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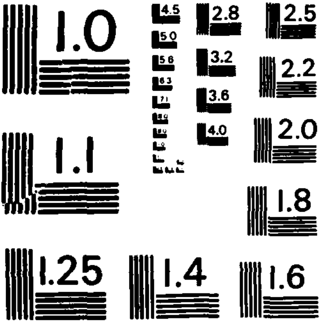
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THE DEPARTMENT OF DEFENSE STATEMENT ON THE SCIENCE AND TECHNOLOGY PROGRAM

BY

DR. RONALD L. KERBER
DEPUTY UNDER SECRETARY OF DEFENSE
FOR RESEARCH AND ADVANCED TECHNOLOGY

BEFORE THE SUBCOMMITTEE ON
RESEARCH AND DEVELOPMENT OF
THE COMMITTEE ON ARMED SERVICES OF
THE UNITED STATES HOUSE OF REPRESENTATIVES
99TH CONGRESS, SECOND SESSION

12 MARCH 1986

THE DEPARTMENT OF DEFENSE

STATEMENT ON

THE SCIENCE AND TECHNOLOGY PROGRAM

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The FY 1987 Department of Defense
Statement on
The Science and Technology Program

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Mr. Chairman and Members of the Committee:

I. INTRODUCTION

I am grateful for the opportunity to testify in support of the Department of Defense (DoD) Science and Technology (S&T) program for FY 1987.

Today I will outline to you the need for a DoD S&T program, the role that it plays in the overall defense program and its relationship to the threat from our adversaries. Also, I plan to describe progress on several of our management initiatives and discuss some major programs that make up the DoD S&T program.

The United States' interests are best pursued within a stable and peaceful international community. Armed conflict, international terrorism and regional instability adversely affect the U.S. and its allies in their efforts to achieve self determination, democratic institutions, economic development and respect for human rights. The complexities of the world over the past decades have led to development of sophisticated military forces to ensure the preservation of our lives and our freedoms. National survival depends upon the success with which we prevent attack upon the U.S.'s vital interests.

The Soviets have long since realized that communist ideology will not be the force of change for the future. They are now using military power as their primary tool to influence international events. The Soviets are willing and have invested a significant amount of their gross national product into increasingly modern and sophisticated weapons for the projection of Soviet influence into various regions of the world. Countering this force is a national challenge.

This Administration has made significant progress toward improving U.S. military forces. Certainly the strategic posture will be strengthened by the PEACEKEEPER, the B-1B and the TRIDENT II; strategic connectivity will be strengthened by improved C^3I; and the ability to respond over a range of combat situations is increased by modernization of conventional forces. However, the weapons we are buying today will have to perform their function into the 21st century and the technology used in their production was evolved over the past several decades. There are some new technologies that can be introduced almost immediately. However, in order to prepare for the longer term future, the DoD and the nation must lay the technology foundation for the future, in the face of great uncertainty, by investing n the technologies needed to meet future challenges. This is a . rategy that can work to the US's advantage.

Technological progress increases the deterrent value of U.S. forces and provides a hedge against hostile technological breakthroughs by potential adversaries. Advanced technology also imposes strategic costs on the Soviets by causing them to divert resources from more easily produced systems to counter more capable U.S. equipment. The importance of technology has never been more crucial than it is today.

The technological superiority that we enjoy over potential adversaries is a direct result of the investments in research and development and the continued search for advanced technologies by industry, universities, and DoD in-house laboratories. There have been significant improvements in materials, optics, lasers, integrated circuits, software, computers, aeronautical propulsion, sensors, and other technologies that are the foundation for future defense systems. The President's Strategic Defense Initiative (SDI) is an important example where new technologies are examined to determine the feasibility of a concept that would enable us to move from a deterrence strategy based on nuclear retaliation to one based on defense against ballistic missiles.

As you will see from the S&T projects discussed later, emphasis is being given to technologies that provide the greatest increase in nearer term capabilities and advantages while ensuring that long range investigations are not overlooked. Also, assessments are made of emerging technologies to ensure not only that high payoff opportunities are pursued but also that adverse technological suprises are avoided.

Projects are being undertaken that cover a broad spectrum of military applications. The uncertainty of the international climate and the range of combat situations and environments that could be encountered necessitate this approach. This need is also emphasized because of the traditional changes in strategy and tactics resulting from shifting balances between offensive and defensive capabilities. The tools for commanders of tomorrow are cast in the technologies the country is exploring today.

The S&T program request for FY 1987 is $5,375 million which includes the Army, Navy, Air Force and Defense Agencies programs less the Strategic Defense Initiative (SDI). Table I is a summary of FY 1986 amounts and our FY 1987 request. The S&T program encompasses the SDI in the Advanced Technology Development category; however, this will be covered by separate testimony. The SDI amounts in Table I are for informational purposes. The S&T funding history is detailed in Appendix I.

The S&T program is the means by which a technical foundation is prepared to meet the uncertainties of the future. The nature of future international situations cannot be precisely defined but we can be certain that, in the terms of world technological competition, advanced technology will be an essential element of national survival. The DoD S&T program, along with the technology explorations of industry and universities, is the means by which we can make significant steps toward developing and maintaining a technological posture second to none.

TABLE I
SCIENCE AND TECHNOLOGY PROGRAM
(Dollars in Millions)

	FY 1986	FY 1987
Research		
Military Departments	858	876
Defense Agencies	166	110
Total Research	1,024	986
Exploratory Development		
Military Departments	1,620	1,769
Defense Agencies	805	830
Total Exploratory Development	2,425	2,599
Advance Technology Development		
Military Departments	1,287	1,463
Defense Agencies	201	321
Total Advanced Technology Development	1,488	1,790
TOTAL SCIENCE AND TECHNOLOGY	4,937	5,375
Strategic Defense Initiative	2,746	4,785

Notes: Numbers may not add due to rounding
Does not include Gramm-Rudman amounts.

