REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave blank)*

2. REPORT DATE
AUG 1996

3. REPORT TYPE AND DATES COVERED
FINAL 10/01/96--09/30/97

4. TITLE AND SUBTITLE
FY97 AIR VEHICLES TECHNOLOGY AREA PLAN

5. FUNDING NUMBERS
C
PE
PR 9993
TA 00
WU 00

6. AUTHOR(S)

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
FLIGHT DYNAMICS DIRECTORATE
WRIGHT LABORATORY
AIR FORCE MATERIEL COMMAND
WRIGHT PATTERSON AFB OH 45433-7562

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
FLIGHT DYNAMICS DIRECTORATE
WRIGHT LABORATORY
AIR FORCE MATERIEL COMMAND
WRIGHT PATTERSON AFB OH 45433-7562

10. SPONSORING/MONITORING AGENCY REPORT NUMBER
WL-TR-97-3000

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT
APPROVED FOR PUBLIC RELEASE; DISTRIBUTION IS UNLIMITED.

12b. DISTRIBUTION CODE

13. AE

Air vehicle technology spans multiple technical disciplines to provide the Air Force and our nation with innovative solutions to both near and far-term defense needs. Our scientists and researchers work in Integrated Product Terms (IPTs) that design, develop and provide optimum air combat capabilities. The IPTs, the TMP and the Mission Area Plans(MAPs), generated in coordination with the warfighter communities, ensure the emphasis of Research Development Test & Evaluation (RDT&E) is focused on the areas of greatest need. Affordability is paramount and is given utmost consideration in all phases of RDT&E within the Air Vehicles Technology Area. During a time of declining budgets and resources, we are challenged to maintain and provide critical technologies, ensuring the nation' s superior defense capabilities. We developed a strategic plan for Air Vehicles RDT&E to ensure we can maintain our leadership role, and to build a foundation for continuing excellence into the future

14. SU

ER OF PAGES
46

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED	SAR

GENERAL INSTRUCTIONS FOR COMPLETING SF 298

The Report Documentation Page (RDP) is used in announcing and cataloging reports. It is important that this information be consistent with the rest of the report, particularly the cover and title page. Instructions for filling in each block of the form follow. It is important to ***stay within the lines*** to meet ***optical scanning requirements***.

Block 1. Agency Use Only *(Leave blank)*.

Block 2. Report Date. Full publication date including day, month, and year, if available (e.g. 1 Jan 88). Must cite at least the year.

Block 3. Type of Report and Dates Covered. State whether report is interim, final, etc. If applicable, enter inclusive report dates (e.g. 10 Jun 87 - 30 Jun 88).

Block 4. Title and Subtitle. A title is taken from the part of the report that provides the most meaningful and complete information. When a report is prepared in more than one volume, repeat the primary title, add volume number, and include subtitle for the specific volume. On classified documents enter the title classification in parentheses.

Block 5. Funding Numbers. To include contract and grant numbers; may include program element number(s), project number(s), task number(s), and work unit number(s). Use the following labels:

C -	Contract	**PR** -	Project
G -	Grant	**TA** -	Task
PE -	Program Element	**WU** -	Work Unit Accession No.

Block 6. Author(s). Name(s) of person(s) responsible for writing the report, performing the research, or credited with the content of the report. If editor or compiler, this should follow the name(s).

Block 7. Performing Organization Name(s) and Address(es). Self-explanatory.

Block 8. Performing Organization Report Number. Enter the unique alphanumeric report number(s) assigned by the organization performing the report.

Block 9. Sponsoring/Monitoring Agency Name(s) and Address(es). Self-explanatory.

Block 10. Sponsoring/Monitoring Agency Report Number. *(If known)*

Block 11. Supplementary Notes. Enter information not included elsewhere such as: Prepared in cooperation with...; Trans. of...; To be published in.... When a report is revised, include a statement whether the new report supersedes or supplements the older report.

Block 12a. Distribution/Availability Statement. Denotes public availability or limitations. Cite any availability to the public. Enter additional limitations or special markings in all capitals (e.g. NOFORN, REL, ITAR).

- **DOD** - See DoDD 5230.24, "Distribution Statements on Technical Documents."
- **DOE** - See authorities.
- **NASA** - See Handbook NHB 2200.2.
- **NTIS** - Leave blank.

Block 12b. Distribution Code.

- **DOD** - Leave blank.
- **DOE** - Enter DOE distribution categories from the Standard Distribution for Unclassified Scientific and Technical Reports.
- **NASA** - Leave blank.
- **NTIS** - Leave blank.

Block 13. Abstract. Include a brief *(Maximum 200 words)* factual summary of the most significant information contained in the report.

Block 14. Subject Terms. Keywords or phrases identifying major subjects in the report.

