on the amount of actual flight time that simulator training can replace. The cost of operating simulators is less than the cost of flying aircraft. For example, the average hourly operating cost for the F-4 and A-7 airplanes is about $853 compared with about $80 for the simulator. (See pp. 15 and 16.)

The extent that simulator training can replace flight training in combat airplanes used in intermediate training and operational squadrons is not known. However, substantial savings are likely. If 25 percent of the flight training in such aircraft can be replaced by training in simulators, GAO estimates annual savings of about $455 million; a 50 percent replacement would save about $910 million annually. (See p. 17.)

Greater use of simulators could help to ease projected fuel shortages. (See p. 16.)

Developing and producing simulators would involve unknown additional costs, but such costs would be warranted in view of the potential savings. (See p. 14.)

The range of potential savings is necessarily broad because under the current state of the art in simulator technology there is no basis to accurately measure the amount of flight training which can be replaced by future simulator use.

With the development of more sophisticated visual simulators, the amount of actual flight characteristics and maneuvering which can be accurately duplicated should increase, permitting more simulator training instead of air training. (See p. 17.)

Simulators offer safer training in many situations. The possibility of an accident always exists during a flight, but accidents obviously cannot occur while using a simulator. Pilots can train as much as needed in simulators to cope with emergency situations, such as engine failures, without risking lives or the airplane. (See p. 18.)

About one of every four airplanes purchased is needed for support purposes, i.e., used for pilot training or to replace airplanes undergoing periodic maintenance. Increased simulator training might release some support airplanes for assignment to operational squadrons, thereby increasing combat capabilities. (See p. 18.)

Simulators could increase pilot proficiency by allowing pilots to use a greater percentage of actual flying time to practice the complex flight maneuvers which cannot be fully simulated. (See p. 19.)

Simulators could also be used to more accurately measure pilot proficiency by using objective grading procedures rather than relying on subjective judgments. (See pp. 19 to 22.)

RECOMMENDATIONS OR SUGGESTIONS

The military services have recently taken several steps to increase simulator development and use for pilot training which GAO believes are constructive. However, continuing emphasis will be necessary for several years. (See p. 21.)

This will require that current research and development funds be spent to achieve future long-term benefits. Accordingly, GAO recommends that the Secretary of Defense require the Navy and the Air Force to:

--Put a higher priority on developing improved simulators which can replace maximum amounts of flight training.

--Insure that development and use of adequate simulators are integral parts of acquisition or modification programs for sophisticated aircraft.

--Use simulators as much as possible to reach and maintain desired proficiency, including the establishment of simulator grading methods which will provide a more accurate evaluation of pilot proficiency. (See p. 21.)

AGENCY ACTIONS AND UNRESOLVED ISSUES

The Assistant Secretary of Defense (Manpower and Reserve Affairs) agreed fully with the recommendations (see app. II) and stated that:

--DOD understands the need to explore alternatives to traditional flight training programs.

--Advance simulators have been delivered, have been placed on order, or are under development for the latest weapon systems in the inventory.

--In-depth studies will be made to objectively determine individual performance, learning transfer, and costs related to this training approach.

GAO plans to evaluate the effectiveness of these actions in future reviews.

MATTERS FOR CONSIDERATION BY THE CONGRESS

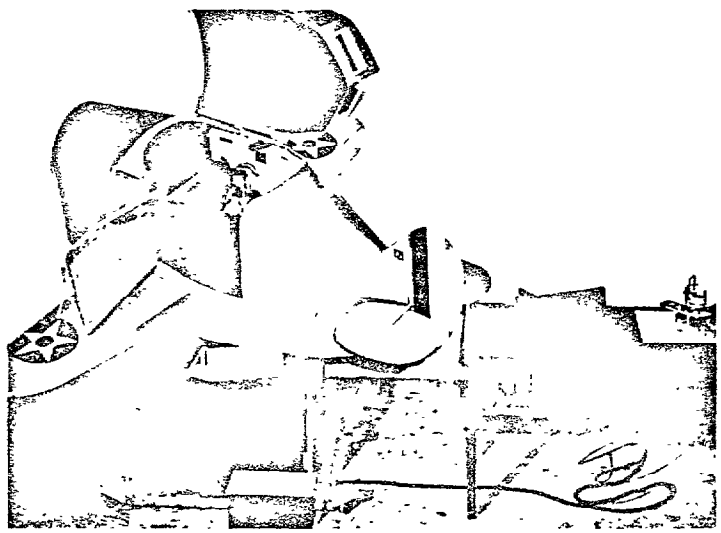
This report shows how military flight training costs can be reduced substantially and the projected shortages of fuel eased somewhat through greater uses of flight simulators by the Air Force and the Navy. No legislation is required, but oversight by the Congress is recommended.