II. MANAGEMENT ACTIONS

Within the context of S&T program management are activities that are not technical programs in themselves but rather are vehicles by which more effective technological products and progress are produced. The origins of these activities stem from both Congress and the Administration and they play a significant role in technology management. This chapter describes and provides status on some of these activities.

A. Small Business Innovation Research Program

The Small Business Innovation Act of 1982 was designed to strengthen the small business role in federal research and development and to stimulate technological innovation in the private sector. DoD is an active participant in the Small Business Innovative Research (SBIR) program and in FY 1985 received over 3,500 proposals and made 525 awards. FY 1986 funding for SBIR will approximately double and the number of contracts awarded under this Act will increase substantially. The FY 1987 program should see even higher levels of support.

The SBIR program is beginning to show results. A small business in New England developed a low-cost 2-frequency laser for performing linear metrology and other precision measuring techniques for defense and is now marketing it in the private sector. While doing work on oxidation resistant coatings another small business has developed a process that permits aircraft engines to operate at higher temperatures for longer periods of time and at lower cost. The firm has been awarded a contract with the Air Force and has teamed with a major aerospace company. Because of these and other examples of innovation by participants, it is our view that the SBIR program is working as envisioned by the Act.

B. Role of Universities in DoD RDT&E.

Universities play a major role toward ensuring the strength of DoD science and technology. They are the principal performers of the basic research which underpins technological advances. Hence, they are vital in maintaining the country's military and economic strength. They also represent a vast resource of trained researchers which makes possible university contributions to the DoD's science and technology program. In addition to generating scientific and technical insight essential for future innovation, university research provides the stimulating environment for developing future scientists and engineers needed by DoD, defense industries, and the nation.

The dialogue continues between the Department and academia to strengthen research capabilities of the nation's universities. In its third year of operation, the DoD-University Forum is currently addressing issues in science and engineering education, foreign language and area studies, and the impact of export controls on university research. Also, the Forum is a place for valuable, candid and constructive discussion on complex matters such as the university role in the Strategic Defense Initiative. The Forum has provided useful feedback on the University Research Initiative by introducing the university perspective during the planning stage. This has enabled the development of a strategy which satisfies DoD objectives and provides a clear focus for the university community.

C. <u>University Research Initiative</u>

The University Research Initiative (URI) emphasizes selected emerging technologies that have a high payoff potential for national defense and at the same time will strengthen the universities' abilities to conduct research and educate scientific and technical personnel in defense-critical disciplines.

DoD has an important stake in both the research produced by universities and the quality of the scientific and engineering personnel being educated in defense-related disciplines because one in six American scientists and engineers are engaged in defense-related areas. The majority of these scientists and engineers, almost one-half million in all, are involved in state-of-the-art technologies that are not only crucial to the defense mission, but also are at the cutting edge of technologies essential to modern society.

Technologies that will be supported under URI include artificial intelligence, robotics, ultrasmall structures, high performance materials, structural and electronic polymers, fluid dynamics, and biotechnology. For each technology selected, a balanced program will be devised to include some or all of the following components: multidisciplinary research centers and/or programs of interest to national security; exchange scientists and engineers to facilitate the flow of ideas between university and DoD laboratories; instrumentation grants to increase the productivity of university research; and, fellowships to train the most qualified people to sustain the momentum generated by URI.

URI is a coordinated tri-Service/DARPA effort, integrated by OSD for maximum effectiveness. It accelerates the advance of emerging technologies and simultaneously improves the quality and challenge of university research.

D. Independent Research and Development (IR&D)

Industry's independent R&D serves a critical function in high-technology industries. A portion of this type R&D is allowed as an indirect cost in DoD contracts, and managed through

DoD's IR&D program. The IR&D effort enables industry to exploit scientific discoveries rapidly, improve current products, and develop new system capabilities in a cost effective manner. This is important to the overall defense R&D effort because it encourages innovative concepts and fosters competition between viable alternatives.

IR&D has led to many significant gains in defense capabilities. Improvements on the B-1B bomber, PEACEKEEPER and Rolling Airframe Missile, E-2C and C-17 aircraft, Mark 48 Advanced Capability Torpedo, the SQS-56 Radar and the TARTAR Fire Control are typical examples. The latest version of the F-15's high performance air-to-ground radar incorporates the result of past IR&D by providing a synthetic aperture radar operating mode in conjunction with a highly capable programmable signal processor that is common to the F-18, F-14, and other F-15 applications.

DoD has emphasized to its contractors the need to expand their interactions with universities and to pay special attention to weapons systems supportability and maintainability. Positive results are emerging in both areas. Industry is encouraged to create joint research programs, consulting agreements, faculty and student employment and scholarships. The goal is to speed the transition of research discoveries from academic to DoD and industrial applications. As for weapons system supportability and maintainability, data compiled by the Naval Supply System Command shows that logistics-related IR&D efforts increased between 10% and 20% after weapons system support was identified as an IR&D special interest item. Corporate IR&D efforts are a valuable adjunct to the DoD S&T program and we are leveraging the resources being devoted to IR&D by emphasizing areas of particular importance to future defense systems.