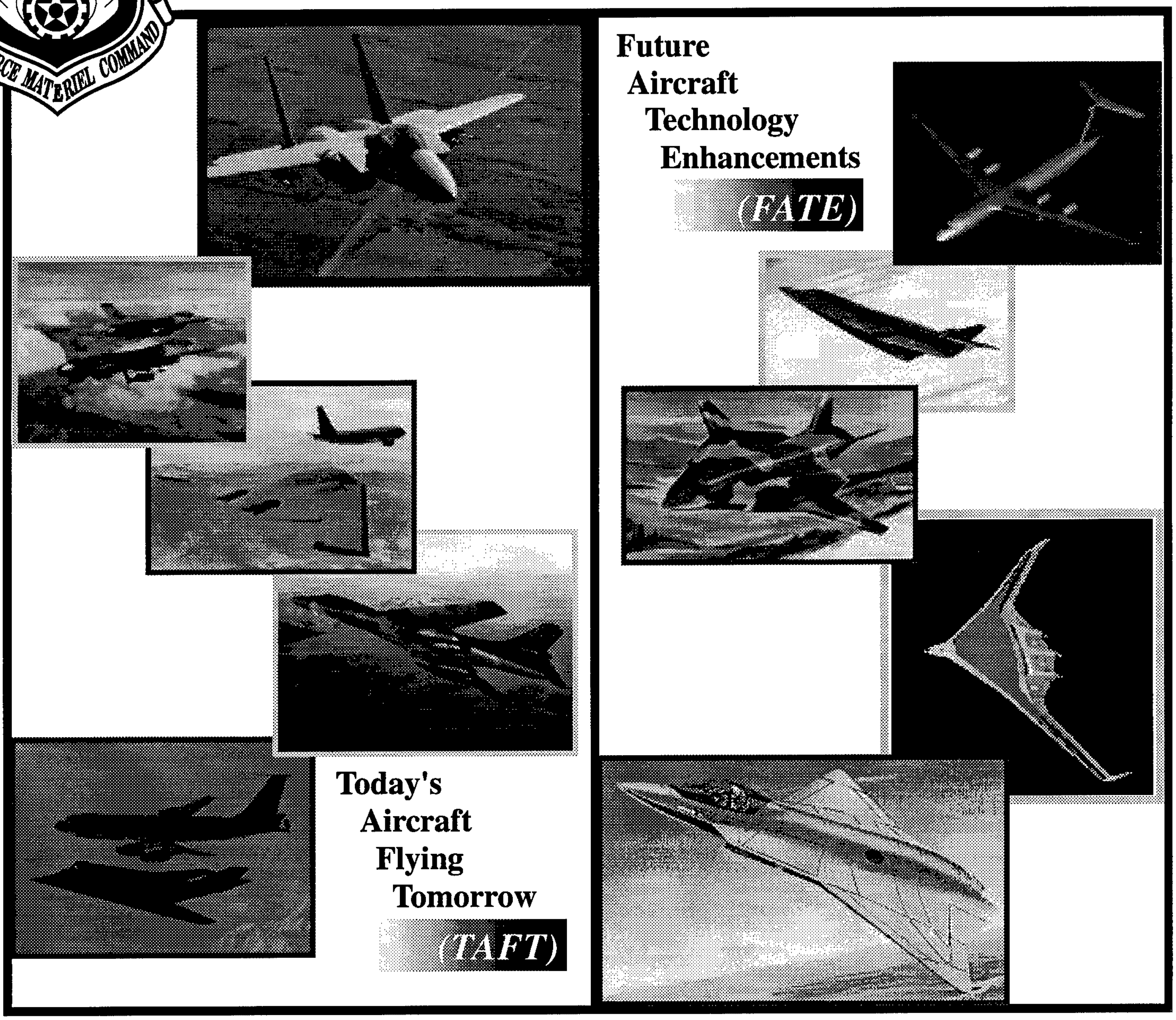
Block 15. Number of Pages. Enter the total number of pages.

Block 16. Price Code. Enter appropriate price code *(NTIS only)*.

Blocks 17. - 19. Security Classifications. Self-explanatory. Enter U.S. Security Classification in accordance with U.S. Security Regulations (i.e., UNCLASSIFIED). If form contains classified information, stamp classification on the top and bottom of the page.

Block 20. Limitation of Abstract. This block must be completed to assign a limitation to the abstract. Enter either UL (unlimited) or SAR (same as report). An entry in this block is necessary if the abstract is to be limited. If blank, the abstract is assumed to be unlimited.

FY97
AIR VEHICLES
TECHNOLOGY AREA PLAN



HEADQUARTERS AIR FORCE MATERIEL COMMAND
DIRECTORATE OF SCIENCE & TECHNOLOGY
WRIGHT PATTERSON AFB, OH

Approved for public release; distribution is unlimited

About the cover:

This composite photograph depicts a collection of fixed wing air vehicles and conceptual designs that have and will benefit from the development of air vehicles technologies. The Air Vehicles Technology Area continues to address the current fleet needs and at the same time develop revolutionary technologies that will satisfy the requirements for the next generation warfighters. In order to accomplish these tasks two new technology emphases have been established: Today's Aircraft Flying Tomorrow or **TAFT**; and Future Aircraft Technology Enhancements or **FATE**.

TAFT extends the capability of the current fleet beyond its projected operational life through the development and transition of advanced technologies. Technologies supporting **TAFT** include survivable aircraft structures, weapons bay noise suppression, extended life tires, and structural life extension techniques such as development of corrosion sensing and monitoring systems.

FATE develops revolutionary technologies that will become the foundation for next generation warfighters. It will be these new systems that will provide the US with air and space superiority into the 21st century. Examples of **FATE** technologies include, affordable LO data system, active aeroelastic wing, robust composite sandwich structures, advanced compact inlets, photonic vehicle management systems, self-adaptive flight controls and electric actuation, to mention some.

Note: This Technology Area Plan (TAP) is a planning document for the FY97-03 S&T program and is based on the President's FY97 Budget Request. It does not reflect the FY97 Congressional appropriations and FY97-03 budget actions, that may impact the S&T budget in selected TAPs. You should consult WL/FIIB, (513) 255-4294 for specific impacts that the FY97 appropriation may have had with regard to the contents of this particular TAP. This document is current as of 1 August 1996.