CHAPTER 1

INTRODUCTION

EVOLUTION OF SIMULATORS

Trying to simulate conditions likely to occur in flight is not new for training airplane pilots. Mechanical pilot training devices have been used for many years to teach students how to use flight instruments and controls--an example being the Link trainer which was widely used by the military during World War II. Such devices were designed to teach basic instrument skills without attempting to duplicate the cockpit surroundings of any particular airplane or actual flying characteristics.



With the introduction of analog computers, an attempt was made in the late 1940s to reproduce certain cockpit and flight characteristics of a particular airplane. These training devices became known as simulators. Technological advancements in electronics and digital computers during the early and middle 1960s combined with visual systems which show the view from the pilot's window have enabled modern simulators to increasingly duplicate the flight characteristics of an airplane and its environment.

DIFFERENCES IN COMMERCIAL AND MILITARY PILOT TRAINING

Military pilots must learn tactical skill--such as air-to-air combat, bombing, and strafing--in addition to the more routine flight skills required of commercial pilots. They must maintain proficiency in more varied areas, many of

which are extremely difficult or impossible to simulate with current technology. As discussed below, other differences and a few similarities exist in the pilot training programs.

We were informed by Navy and Air Force officials that the airlines hire experienced pilots almost exclusively from the military services and teach them to fly specific airplanes. Therefore, basic pilot training is not involved. Pilots must pass the Federal Aviation Administration's (FAA's) proficiency test before being allowed to fly scheduled flights and must pass periodic proficiency flight checks to continue flying. Pilots remain proficient through normal airline flying and periodic refresher training at airline schools.

Unlike the commercial airlines, the Navy and the Air Force teach basic flying skills to nonpilots at basic pilot training schools.

Graduates of basic pilot training schools are sent to intermediate schools to learn flying and tactical skills in a specific airplane, such as the F-4 or the A-7. Like commercial pilots, military pilots must pass proficiency tests. Such tests are required for military pilots to graduate from intermediate pilot training schools.

Graduates of intermediate schools are then assigned to operational squadrons where pilots and crew train continually, except when in combat or on cargo-passenger carrying flights. This phase compares to the commercial pilots' revenue-producing flying. This training is to maintain and refine operational mission-oriented operations. Pilots must pass at least two flying examinations annually to continue flying; one is for proficiency and one is primarily instrument oriented.

SCOPE OF REVIEW

We reviewed the pilot training programs of the Navy and the Air Force to determine the extent of simulator use for pilot training and whether sufficient emphasis has been given to developing and procuring improved simulators. Our review was made at Air Force headquarters, the Deputy Chief of Naval Operations (AIR), and the Naval Air Systems Command, all in the Washington, D.C., area, and at several Navy bases in the southeastern United States. We also obtained

information from FAA, several private companies which specialize in simulator manufacturing, and two major commercial airlines.

CHAPTER 2

LOW SIMULATOR USE IN MILITARY PILOT TRAINING PROGRAMS

Commercial airlines included in our review do most of their transition training in simulators. The Navy and the Air Force still rely heavily on actual flight training. At the time of our review, simulator training time as a percent of total simulator and flight training time ranged from 75 to 89 percent for two representative commercial airlines. As shown below, the Navy and the Air Force use simulators considerably less, mostly for training military pilots to fly cargo airplanes. Even here, however, simulator use is lower than the commercial airlines, although required flying skills are practically identical.

Simulator Training Percentages

Type of training	Navy	Air Force	Commercial
Basic jet	22	24	(a)
Intermediate:			
Cargo/passenger airplanes	(a)	44-52	75-89
Fighter airplanes	19-33	23-35	(a)
Operational:			
Fighter airplanes	2	5-13	(a)