E. Exchange of Technical Information with the Scientific Community

A recent national policy on the transfer of scientific, technical, and engineering information enhances DoD relations with universities and industry. The policy establishes that, to the extent possible, the dissemination of results from Federally funded fundamental research will be unrestricted. While this broad policy incorporates DoD's past practice, the DoD is pleased to re-emphasize it within the Services and Defense Agencies.

The 98th Congress granted DoD the authority to withhold certain export controlled technical data. Implementating directives have established procedures by which technical data can be shared within the U.S. with a minimum of administration and without losing the protection of export laws. Under these procedures, the Services have reported no changes in the total number of presentations and reports reviewed and the number of denials has remained constant. It is our view that a good balance has been achieved between the information needs of the U.S. technical community and the requirement to restrict the flow of valuable information to our adversaries.

F. Management of Mission-Critical Computer Resources (MCCR)

The Deputy Under Secretary of Defense for Research and Advanced Technology serves as the Senior Official for Mission-Critical Computer Resources. In this role, the Deputy is responsible for policy, review, and oversight with respect to systems that fall under Section 2315 of Title 10, United States Code (the Warner Amendment). The Senior Official chairs the Computer Resources Council and is supported in all areas, including technology, by the Defense Computer Resources Board (DCRB). Criteria and procedures have been established for granting exemptions under Section 2315 and for conducting Computer Resources Council (CRC) reviews. Reviews may be called of any MCCR system whose life cycle costs exceed $100 million. The system is working well and significantly improves the procedures by which MCCR resources are acquired.

Consistent with the January 1984 report to Congress on Computer Technology, a Computer Systems Interface Working Group has been established under the DCRB and is developing a coordinated approach to the next generation of military computers. Also established under the DCRB is a Software Reliability Panel that is developing a set of criteria for measurement of software reliability in weapons systems. In addition, the directive on the Management of Computer Resources in Major Defense Systems is being revised to include policies on the use of Ada (the new DoD high order language for MCCR software), the use of commercially-available microcomputers, and improved approaches to software development and maintenance.

G. Program Coordination

Coordination of technology programs within DoD, between government agencies and among allies is a major function of this office. In addition to normal S&T information processes, discussed later in this statement, special procedures are established for cross-Service areas. For example, a technical review group has been established to insure coordination and integration of SDI sponsored activity with other programs. The Department has representation on interagency committees in areas where common interest exists. The Aeronautics and Astronautics Coordinating Board is the mechanism for formal coordination of NASA and DoD activities. International S&T coordination exists primarily through the NATO Defense Research Group and The Technical Cooperation Program. This is supplemented with memoranda of agreements, information exchange programs and other agreements when more specialized arrangements are required. Overall, both formal and informal procedures exist to coordinate DoD S&T activity with appropriate organizations.

H. Program Management and Administration

A number of actions have been taken to improve the management of the S&T program and the pace at which new capabilities are transitioned to forces in the field. For example, the Navy's exploratory development program has been reorganized to reduce the number of program elements to correspond with Navy mission areas and the warfighting objectives of the maritime strategy. This action has significantly reduced administration tasks and paperwork required to define and review the program.

III. SELECTED FY 1986 TECHNICAL PROGRAMS

The S&T program supports many missions and many military applications. Projects range from basic research to large scale demonstrations of potential systems. Much of the work is generic and has many uses. Examples are semiconductor, software, materials, sensor and laser technologies. Other projects such as chemical defense, ballistics, medical and armor technologies are more specific in their military application. It is not practical to discuss all S&T endeavors; however, a number of the projects will be highlighted.

A. Very High Speed Integrated Circuits

We are now at the mid-point in the highly successful Very High Speed Integrated Circuits (VHSIC) program. The goal of the VHSIC program is to increase the U.S. technology lead in integrated circuits (ICs) . ICs are becoming the cornerstone for improved electronics in future weapon systems. The result will be systems that are more reliable and because of their self-test ability, easier to maintain. Also, in addition to the enhanced processing speed afforded by VHSIC, there will be reduced size and weight improvements for many military applications.

Most VHSIC 1.25 micrometer integrated circuits are fully functional with thousands of sample chips available for weapon system insertion. In addition, a number of brassboards are operational that can provide signal processing capabilities at leading edge of technology. The first insertion of VHSIC technology in an operational system has been accomplished in an AN/ALQ-131 electronic countermeasures (ECM) pod used with several U.S. fighter aircraft to counter hostile electronic systems. This insertion demonstrates that VHSIC technology can be applied to systems at an early date to enhance reliability and maintainability. The reliability of the AN/ALQ-131 Techniques Control Assembly (TCA) will be increased 50-60 times using VHSIC technology. The TCA also exploits built-in-test features of VHSIC and significantly reduces mean-time-to-repair of this equipment.

B. <u>Microwave/Millimeter Wave Monolithic Integrated Circuits (MIMIC)</u>

The Microwave/Millimeter Wave Monolithic Integrated Circuits (MIMIC) program is a new start in the DoD S&T program. It involves development of state-of-the-art monolithic gallium arsenide (GaAs) integrated circuit technology for microwave and millimeter wave military applications. The development, manufacture and application of analog monolithic integrated circuits, based on GaAs technology and operating at microwave and millimeter wave frequencies, will be demonstrated to accelerate their use in weapons and equipment.

The MIMIC program is oriented toward major improvements in analog sensor electronics, the "eyes and ears" of electronic systems. It is similar to the benefits that VHSIC will provide for the processor or "brains" of electronic systems. MIMIC's objective is to demonstrate affordable applications in aircraft, missiles, surveillance and other electronic systems. Potential uses include phased array antennas, radar, ECM and communications equipment in addition to millimeter wave seekers for smart missiles.