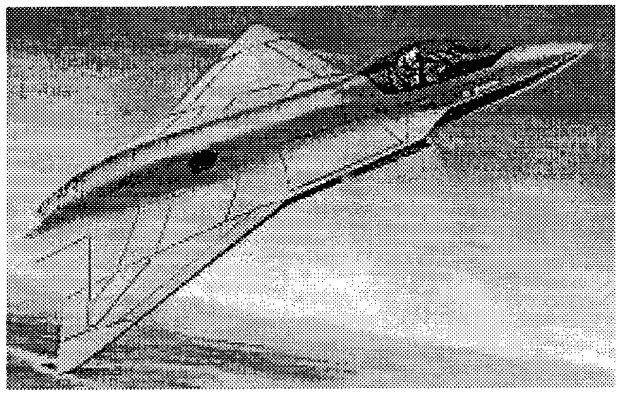
Internet access

Electronic copies of the most recent Air Vehicles TAP and other Air Force TAPs are now available on the world wide web (letters are case sensitive): **http://www.afmc.afmc.wpafb.af.mil:12000/STBBS/info/taps/taps.htm**

Additional information concerning this technology area is available on the Flight Dynamics Directorate home page: **http://www.wl.wpafb.af.mil/flight/fihome.htm**

Comments to this document should be sent to the attention of Mr. Harold Vazquez, WL/FIIB, e-mail: vazquehm@wl.wpafb.af.mil.

AIR VEHICLES



VISIONS AND OPPORTUNITIES

Prelude

Air Vehicles continue to respond decisively to US adversaries with technological advances that ensure our overwhelming military advantage. The Air Force is teaming with the Army, Navy, NASA, academia, and industry to define and develop technologies to meet warfighter capability requirements and address emerging and uncertain threats. These technologies must be affordable.

Wright Laboratory's Flight Dynamics Directorate (FI) has a legacy of innovative design concepts such as fly-by-wire flight control systems, aeroelastically tailored wings, thrust vectoring nozzles and high angle-of-attack flight among other technologies.

Air Vehicles is achieving superior Science and Technology (S&T) advances by focusing on technologies that extend the AF fleet service life as well as technologies that produce revolutionary advances in military weapon systems. Due to budget constraints the current AF fleet must operate well beyond its initially projected operational life. Therefore, ways to significantly extend fleet life and capability, while reducing cost of ownership must be found through aggressive S&T application. We call this emphasis **TAFT**, Today's Aircraft Flying Tomorrow.

Studies such as the New World Vistas and AF 2025 are incorporated and exploited within Air Vehicles S&T to form the basis of the next generation warfighter capabilities. It will be these new system capabilities that will provide the US with air and space superiority into the 21st century. We call this emphasis **FATE**, Future Aircraft Technology Enhancements.

Vision

By the year 2000,

"The Flight Dynamics Directorate will be recognized as the Department of Defense leader in providing the development of military fixed wing air vehicle technologies."

Our vision incorporates **TAFT** and **FATE** areas of emphasis. **TAFT** emphasizes development of near term technologies to extend the AF fleet beyond its original service life. **FATE** emphasizes development of breakthrough technologies for long term revolutionary fixed wing air vehicles. This balanced approach will ensure emphasis on affordability and supportability while encouraging innovative system solutions.

Principal Planning Strategy

The Flight Dynamics Directorate leads the development of several multi-organizational air vehicle S&T strategic planning efforts. One of these efforts is the Fixed Wing Vehicle (FWV) Technology Development Approach (TDA) Integrated Product Team (IPT). This integrated product team consists of the AF, Navy, ARPA, NASA, academia, and industry. Together they identify cooperative and individual S&T programs that are necessary to achieve 5, 10, and 15 year fixed wing vehicle goals. The FWV TDA directly supports the new streamlined DoD Technology Area Plan and its associated Defense Technology Objectives as well as the Joint Aeronautical Commanders Group (JACG) Aviation S&T roadmap. The Flight Dynamics Directorate is also the AF lead in a joint DoD/NASA Fixed Wing Panel which seeks further collaboration of S&T research resources. These planning processes are thoroughly integrated to ensure a balanced and focused national air vehicle technology investment.

Opportunities

The emerging FWV TDA will provide a stabilized framework for which fixed wing air vehicles S&T investments can be identified, prioritized, and executed. The TDA will transition national military fixed wing vehicle goals into warfighter capabilities.

The Air Force Modernization and Planning Process, Mission Area Plans, and Technology Master Process all promote linkage between user needs and S&T research. This cooperation and coordination further helps to focus air vehicles S&T so that the greatest benefits/payoffs are realized. The Flight Dynamics Directorate actively participates and supports these processes.

Summary

Air vehicles technology spans multiple technical disciplines to provide the Air Force and our nation with innovative solutions to both near- and far-term defense needs. Our scientists and researchers work in Integrated Product Teams that design, develop and provide optimum air combat capabilities. It is the cooperation and coordination of these IPTs, consisting of DoD, NASA, academia, and industry that will ensure the emphasis of air vehicles S&T is placed on the highest national defense needs.

During a time of declining budgets and resources, we are challenged to maintain and provide critical technologies, ensuring the nation's superior defense capabilities. Affordability is paramount and is given utmost consideration in all phases of the Air Vehicles Technology Area. We developed a strategic plan for Air Vehicles S&T built around **TAFT** and **FATE** to ensure we can maintain our leadership role, and to build a foundation for continuing excellence into the future.

This plan has been reviewed by all Air Force laboratory commanders/directors and reflects integrated Air Force technology planning. I request Air Force Acquisition Executive approval of the plan.