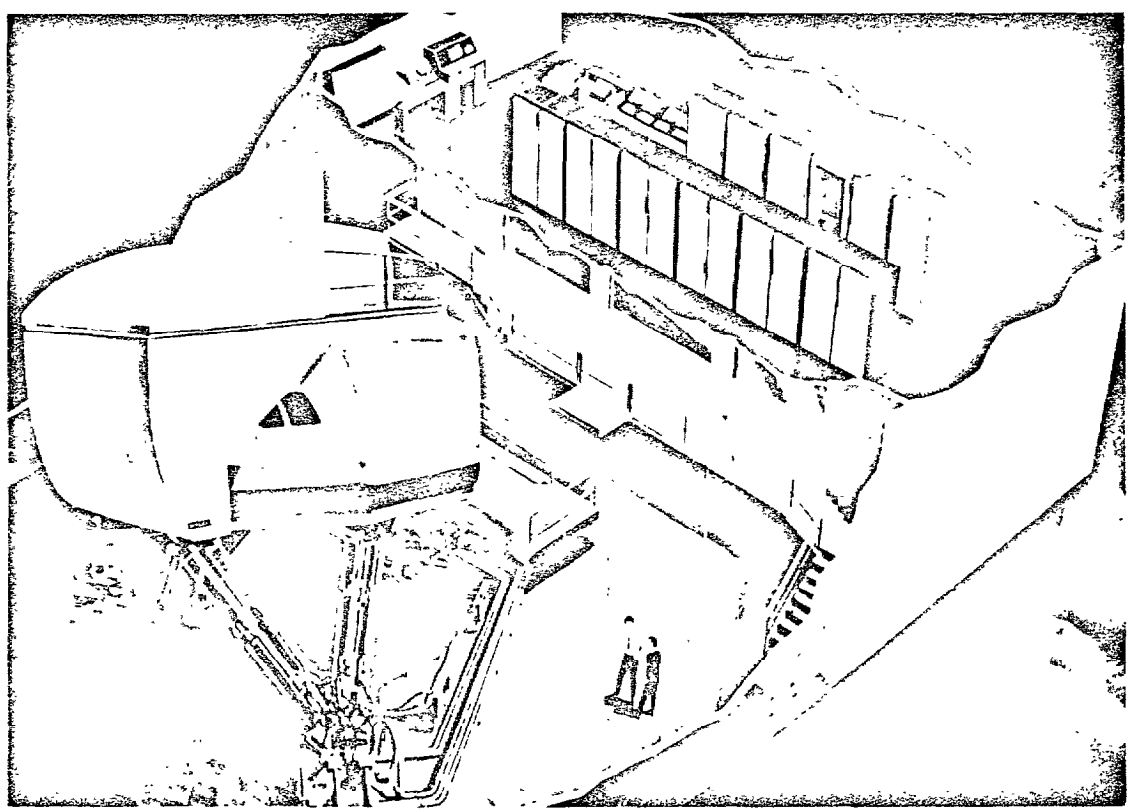
[a]Not applicable.

The military services have not always purchased improved simulators, although technology was available, partly because of operational priorities and requirements brought about by Southeast Asia operations and because simulators and airplanes compete for the same procurement funds. In addition, the services have not sufficiently emphasized the development of improved simulators which could satisfy many of the complex military training needs. As a result, simulator use is very low in operational squadrons where sophisticated simulators are needed to provide realistic training. However, this is where the cost benefits of simulators would be greatest due to the high operating cost of the combat aircraft used in these squadrons.

ROLE OF SIMULATORS FOR AIRLINES

Commercial airlines--which are not confronted with the more complex military tactical flying--train for day and night operations including take-offs, level flights, navigation, and landings. Although the airlines have used training devices and simulators for many years, significant replacement of flight training with simulator training did not begin until 1967.

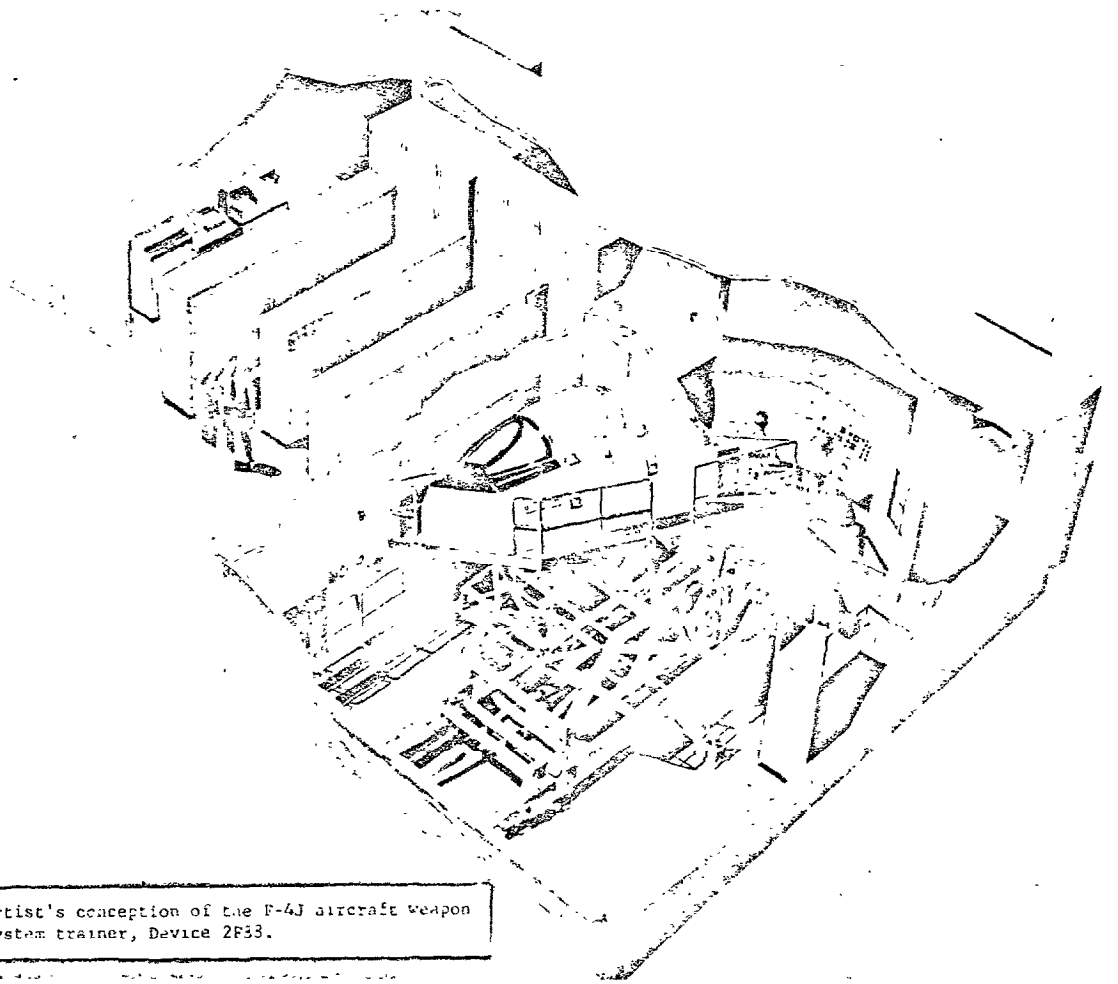
At that time, FAA allowed the airlines to replace much of their transition flight training with simulators when the airlines demonstrated that such training resulted in equally proficient pilots. A commercial airline's $2.3 million L-1011 simulator is shown below.