The MIMIC program will identify major barrier problems that must be solved, permitting industry to concentrate its efforts upon the most critical issues, particularly those affecting affordability. Also, MIMIC will address individual Services' needs and will encourage multi-Service cooperation in later system developments. The program will be managed from the Office of the Secretary of Defense (OSD) with Service participation in both management decisions and program execution. The MIMIC effort compliments Defense Advanced Research Projects Agency (DARPA) and Strategic Defense Initiative Organization (SDIO) low power, radiation hard digital GaAs integrated circuit programs. The payoff from a successful MIMIC program will be both increased performance and affordability for a wide range of equipment at frequencies of great interest to military applications.

C. Software Technology

Computer software, the intelligence programmed into mission-critical computer systems, is a key element in the ability to make significant technology improvements in most modern weapons. A three-pronged initiative to provide more reliable and cost effective software for Defense systems is being pursued.

The Ada common computer programming language has been designated for use in DoD mission critical systems. Over 100 Defense programs, including the Advanced Tactical Fighter, the WWMCCS Information System, and the Advanced Field Artillery Tactical Data System are programmed to use Ada. It is also being used outside DoD. Ada is a military standard, an American National Standards Institute standard, a Federal Information Processing standard and is expected to be accepted by the International Standards Organization in 1986. There is a growing private sector base for widening the use of Ada. Approximately 40 companies are developing Ada compilers and most major contracting firms have a nucleus of Ada expertise. The use of Ada as a standard language in mission critical computers promises to be a very significant step toward improving productivity and performance in the software development and maintenance process.

The Software Engineering Institute (SEI), intended to accelerate the use of new software technology in Defense systems, is operational at Carnegie Mellon University. Key projects include: (1) approaches to using commercially-available software, (2) the evaluation of Ada compilers and software tools, (3) the development of a showcase "software factory", and (4) the improvement of graduate level curricula in software engineering. The SEI has established both industry and university affiliate programs and is providing assistance in software engineering for Defense systems.

The Software Technology for Adaptable, Reliable Systems (STARS) program will improve DoD's software capability by bringing a high degree of discipline, technology, and automation to software development, evolution, and management processes. The goal is to meet defense software requirements of the 1990s by achieving a tenfold increase in today's productivity and comparable improvements in quality and reliability. STARS has already demonstrated reusable software capabilities for missile guidance and control and signal processing. The program is now focusing on exploitation of tools and other products already emerging from the private sector. In addition, STARS is being oriented to better support on-going major efforts such as the World Wide Military Command and Control System, SDI and the strategic computing program. The plan includes development and prototyping of common interface concepts to achieve compatibility among software engineering environments across industry and DoD and to provide incentives to create a robust software tools marketplace. The improvement of software development, productivity and reliability is a major S&T objective and the STARS program is a key step toward achieving that goal.

D. Aircraft Technology

Airpower continues to be a key factor for a credible national defense posture. This factor is well recognized by potential adversaries, as evidenced by their deployment of capable and technologically advanced aircraft. The DoD aircraft technology program is directed toward maintaining superiority of U.S. aircraft in a cost effective and timely manner. A key aspect of the S&T program is the transitioning of technology from laboratory devices to application via large scale demonstrations. Several "firsts" have been achieved this past year.

In cooperation with NASA, flight testing of a modified F-111 aircraft with a smooth contour variable camber wing has been initiated. This Mission Adaptive Wing can automatically change shape in flight to optimize aerodynamic performance for the mission segment being flown. That is, the wing can be shaped for maximum maneuverability, for maximum cruise range, or for reduced supersonic trim drag. The technology is potentially applicable to a wide range of military aircraft from fighters to strategic bombers.

Also, flight tests of the Advanced Digital-Optical Control System (ADOCS) in a modified UH-60 Blackhawk helicopter have been initiated. This fly-by-light system features data transmission through optical fibers rather than wire, as in the conventional fly-by-wire systems. The ADOCS offers increased battlefield survivability and improved reliability. In addition, it will permit development of task-tailored handling qualities for improved mission effectiveness and reduced crew fatigue.

The Air Force is continuing to investigate the feasibility of an Advanced Maneuvering Attack System (AMAS) on the F-16 Advanced Fighter Technology Integration aircraft. The AMAS provides highly accurate and survivable maneuvering attack profiles against ground targets at very low altitude, as well as improved capabilities in air-to-air combat. This investigation will yield a better understanding of the concept of advanced tactical flight management for application to the Air Force Advanced Tactical Fighter (ATF).

Modification of an Air Force F-15 aircraft to demonstrate enhanced maneuvering capabilities and short takeoff and landing technologies is continuing. The technologies involved include two-dimensional thrust vectoring and reversing exhaust nozzles, an integrated flight and propulsion control system, advanced cockpit displays, three lifting surfaces (wing, tail and canard), and rough/soft field landing gears. The program will demonstrate improved combat maneuverability and effectiveness and the capability for operations from bomb-damaged or unprepared runways. The first flight is planned for early 1988.

E. National Aerospace Plane

Joint planning is underway with NASA for a National Aerospace Plane research program that could, if successful, lead to a new family of aerospace vehicles. Conceptually, a future aerospace plane would operate as an airplane at hypersonic velocities in the upper atmosphere, or as a space launch vehicle capable of accelerating directly into orbit. The impact on both aeronautical and space operations would be significant.