RICHARD W. DAVIS, Colonel, USAF
Commander
Wright Laboratory

RICHARD R. PAUL
Major General, USAF
Technology Executive Officer

CONTENTS

NOTES

INTRODUCTION

Background

The Air Vehicles Technology Area, highlighted in Figure I.1, is part of the Air Force Science and Technology (S&T) program. The Air Vehicles Technology Area Plan (TAP) identifies how advanced aircraft technology is developed to address solutions to user needs by using the Technology Master Process (TMP) and the Mission Area Plans (MAPs) adopted by HQ AFMC and the user community.

All Air Force aircraft in service today incorporate design criteria and subsystem designs that were developed and validated in the Air Vehicles Technology Area. Recent successful accomplishments include:

- Operational flight test of axi-symmetric, thrust vectoring nozzles on F-15 ACTIVE aircraft. Flight tested configuration self-optimizing flight control software to demonstrate range/payload improvements.
- Validation of the performance of advanced compact inlet systems in a cooperative wind tunnel experiment with NASA, yielding data for low volume, low cost survivable inlets for subsonic and supersonic flight.
- Integration of improved accuracy computer models into crack growth analysis, enabling the first time prediction of structural life in arbitrary stress fields and with residual stresses.
- Flight validation of low horsepower electric actuators on aileron of NASA F-18 in joint USAF, Navy, and NASA program to support ACC's need for increased survivability and decreased maintenance costs.
- Development of an improved air-to-air targeting decision aid and successful testing of a missile trajectory prediction algorithm.
- Transition of mission compatible birdstrike resistant transparencies to production for F-15, F-16, T-38, and F-18. Demonstrated injection molding process for low cost transparencies.
- Demonstration of Combined Fire Fighting Hazardous Material Ensemble for use in intense heat (3,000 °F) and highly energetic chemical spill environments.

These accomplishments are directly tied to warfighter needs through the Technology Planning Integrated Product Team (TPIPT) and the Mission Area Plans (MAPs) process. The users and their specific needs are outlined within our Thrust writeups.

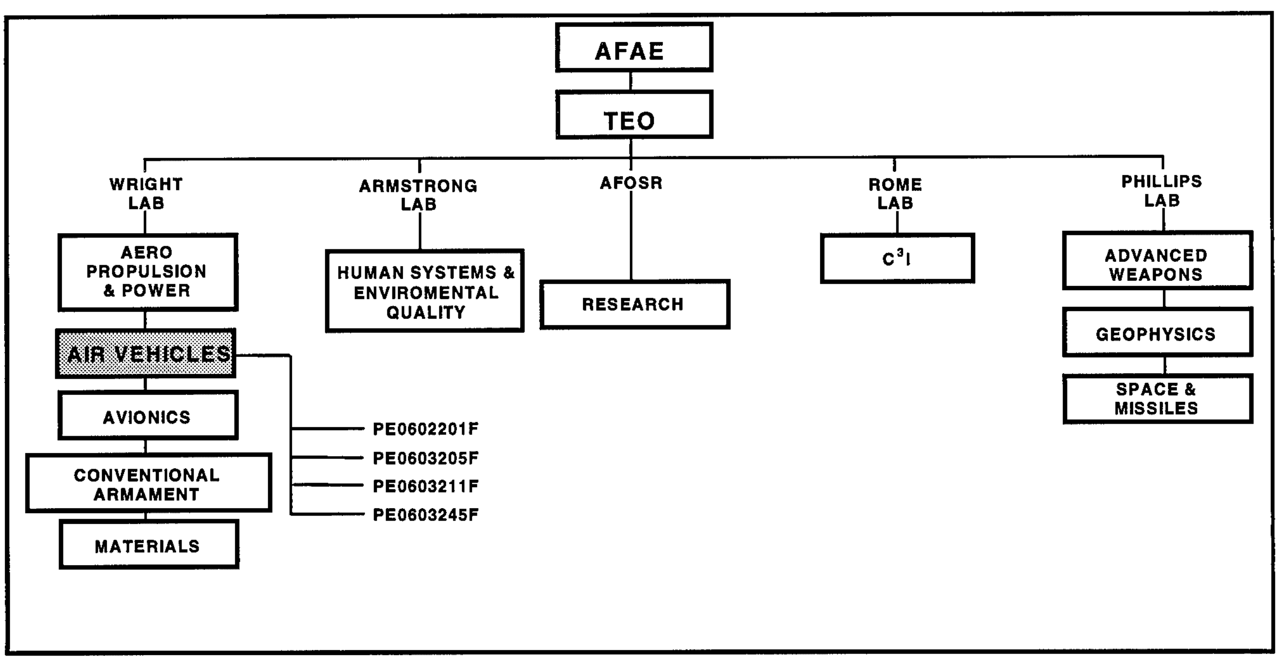


Figure I.1: Air Force S&T Program Structure

Air Vehicles technology users include the Aeronautical Systems Center (ASC), which manages the development and fielding of new aircraft and armament systems; Air Force Materiel Command (AFMC) and MAJCOMs, which develop, process, use, maintain and upgrade the existing aircraft fleet from "cradle to grave"; the aerospace industry, which develops, designs and manufactures military and commercial aerospace vehicle systems; and the Army, Navy, Marines, Coast Guard and Federal Aviation Administration (FAA) , which rely on the Air Force for development/demonstration of Fixed Wing Air Vehicles technologies. The Air Vehicles Technology Area is the Tri-Service Lead for Fixed Wing Aircraft in Integration Technology, Aeromechanics, Structures, Flight Control, Pilot Vehicle Interface, Vehicle Subsystems and Air Base Technology. These technologies are mirrored in the Air Vehicles Thrust titles shown in Table I.1.