The airlines' goal of doing all transition training in simulators may be possible with further improvements in visual systems.

ROLE OF SIMULATORS FOR NAVY AND AIR FORCE

Existing simulators which are nonvisual systems provide military pilots with some training in instrument flying, electronic countermeasures, emergency procedures, and radar-controlled bombing and missile firing. A $5 million F-4J simulator currently used by the Navy is shown below.



Artist's conception of the F-4J aircraft weapon system trainer, Device 2F33.

In some instances, however, the services have not acquired improved simulators, or they bought them so late that training phases which could be given in simulators had to be given in the airplane because the simulators were not available. For example, from July 1969 through December 1971, the Navy and the Marine Corps received eight new types of combat airplanes and the Air Force received five. For six of these aircraft we found that:

--Although the Air Force planned to buy an F-111F simulator, it was not bought because of money shortages and because the airplanes received a higher priority than the simulator for available program funds. Air Force officials informed us that a contract was awarded in September 1972 to modify an F-111D simulator and that the simulator is expected to be received during late 1974, about 3 years after receipt of the airplanes.

--A modified mission simulator for the Marine Corps' A-4M was scheduled for receipt 1-1/2 years after the airplane. Navy officials said money shortages prevented earlier modification.

--A flight simulator for the Marine Corps' AV-8A was scheduled for receipt 2 years after the airplane. The procurement was delayed until a significant number of airplanes was received.

--The Navy deferred funding the EA-6B tactics simulator for 1 year because of money shortages. As a result, the simulator was scheduled for receipt 1 year after the airplane.

--Simulators bought for the Navy's A-6E and E-2B did not provide complete nonvisual training. Navy officials said a shortage of funds prevented modifications of existing simulators to the A-6E design and that the E-2B simulators now being purchased are modified E-2A simulators.

Simulators are being produced for three Navy airplanes to be received in the future--the S-3A, F-14A, and E-2C which is only a part task trainer and not a complete weapon system trainer. We were informed that plans are in effect to establish timely simulator procurements for three future Air Force airplanes--the F-15, B-1, and A-10.

Because simulators and airplanes compete for the same procurement funds, we believe it is important that sufficient priority is put on the development of simulators for these new airplanes so that simulators can be received prior to or concurrently with the airplanes.