DoD and NASA have carried out hypersonic research for a number of years and recent advances in hypersonic propulsion, advanced materials, structures and computational fluid dynamics have contributed to a consensus that an aerospace plane is possible. The concept, developed by DARPA and NASA, centers on a hydrogen-fueled aircraft capable of horizontal takeoff and landing and operating at speeds between Mach 5 and Mach 25 and at altitudes between 100,000 and 350,000 feet. Present plans involve the maturation of key technologies, propulsion module development, and airframe design of a flight research vehicle.

Participants in the proposed program include the Air Force, Navy, DARPA, SDIO and NASA and a program management structure is in place. The FY 1987 request includes specific program elements to fund the DARPA, Navy and Air Force portions of the program. Successful demonstration of the aerospace plane concept will open new horizons for applications such as a long range air defense interceptor, space transportation and global transportation systems.

F. Materials and Structures

The S&T program continues to emphasize materials development with most of the effort being in metal-matrix, carbon-carbon and ceramic matrix composites. The metal-matrix composite program has moved into the demonstration phase with each of the Services engaged in important development and test programs. The Army is developing lightweight metal-matrix and organic matrix composites for howitzer and bridge building components. The Navy is fabricating missile fins which will be flight tested during the coming year and the Air Force has successfully ground tested a full scale tactical missile motor case built almost entirely of metal-matrix composites. In addition, the design, fabrication and testing of full scale ventral tail fins for a fighter aircraft is underway.

In the spacecraft area, development of a small metal-matrix antenna that will meet survivability requirements for space components is underway. An identical antenna is being made from carbon-carbon composites so that direct comparisons of electrical and survivability characteristics of both materials can be obtained. While most of the composite materials work in the S&T program is supporting traditional terrestial use and spacecraft requirements, the Strategic Defense Initiative program also draws on the existing technology base for its needs and in some cases has jointly supported new programs. In a similar fashion, the National Aerospace Plane program will draw heavily on material technologies that have emerged over the past few years.

Tactical, strategic, and space missions continue to dictate the need for greater survivability in hostile environments. Most material and structures projects include testing for susceptibility and vulnerability to directed energy weapons in addition to traditional performance and environmental tests. This is considered an essential element of future programs because of the ever increasing ability of the Soviets to field advanced laser systems. The materials and structures program meets this challenge.

G. Aircraft Propulsion Technology

Aircraft propulsion technology continues to be a high-payoff area for DoD. During the past year, we demonstrated most of the engine technology required to permit the development of a

Joint Advanced Fighter Engine without incurring performance compromises that have plagued some past fighter engine developments. Also, significant performance improvements were demonstrated in the 6000-hp class Modern Technology Demonstrator Engine programs in a technical effort that will be completed in 1986.

Because propulsion system performance gains are the source of high military payoffs, we are defining an innovative integrated exploratory and advanced technology development program aimed at increasing the capability of aircraft turbine engines by 100% by the turn of the century. The major features of this program are integrated materials/propulsion technology efforts and DoD/contractor efforts to permit higher payoff/higher risk approaches in exploratory development. Six major aircraft engine manufacturers have formulated and presented their individual plans for achieving this goal, which include significant complementary Independent Research and Development efforts. The program will be fully defined this year, and will lead to large increases in aircraft capability (for example, a sustained Mach 3+ capability in an F-15 size aircraft and a cruise missile of intercontinental range in an air launched cruise missile size vehicle) by the turn of the century as well as continued U.S. preeminence in this vital area.

H. Medical Research and Development

The objective of the Medical and Life Sciences program is to improve combat casualty care, to prevent militarily important diseases and injuries, to maintain and enhance combat effectiveness, and to increase human safety in military systems. The Armed Services Biomedical Research Evaluation and Management Committee (ASBREM) continues to ably plan and coordinate tri-Service aspects of the medical R&D program. In addition to conducting FY 1986 S&T reviews, ASBREM assisted OSD in topical reviews of the medical materiel as well as impact and acceleration research programs. ASBREM has become an essential tool in the management of medical research and development.

The Medical and Life Sciences program continues to address both basic and applied research unique to military operations. During the past year, the program has conducted a field study on the use and nutritional value of new rations and the suitability of a new combat field feeding system. Also, human testing on an anti-malarial vaccine was initiated and a much improved system for the care of Air Force casualties contaminated with chemical agents was developed. Cold weather uniforms for helicopter pilots, better boots and gloves for the soldier and new anti-G devices for pilots are typical examples of essential personnel support items required to better accomplish the combat mission.

I. Chemical Defense Technology

The continuing chemical threat to U.S. forces drives an expanding chemical defense program in both defensive and retaliatory areas. The development, testing, and procurement of products resulting from technology advances are being undertaken to overcome major deficiencies. In addition to development of protective and retaliatory systems, programs for safe and effective disposal of obsolete, unusable, or leaking chemical munitions are underway. This is important because in the event that a chemical warfare treaty is achieved, stockpiles must be destroyed by a predetermined date, a difficult task with present technologies.

The chemical defense S&T program is performed by the Military Departments with the U.S. Army serving as the executive agent under a joint-Service agreement that coordinates requirements and programs. In order to broaden the innovative base, the program has been expanded into university and industrial organizations as well as DoD in-house laboratories. Progress is being made in many areas.

A mobile nuclear, biological and chemical (NBC) reconnaissance system, easily operated by untrained troops, is being tested. A mobile remote detector based on the principle of differential absorption/differential scattering LIDAR was constructed and successfully tested against simulants in open air ranges out to eight kilometers. Also, several items of equipment to assist in the care of battlefield casualties have been developed and promising leads exist to improve pretreatment of nerve agent poisoning. These and other projects improve our chemical defensive posture.