Table I.1: Major Technology Thrusts
1. INTEGRATION TECHNOLOGY
2. AEROMECHANICS
3. STRUCTURES
4. FLIGHT CONTROL
5. PILOT VEHICLE INTERFACE
6. VEHICLE SUBSYSTEMS
7. AIR BASE TECHNOLOGY

Air Vehicles S&T Funding

The funding to achieve the required Air Vehicles research is shown in Figure I.2, and reflects the Air Vehicles technology area share (7% in FY97) of the AF S&T budget. All funding is based on the President's FY97 Budget Request and is subject to change based on possible congressional action.

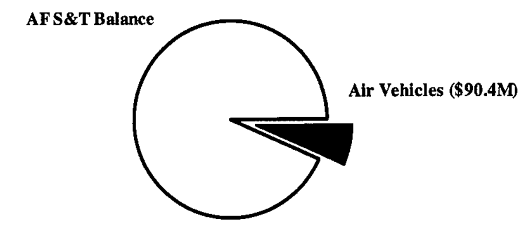


Figure I.2: Air Vehicles S&T $ vs Air Force S&T $

The Air Vehicles Thrust Areas funding breakdown is shown in Figure I.3.

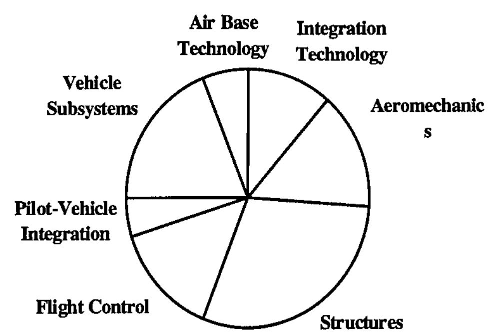


Figure I.3: Major Technology Area $

Relationship to Other Technology Areas

Air Vehicles Thrusts have relationships with our allies through Data/Information Exchange Agreements (DEAs/IEAs), and Memoranda of Understandings/Agreements (MOUs/MOAs). We have over 30 DEAs/IEAs with foreign countries to conduct research and development in basic technologies such as computational fluid dynamics, airframe weapons integration, aerothermodynamics optimization, aeroelasticity analysis methods, life prediction techniques for high-temperature structures, high AOA flight stability and control, flight control techniques, structural integrity, robust coatings and epoxy transparency repair, among others.

We have MOUs with the Air Force, Army, Navy, and NASA in subsystems and display technologies research, as well as working relationships with the Advanced Research Projects Agency (ARPA) on the congressionally directed

High Definition Systems program. Specifically, we have an MOU between the Navy and the Air Force to conduct full-scale aircraft structural testing for the Navy. This joint effort will save the Navy the cost of moving its existing full-scale facility to Patuxent River, MD. Additionally, we have MOAs with the FAA and NASA Langley to explore aging aircraft technology.

The Integration Technology Thrust has a joint program, Innovative Aerodynamic Control, with NASA Dryden that will develop and flight demonstrate the use of thrust vectoring for increasing cruise range and reducing drag during "high g" maneuvers. Emphasis will be placed on using the vectoring nozzle for pitch and yaw trim while moving the aerodynamic controls to a low drag streamlined position.

The Aeromechanics Thrust works closely with the Navy and ARPA to provide affordable performance improvements for future fighter aircraft. Joint efforts are being accomplished with NASA to develop maneuverable extended range configurations for advanced low signature fighters and transports. Rapid aerospace vehicle assessment and optimization codes are being developed, with close collaboration between NASA, AFOSR and Wright Laboratory scientists, to maximize the payoff from each agency's investment. The Aeromechanics Thrust provides technical support to ASC in the application of computational fluid dynamics (CFD) methods for solutions to flight problems encountered by today's operational aircraft. Multibody CFD methods are being developed for certification of stores carriage and release. Aeromechanics programs in nozzle and inlet integration technology are accomplished as a team with the Aero Propulsion and Power Directorate to increase performance, reduce weight and reduce signature.

The Structures Thrust has a joint effort with the Naval Air Warfare Center to explore structural health monitoring of the Air Force and Navy aircraft and significant improvements to the aircraft structural integrity programs. A cooperative program with NASA Langley is testing the buffet alleviation approaches on a 16% model of the F-18 tail. A collaborative in-house effort with the Aeromechanics Thrust and Flight Control Thrust is underway to control buffet on twin-tail fighter aircraft at high angle of attack. Integrated Process Teams have been developed with the Aeromechanics and Flight Controls subthrusts to develop and demonstrate multidisciplinary design and analysis methods and active aeroelastic wing technologies. Research jointly funded with the FAA is being conducted to account for the effects of corrosion and multiple site damage in structural risk analysis. A Memorandum of Understanding with NASA and FAA is covering aging aircraft work in corrosion fatigue, widespread fatigue damage, and repairs. A jointly funded program with Phillips Lab and NASA is developing thermal protection systems, cryogenic tanks, and composite primary structures for reusable launch vehicles. A program is underway with NASA Langley, Georgia Tech and Lockheed on modification and verification of our flagship computer program, ENS3DAE, for analyzing the computational fluid dynamics of aeroelasticity.