More sophisticated systems needed for combat airplanes

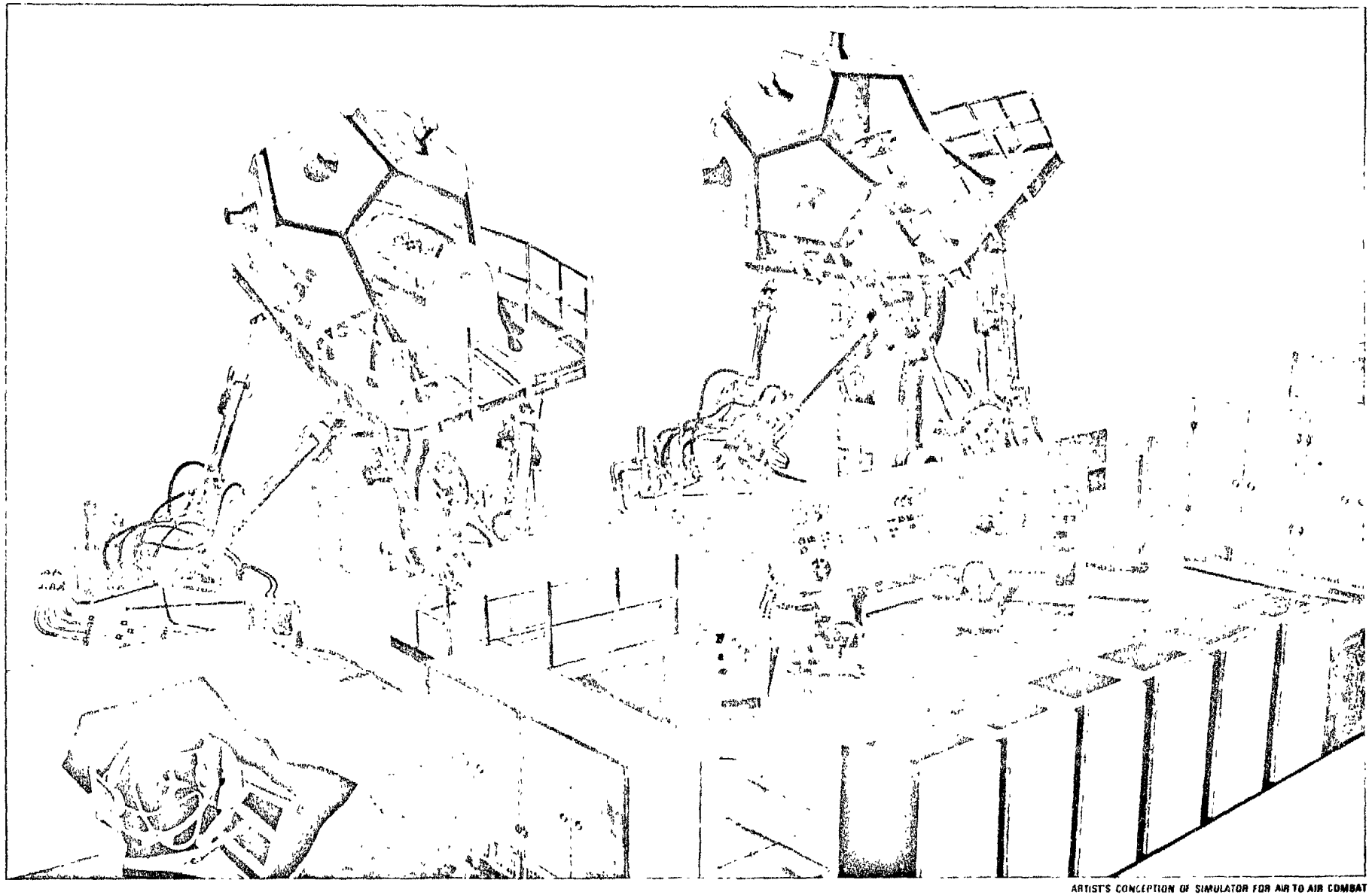
More sophisticated, wider view visual simulators are needed for the more complex training in visually oriented combat maneuvers, such as close air support, weapons delivery, formation flying, and air-to-air combat. The military services are developing experimental simulators which may eventually satisfy some of these visually oriented training needs.

The Air Force in 1968 and 1969 tested visual simulators used by commercial airlines but found them inadequate for training pilots in the complex combat maneuvers of fighter airplanes. According to Air Force officials, research and development work on visual systems was done from 1968 to 1972 at a cost of $4.3 million to attempt to satisfy these Air Force training needs. Development contracts totaling $31 million were awarded in 1971 and 1972 to build two experimental simulators for air-to-air combat and basic pilot training. The $13 million simulator for air-to-air combat is shown below.

The Navy has not put as much emphasis as the Air Force on developing needed simulators. The Navy tested a daytime carrier-landing visual simulator in 1965 but found it inadequate because the picture was not coordinated with the movements of the airplane. In 1970 the Navy purchased, for $4.6 million, two A-7E night carrier landing simulators with an off-the-shelf visual system. These simulators, which were bought after the manufacturer demonstrated that they offered equal pilot proficiency, were delivered in 1972 for use at pilot training schools 3 years after the A-7E aircraft were delivered.

In addition to the visual simulator discussed above, a prototype visual system costing $1.5 million was acquired by the Navy in 1972 for experimental use in training phases, such as weapons delivery, takeoffs, and landings.