In addition to the defensive programs, the Department is undertaking relatively modest retaliatory improvements. Exploratory work is in progress to develop new, more efficient and cost effective air delivered systems. Also, we are continuing advanced development of the Multiple Launch Rocket System chemical warhead to provide our forces with a mid-range ground launched delivery system, a capability we do not now have. These new capabilities will improve the nation's overall deterrent posture in this critical area.

In the management area, an NBC survivability office has been established to facilitate incorporating NBC protection into military equipment and, to better handle chemical data, a chemical/biological defense Information Analysis Center is being established. A total of seven development items were type classified and four new items achieved materiel release/first unit equipment status this year. The Foreign Weapon Evaluation program has been an excellent means of acquiring allied equipment and several items are currently being tested. The DoD will continue to emphasize chemical defense developments in order to ensure a credible U.S. chemical deterrent and if deterrence fails that U.S. forces will be able to survive and operate on the chemical battlefield.

J. Research

The DoD Research (6.1) program provides a long range outlook for the Department. This work is accomplished by the universities, industry and the in-house laboratories. However, the universities are the dominant performer with about 50 percent of the research funds allocated for their explorations. The goal is to improve the U.S. technology posture and help guard against adverse technological surprise. Typical examples of areas to be emphasized this year include:

o Nonmetallic Structural Materials: A credible nonmetal structural material must possess an appropriate combination of strength, stiffness, toughness, durability, and damage tolerance. This program is directed toward the understanding and control of two classes of nonmetallic materials that depend predominantly on covalent or ionic bonding: ceramics for high temperature applications and hydrated cements for construction uses. An understanding of fundamental principles in these areas will obviate or diminish the need of trial-and-error testing common in materials development. Also, it will enable future developers to model the performance of these materials for future applications.

o Hot Atom Surface Chemistry: Difficulties are created when spacecraft traveling in low-earth orbits (200-600 km) collide with ambient atmospheric particles at velocities on the order of 8 km/sec, corresponding to energies near 5 eV for oxygen atoms, the predominant species present at these altitudes. Materials in space react with oxygen, degrading performance or causing catastrophic failure of optical, electronic, or structural components. The diffuse region of light (the "Shuttle Glow") observed surrounding the surfaces of spacecraft and satellites has not been fully explained but reactions at or near vehicles surfaces are implicated. These and other hypotheses need to be tested by laboratory experiments on the reaction of thermally fast atomic and molecular species with surfaces and with each other to minimize adverse effects of these high speed collisions.

o Millimeter Waves and Target Acquisition: Imaging sensors are required for advanced target acquisition systems. Millimeter waves can operate through aerosols but techniques for better control and processing of this type radiation is needed. Research programs will study surface electromagnetic wave phenomena in the millimeter wave length regime and explore the applicability of multi-aperture systems for imaging in cluttered environments. In the next two years experiments on the effects of adverse weather upon the propagation and imaging ability of near millimeter waves should be completed and the applicability of computer models to simulate the performance of near millimeter wave returns from snow and vegetation will have been assessed. This will form the basis for first-principles modeling efforts of near millimeter wave "clutter" and provide a stronger base for the design and use of systems employing millimeter wave techniques.

o Plasma Based Propulsion: The increasing emphasis on an improved propulsion capability in earth orbit presents unprecedented challenges for the advanced space propulsion community. A major portion of the research under this initiative will be the improvement of magnetoplasmadynamic thrusters so that they become capable of sustained operation at megawatt power levels. Electrode and insulator lifetimes have been identified as primary barriers to sustained operation. The research will be directed to electrode mass loss mechanisms and other conditions that cause inefficient operations.

The above examples are but a few of the investigations underway in the basic research program. Research is being conducted in submicrometer electronics, biotechnology, artificial intelligence, free electron lasers and other projects of military interest. It is from this broad range of basic research projects that technical options of the future will be shaped.

K. Search and Surveillance

The undersea, battlefield, and aerospace search and surveillance missions continue to generate requirements for electronic systems development. These systems are normally based on some form of acoustic, radio frequency, microwave, millimeter wave and/or electro-optics sensor technology. They are used to achieve increased capabilities in target detection, target location and target identification by increasing sensor resolution and sensitivity and by decreasing the false alarm rate. At the same time it is necessary to achieve savings in cost, weight and volume, along with improved survivability, reliability and maintainability. Examples of S&T programs in search and surveillance are discussed below:

o <u>Night Operations</u>: Night and inclement weather sensor systems for land combat vehicles, aircraft, ships, missile systems, and fire control continue to be improved. Active sensor developments include coherent laser radar and millimeter wave radar devices. Passive sensor devices include infrared search and track systems and focal plane thermal imaging arrays with thousands of detectors, as well as battlefield acoustic sensors. Advances in uncooled detectors for thermal imagers have led to a new thermal sight for the M16A2 rifle that will be demonstrated in 1986. This sight will be effective at combat ranges and will weigh less than four pounds. In addition, common module, low cost carbon dioxide laser rangefinders and target designators are being developed to complement night vision systems. These technology advances provide U.S. forces with an excellent night and near all weather operational capability.

o <u>Aerospace and Surface Surveillance</u>: Long range, high resolution airborne and spaceborne radar and infrared sensor systems needed to locate and identify targets in the air and on the surface are being developed. The Air Force Avionics Laboratory and NASA are jointly conducting experiments using shuttle and airborne radar components along with advanced signal processing techniques to demonstrate the potential for spaceborne radar as a stand-off illuminator in a bi-static mode for passive all-weather surveillance. Bi-static radars, with the transmitter and receiver on different platforms, permit passive operation with respect to hostile radar warning systems. Another important thrust is the development of flush mounted solid state phased array transmit/receive modules on military platforms to eliminate cumbersome rotating search and surveillance radar antennas. Also, a major effort is underway to harden sensors against electronic jamming and laser countermeasures.

o <u>Undersea Surveillance</u>: The trend toward less noisy hostile submarines necessitates emphasis on the development of better sensors and techniques to locate quiet targets. Among the developments are non-acoustic techniques, such as magnetic and optical sensors with advanced signal processing, that are proving to be effective in the detection, localization and classification of undersea targets. It is extremely important that the U.S. maintain a technology lead in this area so that commanders engaged in combat will have the best equipment in the world for developing strategy and tactics that will ensure success in an important military mission--undersea warfare.