The Flight Control Thrust has a joint critical experiment with NASA and the Navy. This program, Electrically Powered Actuation Design (EPAD), flight validates electrical actuation designs for primary control surfaces of high performance military aircraft. Closely related are the Thrust's role as agent for the ARPA sponsored Electric Actuation and Control System Technology Reinvestment Program (TRP) developing a "flight sized" electric actuator for the F/A-18 stabilator, the cooperative work with the Aerospace Propulsion and Power Directorate to develop flight control technology required for the More Electric Aircraft, and collaborative efforts with the Structures Thrust to develop advanced flight control techniques and actuation devices to enable the control of aeroelastic wings and other innovative structure designs. Additional ARPA sponsored programs where the Flight Control Thrust is agent include: (1) Fly-By-Light Advanced System Hardware program that develops dual-use fiber optic technology for commercial and military air vehicles; (2) Laser Wind and Hazard Profiler program that will improve the ability to measure flight vehicle air data and wind conditions for weapon delivery as well as detect dangerous wind conditions. The Flight Control Thrust is the Government team leader for the ARPA sponsored consortium to develop an Autonomous Landing Guidance System for all weather operations. This thrust is also investigating the survivability of flight control systems. Programs are being developed to research the impact of internal blasts on transport aircraft flight control systems for the Federal Aviation Administration, and identifying threats and survivability enhancements to military flight control equipment for the Joint Technical Coordination Group for Aircraft Survivability. The USSOCOM sponsored Intraformation Positioning System program develops technology that provides flight management, control, and deconfliction during ingress, egress, rendezvous, formation, and terminal area operations. The Air Force Office of Scientific Research (AFOSR) sponsors Flight Control Thrust research in multivariable control theory to develop and mature new design methods and flight control algorithms. AFOSR also sponsors research in Air Vehicles targeted at developing better aerodynamic modeling techniques to capture highly nonlinear effects.

The Pilot Vehicle Interface Thrust has the in-house research program, Crew Station Associate Technology (CSAT), that focuses on a capability for parallel, real-time data processing for aircrew decision aids. CSAT will integrate analytical information processing methods, sensor fusion methods, appropriate processing hardware, and methods of information and software management. This Thrust also has the Advanced Crew-Tailored Cockpit Concepts (ACTCC) program that ensures the latest state-of-the-art information control and display formats are available to increase situational awareness and optimize workload, thus improving combat effectiveness. ACTCC currently conducts research in four areas: variable-detail electronic landing and target approach charts, voice control of cockpit information, flight pathway head-up and head-down display formats, and target designation for 3-dimensional autostereo tactical displays. The Pilot Vehicle Interface Thrust is coordinated with the Joint Cockpit Office in conjunction with the Armstrong Laboratory Crew Systems Technology Thrust, which includes efforts of Armstrong Laboratory's Human Factors Engineering Division and Wright Laboratory's System Avionics Division and Advanced Cockpits Branch. A robust and complementary cockpit integration development program has been established between these organizations. Coordination with the Army and Navy on the development of Active Matrix Liquid Crystal Display (AMLCD) and graphical processors is accomplished through direction by the Joint Aeronautical Commanders Group for the Flat Panel Cockpit Display project.

The Vehicle Subsystems Thrust has two MOUs with NASA Langley Research Center (LaRC) on the Radial and Bias Aircraft Tire Testing and the Improved Tire Life programs. NASA LaRC supplies facilities and manpower, and the Air Force supplies hardware, data and manpower. The Vehicle Subsystems Thrust has an MOU with the FAA to conduct research aimed at providing hardening techniques to increase the survivability of transport aircraft. The FAA provides 100% funding, while the Air Force supplies test facilities, manpower, test articles and data. The Vehicle Subsystems Thrust is also working closely with other services and the FAA to explore options for replacing banned ozone depleting substances such as Halon. This Thrust is working closely with Armstrong Laboratory within the technology area of crew escape to expand the performance envelope of ejection systems.

Changes From Last Year

The Air Vehicles Technology Area – except Pilot Vehicle Interface, and Air Base Technology – is aligned with the DoD Technology Area Plan (DTAP) for Air Platforms as supported by the Fixed Wing Vehicle Technology Development Approach. The Air Platforms Technology Area is the integration lead for DoD Fixed Wing Air Vehicles.

The Civil Engineering and Environmental Quality Technology Area Plan has been eliminated. The Civil Engineering portion, renamed Air Base Technology is now a thrust of the Air Vehicles Technology Area Plan.

The Air Vehicles Pilot Interface Thrust supports the DTAP in Human Systems Interface.

The Flight Dynamics Directorate (FI) has initiated a joint aircraft conceptual design standard with academia, industry and government agencies. The central focus is on multi-disciplinary designs, and the goal is to develop an integrated design as a conceptual design baseline.

The Air Vehicles Thrusts are responding to the Air Force's new emphasis in unmanned/uninhabited combat air vehicles (UCAV) and other air vehicle configurations, as recommended by the SAB's New World Vistas Study.

The Flight Dynamics Directorate will develop integration technologies, aeromechanics, structures, controls, and subsystems for a range of potential hypersonic systems (air breathing and rocket-powered, missile and aircraft) for the Aero Propulsion and Power Directorate's Hypersonic Technology program (HyTech).

THRUST 1: INTEGRATION TECHNOLOGY

User Needs

The Integration Technology Thrust provides technology solutions to a variety of user needs as stated in the MAPs, Mission Need Statements, Operational Requirement Documents and user-proposed Advanced Technology Demonstration programs. Many of these deficiencies evolved from operational user needs through strategies-to-task analyses. The users for Integration Technology include Air Combat Command (ACC), Air Mobility Command (AMC), Air Force Special Operations Command (AFSOC), Air Education and Training Command (AETC), Air Force Materiel Command (AFMC), Aeronautical Systems Center (ASC), major System Program Offices, other government agencies such as National Air Intelligence Center, commercial industries and universities.