Navy- and Air Force-sponsored studies completed in 1972 predict that by the mid-1980s--through improved training techniques and better simulators--flight time at basic pilot training schools could be reduced by about 49 percent for the Air Force, and by about 46 to 48 percent for the Navy's jet



ARTIST'S CONCEPTION OF SIMULATOR FOR AIR TO AIR COMBAT

and propeller schools. These estimates are now being validated though experimentation by the services.

We believe increasing amounts of military pilot training can be done in simulators at intermediate training schools and for operational squadron training as better ones are developed. However, meeting these goals will require the two services to increase emphasis on simulator development and use.

The cost of developing and buying sophisticated visual simulators cannot be determined at this time. Likewise, the full potential of simulator technology is unknown. These questions cannot be answered until simulator training capabilities and limits have been evaluated using experimental simulators, such as the air-to-air device now being developed by the Air Force.

However, in view of the potential benefits of simulators and their costs in the past, we believe investment in simulator development now would more than pay its way by decreasing future training costs.

CHAPTER 3

SIMULATOR TRAINING BENEFITS

The Navy and the Air Force fly approximately 8.4 million hours a year in all types of aircraft. Hourly operating costs for fuel, maintenance, and spare parts range from less than $50 for light trainers and utility aircraft to more than $1,500 for certain operational combat aircraft.

Increased use of simulators could significantly lower the military's pilot training costs. For example, the Navy and the Air Force could save about $390 to $1,400 an hour in operating costs when simulator training replaces flight training in combat airplanes used in intermediate pilot training and operational squadrons. Potential savings would depend on the amount of flying hours replaced by simulators. We believe that, with increased emphasis on developing and using more sophisticated simulators which can duplicate more of the complex flight maneuvers required for combat operations, annual training and accident costs could be substantially reduced. In addition, pilot losses would probably be reduced, fewer support airplanes would be needed, pilot proficiency could be increased and more accurately tested, and the projected fuel shortages might be eased.

The trade-off possibility of flying time for simulator time for various missions is not known. However, technical experts agree that significant savings should be available by substituting simulators for some flying time. The state of the art in simulation should be accelerated so that whatever cost benefits are possible can be exploited to offset the projected high training costs for the sophisticated aircraft currently in development, such as the F-14, F-15, B-1, and S-3. Cost-benefit analyses should, where practicable, include estimates of the costs of developing, producing, and operating new simulators.

LOWER TRAINING COSTS

Training costs are lower in simulators than airplanes primarily because the operating expenses associated with "flying" the simulators are lower. The following comparison of hourly simulator and airplane operating costs for certain military and commercial airplanes illustrates the significant

potential savings obtainable by substituting 1 hour of flight time for 1 hour of simulator time. The conclusion, however, should not be made that this substitution can be made on a one-to-one basis. The transfer of training effectiveness of simulators is the subject of current and planned research within the military departments.

Greater use of flight simulators may also ease the projected energy crisis because fuel consumption would decrease to the extent that simulator hours are substituted for flying hours. According to Air Force data, the A-7 attack airplane consumes an average of 680 gallons of fuel per flying hour and the F-4 fighter consumes about 1,400 gallons.

Comparison of Simulator and Airplane Operating Costs (note a)

Airplane type	Hourly operating cost		Hourly savings with simulators
	Airplane	Simulator	
Military:			
A-7 attack and F-4 fighter (average)	$ 853	$ 80	$ 773
P-3 patrol airplane	450	60	390
FB-111 and B-52 bombers (average)	1,473	90	1,383
Airline A:			
Various commercial airplanes	400-1,500	60	340-1,440
Airline B:			
Boeing 727	420	90	330
Boeing 747	970	140	830

[a]Based on Navy, Air Force, and commercial airline cost data for fuel, spare parts, maintenance salaries and overhead, and simulator operator pay. Development and procurement costs for aircraft or simulators are not included.

Some military training personnel believe that enhanced simulation programs will save money; however, it is not possible at this time to say how much. To show the potential savings, we computed the dollar impact for various percentage reductions in flight time through the use of simulators for Navy fighters and patrol airplanes and for Air Force fighters and bombers. If 25 percent of the flying time in these airplanes was replaced with simulator time, savings might reach about $455 million annually. With a 50-percent replacement, savings might reach about $910 million annually. Our computation is shown in appendix I. We believe additional savings would result from fewer airplane accidents and associated costs, which in 1971 were about $542 million for all Navy and Air Force noncombat airplane accidents.

Although only 26 percent of the total Navy and Air Force flying is in fighters, patrol airplanes, and bombers, they represent the greatest potential for savings because of their high operating costs and because, except for actual combat missions, virtually all their flying is for training. The introduction of the sophisticated F-14, F-15, B-1, and S-3 airplanes in the near future will probably mean even higher operating costs for combat airplanes.