L. Avionics/Navigation

The development of a single integrated system to replace numerous electronic "black boxes" that perform essential functions on aircraft platforms has been a design goal for several decades. The emergence of VHSIC devices, computer software improvements and the digital revolution make this objective a reality. Also, progress has been made in low cost laser and fiber optic sensors, 3-D panoramic high brightness cockpit displays and voice interactive systems. In addition major advances are underway in cockpit automation, pilot decision aids and artificial intelligence to optimize use of radar, electronic warfare, electro-optics sensors and weaponry equipment. Avionics and its uses continue to be a fruitful S&T work area because of rapid technological changes in this area and the major impact it has on mission effectiveness.

M. Directed Energy Technology

The focus of directed energy technologies is transitioning from higher power lasers to lower power devices with a potential for near term conventional weapon applications. High power laser devices are now in the Strategic Defense Initiative research program.

Candidate devices are being developed to establish two parameters (capabilities and limitations) that will form the basis for making future weapon decisions. Current efforts will result in rugged, small, low cost devices suitable for military applications. Laser developments include devices that are capable of operating at wavelengths that result in higher quality atmospheric transmission and at frequencies that can be shifted rapidly to optimize their effectiveness. Other efforts are focused on technologies to improve the optical quality of laser beams, to reduce dependence on complex, high cost optics and to improve the delivery of laser energy at significant ranges.

N. <u>Conventional Weapons Technology</u>

The conventional weapons program provides technology for advanced weapons required in non-nuclear armed conflict. This includes weapons ranging from small arms, tanks, artillery and aircraft guns, land and sea mines to guided missiles, projectiles and torpedoes. The program continues to make significant progress.

Among programs underway is the Army's Fiber Optics Guided Missile (FOG-M) that has demonstrated the use of a commercial optical fiber as a data link between a missile and a ground based command station. Target images from the seeker are transmitted via a trailing fiber to a ground station and guidance signals are then sent back to the missile via the same fiber. The original application was for an antiarmor weapon. However, recent experiments have shown that the FOG-M has potential use in an air defense role. Indeed, the tenth firing of the FOG-M demonstrated this capability against target helicopters.

There is an urgent need to increase the safety of munitions without compromising their performance. The Navy is concerned about the survivability of ships that contain large stores of high explosives. Munitions that could survive exposure to fires, impacts from bullets and adverse electromagnetic environments would have attractive advantages. Technology programs have produced some explosive and propellant chemicals that reduce sensitivity without reductions in energy output. These are being scaled to full sized warheads and rocket motors for testing.

The Services are jointly demonstrating a Hyper Velocity Missile (HVM) that has potential for defeating advanced armored vehicles. The HVM is an alternative to gun launched weapons. It uses advanced propulsion material and laser guidance methods to accelerate a long rod heavy metal penetrator to very high velocities. The guidance system for both ground and air launched versions of HVM will be tested this year at stand-off ranges. This program also has multiple applications. By replacing the penetrator with an appropriate warhead, a ground launched HVM has potential as an air defense weapon.

O. Underseas Weapons and Targeting

Technology is being developed to counter a rapidly expanding undersea threat posed by the deployment of new Soviet submarines exploiting advanced technologies. Among the efforts underway, the Navy and DARPA are jointly developing undersea warheads using entirely new concepts. Also, the Navy has joined with the Department of Energy in a program to take advantage of their expertise and computer modeling resources to develop warhead concepts for use in the next generation of undersea weapons. These efforts along with a number of new undersea sensors and torpedo product improvements will enhance the ability of the Navy to operate effectively in an underseas environment.

P. Training Technology

As training of both active and reserve forces is a major peacetime activity, it is important that it be done well and at acceptable cost. Technology advances in computer software, electroluminescent displays, voice synthesis and recognition and computer generated imagery make possible a range of options for increasing training effectiveness. For the maintenance technician, a portable training and job aid device will be demonstrated. This briefcase sized device will weigh less than 30 pounds and could replace, if needed, approximately 25 linear feet of manuals and instructional material. In addition, the development of lower cost visual systems will be emphasized so that visual scenes can be used in more simulators. Realistic and affordable visual scenes are one of the key components of a wide range of training simulators. Training is a major DoD expense and technologies to make training better and more cost effective must be exploited.

IV. SUPPORTING TECHNOLOGIES

The DoD S&T program encompasses supporting activities that are of importance to the mission organizations, to the performing R&D organizations and to the general well being of military installations. Several of these topics are discussed below:

A. Environmental Sciences Research and Global Environmental Support

Meteorology, oceanography, terrestrial science and space science are major military considerations that are discussed under environmental sciences. This program is developing methodologies and equipment to optimize the performance of existing and emerging systems, sensors and platforms. Environmental situations can limit or even render inoperative many systems and sensors. Hence, it is important to incorporate environmental considerations in designs so that potentially adverse conditions can be avoided, mitigated, or exploited.