The programs in this thrust have been derived to solve the following user-documented needs:

- ACC requirements for quick reaction; increased range, maneuverability, and payload; low observable weapon carriage; smart weapon support; controlled-flight departure prevention; enhanced survivability; high AOA simulation testbed; and affordable technologies for the 21st century.
- AMC requirements for improved cockpit commonality, reliability and maintainability; real-time information to aircrews; and all-weather intraformation station keeping capability.
- AFMC requirements to support the Air Force Test Pilot School and to provide quick reaction support to the major weapon Systems Centers and Logistics Centers in the areas of control hardware and software, aeromechanics, structures, subsystems and cockpit avionics.
- AFSOC requirements for improved thermal energy management systems, night/in-weather covert intraformation collision avoidance.

Goals

The primary Integration Technology Thrust goals are to identify, mature, and transfer the benefits of advanced multi-disciplinary technologies. The Integration Technology Thrust in concert with the Office of the Director for Defense Research and Engineering (ODDR&E) has aligned the following goals to National, Interservice, and Air Force user needs. These goals are grouped in the technology subthrust areas of Advanced Development and Advanced Concepts. (See Figure IT-1). The Integration Technology Thrust will achieve the following goals for a class of baseline air vehicles (F-22, C-17 and A/MC-130) by the year 2005:

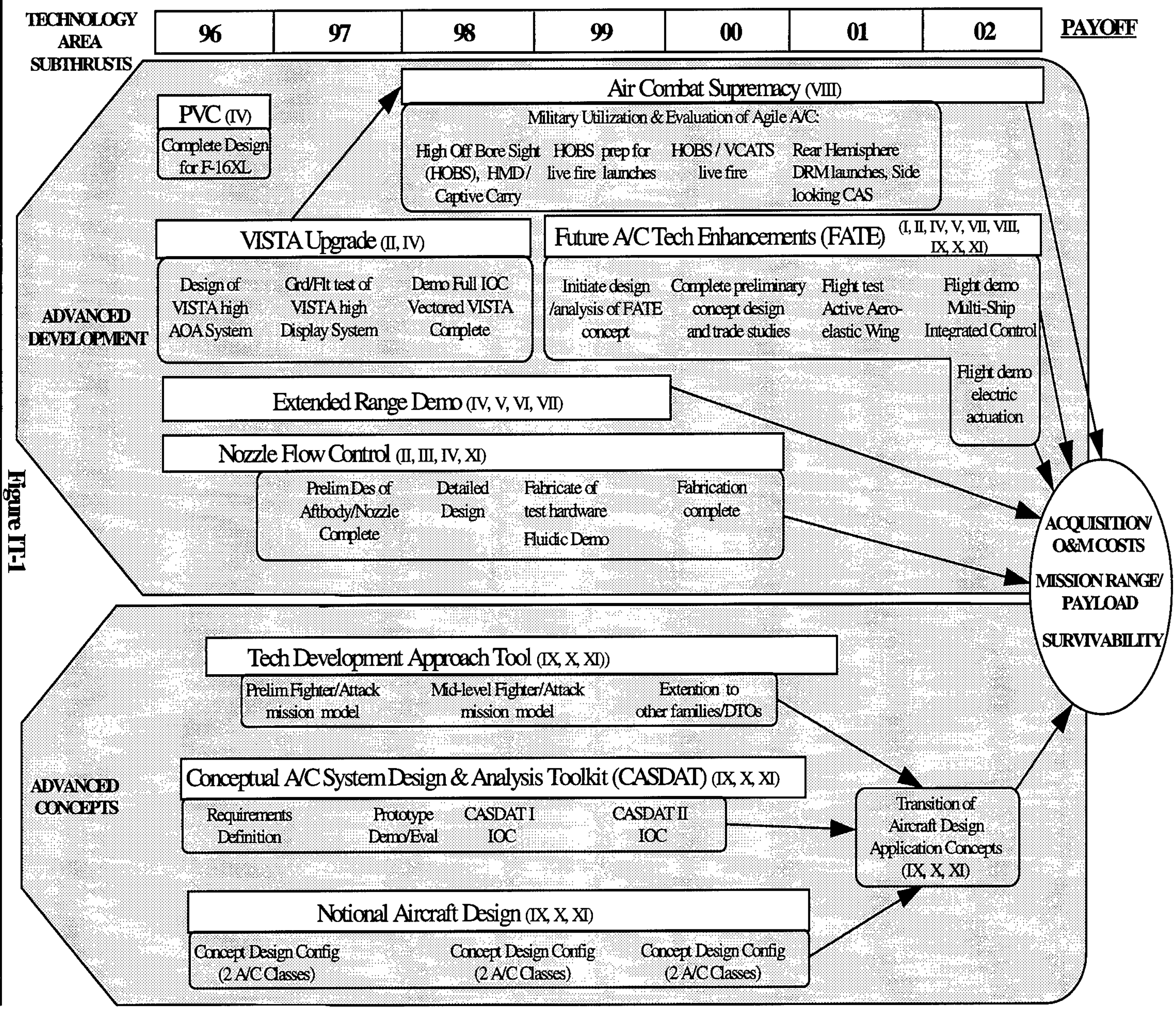
I. 20% reduction (RED.) in maneuvering wing weight
II. 20X increase (INC) thrust vectoring nozzle life
III. 60% RED hinged control surfaces
IV. 60% RED loss-of-control accidents
V. 25% Twin-tail buffet alleviation
VI. 25% INC. limit-cycle oscillation speed
VII. 25% INC flutter speed
VIII. 6X INC air combat no escape zone
IX. Develop baseline notional aircraft designs for all classes of aircraft families identified in the DoD Technology Area Plan for Air Platforms.
X. Develop conceptual aircraft systems design & analysis toolkit for all classes of aircraft families identified in the DoD Technology Area Plan for Air Platforms.
XI. Develop system level integration to exploit synergistic benefits of Fixed Wing Air Vehicles technologies.