The range of potential savings shown above is necessarily broad because, under current simulator technology, there is no basis to accurately measure the amount or types of flight training which can be replaced by future simulator use. However, with the development of more sophisticated visual simulators, the amount of actual flight characteristics and maneuvers which can be duplicated with a high degree of fidelity should increase, permitting more simulator training in lieu of actual flight training.

Our estimates were made to show the significance of the potential savings rather than to be goals which should be reached by the Navy and the Air Force. The estimate depends on replacing flight time, but the extent that this can be done is unknown. Although the commercial airlines have set a goal of doing all training in simulators, we doubt that the military will be able to replace as much flight training because of the difficulties in simulating total realism of a complex military mission. Nevertheless, we believe substantial savings are achievable.

SAFER TRAINING

Greater use of simulators would probably reduce losses during training missions. An accident is always possible while flying an airplane, but flight accidents obviously cannot occur while "flying" a simulator. Inexperienced pilots can safely train as much as needed in simulators to handle emergency situations, such as engine failure, without risking the pilot's life or the airplane.

Transfer of training in high-stress situations, such as emergencies, has not been fully evaluated. The stress factor, an important ingredient in pilot task reactions, may be different in the simulator and, therefore, some actual flying will probably be required to retain the realism of flying hazards.

During 1971 Navy and Air Force non-combat-related accidents cost about $542 million, and 69 Navy pilots and 67 Air Force pilots were killed. If flying time were reduced, assuming desired proficiency is maintained, it is likely that pilot losses would also be reduced.

FEWER SUPPORT AIRPLANES NEEDED

Another advantage of replacing flight training with simulator training is that fewer support airplanes would be needed--support meaning airplanes used in intermediate pilot training or to replace airplanes being overhauled. For every 100 airplanes in operational squadrons, 25 additional airplanes are required for intermediate pilot training and 13 to 25 more are needed to replace airplanes undergoing major overhaul. If flying hours per student are reduced, many of these support airplanes would not be needed.

The use of simulators in training programs would mean that some support airplanes could be reassigned to operational squadrons, thereby increasing combat capabilities. For airplanes now under development, the reduced need for support airplanes would allow more to be bought for the operational squadrons or would release dollars for other purposes.

MORE ACCURATE PILOT PROFICIENCY GRADING

We believe simulators could be used to increase pilot proficiency by allowing pilots to use a greater percentage of actual flying time to practice the more complex flight maneuvers which cannot be fully simulated. Simulators could also be used to more accurately measure pilot proficiency by using systematic grading procedures.

Pilot proficiency is evaluated by comparing pilot performance to Navy or Air Force performance standards for the type of training involved. We believe measures of pilot proficiency would be more accurate if simulators were developed and used more for testing.

To graduate from basic pilot training schools, Navy and Air Force students must receive a minimum overall numerical grade based on written tests and an objective-subjective evaluation of all airplane flights. Experienced pilots assign a grade--based on established tolerances from the standard--to various segments of each flight. For example, a grade is given for takeoff, climb, and landing procedures.

To graduate from intermediate pilot training schools, Navy and Air Force pilots must pass a written proficiency test made up of standardized questions and receive a passing grade on an airplane flight test which consists of takeoff, various flight maneuvers, weapons delivery, and landing. A similar test is required to continue flying in the operational squadrons. Pilots of both military services must pass an annual retest of the proficiency exam.

Evaluators assign points or grades to each segment of the flight test. The Air Force has established standardized grading instructions which show performance tolerances, but the Navy does not have any standard tolerances.

Objective grading of pilot proficiency using simulators would provide more consistent and accurate results for many phases of flight training and eliminate the possibility of human bias and error associated with the current evaluation method. Recent Navy- and Air Force-sponsored studies show that simulator grading accurately evaluates pilot proficiency for certain flight maneuvers. FAA currently tests commercial airline pilots in simulators for many segments of proficiency evaluation.

We believe, after desired proficiency levels and accurate grading methods are established, simulator training should be fully evaluated and used where feasible and practical. Some flight testing would still be necessary in training phases which could not be totally transferred to the simulator, but simulators could be used for much of the testing.

CHAPTER 4

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

The Navy and the Air Force should increase simulator training to benefit from its lower cost and safer pilot training. Although they have recently taken several constructive steps, continuing emphasis will be necessary for several years.

We believe the state of the art in simulation and experiments with simulators--together with careful analysis--should be emphasized so that whatever cost-benefits are possible can be exploited in an attempt to offset the projected high training costs for the near-future sophisticated systems.

With this increased emphasis, the development of simulators today could pay their way by significantly decreasing future training costs.

RECOMMENDATIONS

Accordingly, we recommend that the Secretary of Defense require the Navy and the Air Force to:

--Put a higher priority on developing improved simulators which can replace maximum amounts of flight training.