Research in environmental sciences tends to emphasize tactical support situations that involve tactical decision aids (TDA). TDAs use environmental and other available data to give on-scene commanders current information upon which to base tactical decisions. In the Army, for example, the Air-Land Battlefield Environment (ALBE) program develops environmental instrumentation and models to transform raw data into TDAs that can be used by commanders and their staffs without further interpretation. Both the Navy and the Air Force have similar efforts oriented toward Service-unique requirements. There is inter-Service cooperation wherever commonality exists.

In a macro sense, DoD's central data processing facilities have been upgraded with the CYBER 205 at the Navy Fleet Numerical Oceanography Center and the CRAY XMP at the Air Force Global Weather Central. In satellite technology, planning for a new generation of the Defense Meteorological Satellite Program is underway and the Navy is preparing to launch the Navy Remote Oceanographic Satellite System by the end of the decade. These are outstanding improvements, but they are only a beginning. The environmental sciences R&D program must be continued to provide tactical units with modern capabilities to meet current and future operational requirements.

B. Scientific and Technical Information

The S&T program and R&D in general requires an effective exchange of technical information. This is accomplished primarily by the Defense Technical Information Center (DTIC), Information for Industry Offices (IFIOs) and specialized Information Analysis Centers (IACs). DTIC maintains data bases on planned DoD research projects, summaries of technical work in progress, reports ot completed R&D efforts and descriptions of industrial Independent Research and Development projects.

The Information for Industry Offices were established to permit industry access to information on DoD acquisitions, R&D requirements, plans, and future needs. At these offices, industry can review operational requirements, S&T objectives, and other planning documents relevant to the R&D capability of their respective organizations. The IFIOs have been most useful to contractors for planning their IR&D programs.

The Information Analysis Centers collect, review, analyze, summarize and provide advisory services in well-defined specialized fields. IACs are distinguished from documentation centers and libraries, whose functions are primarily concerned with collecting and disseminating documents, by their concern with technical information contained in the documents. A Chemical/Biological Defense Information Analysis Center is being established and a High Temperature Materials Information Analysis Center is being created by reorienting the mission of an existing IAC. Information Analysis Centers continue to provide a valuable support function for the scientific and engineering community.

DoD laboratories have become increasingly involved with state and local governments and the private sector to improve the transfer and exchange of technologies and expertise. These technologies are transferred through consultations and assistance provided by the laboratory engineers and scientists in their areas of expertise. This is an important aspect of DoD's role because it is important that wide use be made of federally developed and sponsored R&D as encouraged by the Stevenson-Wydler Act.

C. Environmental Quality Technology

Environmental quality R&D is underway to assess the impact of activities on the environment and to develop equipment and techniques that meet both environmental standards and military requirements The DoD program is oriented toward aircraft, missiles, ship wastes, and industrial type operations that are unique to the DoD. Specific functions performed include environmental and public health effects, monitoring, management, assessment and planning. Also, included are pollution reduction, control, and treatment technologies. Programs are directed toward achieving new and more cost-effective technologies, adaptation of best available technology, or development of new technology if required for national security activities.

The DoD program is directed toward unique military operations and needs. However, to assure an awareness of all technology application available for DoD needs, a Memorandum of

Agreement (MOA) has been established with the U.S. Environmental Protection Agency. In addition, the individual Services maintain MOAs in specific areas of interest. The DoD-wide program is managed via a detailed coordinating paper in addition to the normal staff and command mechanisms. This coordinating paper is exchanged with other Federal agencies that have an interest in environmental R&D.

In the environmental quality program, missile and shuttle exhaust cloud models for monitoring contaminants have been completed. A waste water treatment to destroy hydrazines also has been completed and an automatic aircraft sonic boom monitoring system has been developed. Also, the evaluation of trash compactors and incinerators designed for shipboard use will provide essential tools for modern naval operations. These programs are fulfilling the need to minimize pollution problems in military operational and industrial environments as well as making DoD a good neighbor and in conformance with standards applicable to the processes involved.

V. CONCLUDING REMARKS

It has not been possible to cover all technologies in these discussions. In addition to topics discussed in the statement, promising opportunities are being explored in the non-medical aspects of biotechnology, research to increase the efficiency and reduce costs in logistics functions, robotics and manufacturing sciences. The program is balanced to cover these and other revolutionary and evolutionary technologies essential for modernization of future forces.

Science and Technology

The Department is committed to ensuring that the (S&T) program is maintained at a viable level and that it will continue to be performed by a combination of industry, universities and DoD in-house laboratories. It is our view that this broad innovative base has served the country well and we will continue to depend upon it for the concepts, equipment and techniques needed for continued U.S. national security strength.

Your continued support of DoD S&T goals is appreciated.

APPENDIX I

Science and Technology Program History
(Dollars in Million)

Fiscal Year	6.1	6.2	6.3A	Total
FY-77	373	1,305	-	-
FY-78	413	1,389	472	2,274
FY-79	475	1,535	525	2,535
FY-80	553	1,718	604	2,875
FY-81	615	1,986	606	3,207
FY-82	697	2,233	759	3,689
FY-83	786	2,457	834	3,877
FY-84	843	2,211	1,410	4,464
FY-85	852	2,268	1,363	4,483
FY-86	1,024	2,425	1,488	4,937
FY-87	986	2,599	1,790	5,375
FY-88	1,080	2,839	1,956	5,875

Notes: 6.1 - Research
6.2 - Exploratory Development
6.3A - Advanced Technology Development less Strategic Defense Initiative.
Does not include Gramm-Rudman reductions.

END

DTIC

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