--Insure that development and use of adequate simulators are integral parts of acquisition and modification programs for sophisticated aircraft.

--Use simulators as much as possible to reach and maintain desired proficiency, including the establishment of simulator grading methods which will provide a more accurate evaluation of pilot proficiency.

AGENCY COMMENTS

The Assistant Secretary of Defense (Manpower and Reserve Affairs) agreed fully with the recommendations (see app. II) and stated that:

--DOD understands the need to explore alternatives to traditional flight training programs.

--Advanced simulators have been delivered, been placed on order, or are under development for the latest weapon systems in the inventory.

--Indepth studies will be made to objectively determine individual performance, learning transfer, and associated costs of this training approach.

We plan to evaluate the effectiveness of the actions in our future reviews of flight simulation.

MATTERS FOR CONSIDERATION BY THE CONGRESS

This report shows how flight training costs can be reduced substantially and the projected shortages of fuel eased somewhat through greater use of flight simulators by the Air Force and the Navy. No legislation is required, but oversight by the Congress is recommended.

GAO ESTIMATES OF LOWER TRAINING COSTS (note a)

	Flying hours (note b)	Savings per hour using simulators (see p. 16)	Estimated savings by replacing flying hours with simulator hours (note c) 25% replacement	50% replacement
			(millions)	
Navy (note d):				
Fighters (note e)	619,089	$ 773	$119.6	$239.3
Patrol	276,949	390	27.0	54.0
Air Force (note f):				
Fighters	1,077,775	773	208.3	416.6
Bombers	294,426	1,383	101.8	203.6
Total			$456.7	$913.5

[a]Excludes costs of airplane crashes during training.

[b]Total hours shown are for all operational aircraft in the categories shown.

[c]Does not include costs of developing and producing simulators.

[d]Flying hours during fiscal year 1972.

[e]Excludes flying time while assigned to aircraft carriers.

[f]Flying hours during calendar year 1971.

APPENDIX II

AVAILABLE

ASSISTANT SECRETARY OF DEFENSE
WASHINGTON, D C 20301

MANPOWER AND
RESERVE AFFAIRS

4 JUN 1973

Mr. Harold H. Rubin
Deputy Director, Technology Advancement
U. S. General Accounting Office
Washington, D. C. 20548

Dear Mr. Rubin:

Attached are the Department of Defense comments on the General Accounting Office draft report, dated March 15, 1973, "Cost-Benefit Possibilities Through Greater Use of Flight Simulators in Military Pilot Training Programs" (OSD Case #3587).

We fully agree with the draft recommendations or suggestions that (1) increased emphasis be placed on development of improved simulators, (2) the simulation device be an integral part of the acquisition and modification of the basic system, and (3) maximum effective use be made of simulators to achieve and maintain desired proficiency levels.

We draw your attention to the fact that the degree to which simulators can replace flight training in combat type airplanes is currently unknown. The amount of savings associated with a hypothetical substitution program is, therefore, subjective until detailed studies can be made.

The Department of Defense understands the need to explore alternatives to traditional flying training programs. Advanced simulators have been delivered, been placed on order or are under development for the latest weapon systems in the inventory. In-depth studies will be made to objectively determine individual performance, learning transfer and associated costs relative to this training approach.

The attached comments relate to referenced statements in the report.

Sincerely,

Robert C. Taber
Lieutenant General, U. S. Army
Principal Deputy

Enclosure *(See GAO note.)*

GAO Note: Deleted comments relate to matters which were discussed in the draft report but which are not pertinent to this report.

PRINCIPAL OFFICIALS OF THE

DEPARTMENT OF DEFENSE

AND THE DEPARTMENTS OF THE NAVY AND THE AIR FORCE

RESPONSIBLE FOR ADMINISTRATION OF ACTIVITIES

DISCUSSED IN THIS REPORT

	Tenure of office	
	From	To
DEPARTMENT OF DEFENSE		
SECRETARY OF DEFENSE:		
James R. Schlesinger	June 1973	Present
William P. Clements, Jr. (acting)	May 1973	June 1973
Elliot L. Richardson	Jan. 1973	May 1973
Melvin R. Laird	Jan. 1969	Jan. 1973
Clark M. Clifford	Mar. 1968	Jan. 1969
DEPARTMENT OF THE NAVY		
SECRETARY OF THE NAVY:		
John W. Warner	May 1972	Present
John H. Chafee	Jan. 1969	May 1972
Paul R. Ignatius	Aug. 1967	Jan. 1969
DEPARTMENT OF THE AIR FORCE		
SECRETARY OF THE AIR FORCE:		
John L. McLucas (acting)	May 1973	Present
Robert C. Seamans, Jr.	Jan. 1969	May 1973
Dr. Harold Brown	Oct. 1965	Jan. 1969