These goals are fully aligned with the Defense Technology Objectives in the Defense Technology Area Plan for Air Platforms.

Major Accomplishments

- Conducted operational flight test of axi-symmetric, thrust vectoring nozzles on F-15 ACTIVE aircraft. Flight tested configuration self-optimizing flight control software to demonstrate range/payload improvements.
- Designed internal pneumatic vortex flow control hardware to determine feasibility of using vortex flow field manipulation as a viable means of air vehicle low observable flight control.
- Flight tested an embedded GPS/INS navigation system on the AFTI/F-16 as a risk reduction demonstration for the F-16 planned upgrade program.

INTEGRATION TECHNOLOGY THRUST



Note: Roman numerals indicate linkages of milestones and goals; i.e. milestone contribution to goal (See Goals Section)

Figure II-1

Integration Technology 6 Air Vehicles

- Completed inlet distortion wind tunnel tests on the Pratt & Whitney F-100-229 engine and Pitch-Yaw Balance Beam Nozzle as part of the VISTA/NF-16 Upgrade program. Tests were conducted at AEDC to map inlet distortion of the large inlet with a P&W engine.
- Conducted a coordinated data call between industry, academia, and government agencies for notional aircraft design concepts that will serve as a bench mark for evaluation of advanced technologies with respect to user benefits and affordability.
- Completed data analysis on the Conceptual Aircraft System Design Analysis Toolkit requirements. This tool will enable Air Vehicle S&T to be evaluated on baseline notional aircraft designs. These evaluations will identify technologies that will provide the most promise in terms of capability and affordability.

Changes from Last Year

The Integration Technology Thrust was reengineered to incorporate technology-driven notional air vehicles concepts which are incorporated into the Advanced Concepts core area. This core area emphasizes synergistic benefits derived from integrating multidisciplines within its technology base. This integration emphasis spans both near-term (current fleet) and technology-driven future notional air vehicles.

Milestones

The milestones, outlined in Figure IT-1, are grouped in their respective subthrust area. The following milestones further expand the Goals section into specific quantifiable events by fiscal year.

Advanced Development

Pneumatic Vortex Control:

FY96: Complete design forebody blowing system and digital FCS upgrade of the NASA DFRC F-16XL aircraft.

Air Combat Supremacy:

FY99: Begin military utility evaluation flight tests of agile aircraft, head steerable weapon cueing, high off-boresight agile missile system as part of the Air Combat Supremacy (ACS) program. Begin preparation for HOBS live fire launches.

FY00: Expand military utility evaluation flight tests with live fire of high-off boresight missile from agile aircraft with visual cueing and targeting system (VCATS) helmet mounted display.

FY01: Off-the-shoulder and rear hemisphere live fire demonstrations of Armament Directorate dual range missile configuration equipped with side-looking conformal array seeker (CAS).

VISTA Upgrade:

FY96: Initiate the design of the VISTA high angle-of-attack (AOA) system and programmable display capability.

FY97: Complete all ground and flight test development of the VISTA programmable display system.

FY98: Complete all ground and flight test development of the VISTA high AOA system. Demonstrate full Initial Operational Capability of the VISTA high AOA system. This will realize a 5% reduction in development cost by providing the Air Force with a unique capability for the simulation and demonstration of high AOA flight operations.

Future Aircraft Technology Enhancements (FATE):

FY99: Initiate design and analysis of the FATE concept.

FY00: Complete preliminary concept design and technology trade studies for FATE.

FY01: Flight demonstrate Active Aeroelastic Wing. This will realize a reduction in maneuvering wing weight, cruise/maneuver drag and hinged control surfaces; providing control authority for tail-less configurations.

FY02: Flight demonstrate multiship integrated control and electric actuation resulting in the capability to control multiple vehicle composite strike forces and use electric actuation as primary devices for flight control surfaces.

Extended Range Demo:

FY96: Obtain cruise range optimization by utilizing thrust vectoring to produce the pitch normally obtained by the tail. This is the first step toward reducing the drag and/or rudder size.

FY97: Complete all-envelope (subsonic/supersonic) "quasi-tailless" flight evaluation on F-15 range enhancement aircraft using the rudder to cancel vertical tail effects.

FY98: Complete all-envelope flight evaluation of reduced (~1/2) tail thrust-vectored F-15 ACTIVE, demonstrating the feasibility of future directionally unstable, highly maneuverable, tailless fighters.

Nozzle Flow Control:

FY96: Complete study of advanced nozzle concepts that are low cost, low weight, highly survivable and structurally integrated.

FY97: Preliminary design of advanced nozzle concepts that are low cost, low weight, highly survivable and structurally integrated.

FY98: Complete subscale aerodynamic testing of advanced nozzle concepts to determine fluidic throat area control and fluidic thrust vectoring performance.

FY99: Completed detail design of advanced nozzle concepts that are low cost, low weight, highly survivable and structurally integrated. FY00: Integrate advanced nozzle concepts into a 21st century fighter airframe and conduct installed aero performance testing.

Advanced Concepts

Technology Development Approach:

FY96: Government and Industry Fixed Wing Vehicle (FWV) Technology Development Approach (TDA) is constructing a representation of the national FWV 15-year plan in terms of payoffs, goals and technical effort objectives in 5-year increments. The integrated product team is presently in a major effort to "stand up" the Fixed Wing program.

FY96: Demonstrate a preliminary combat model for a fighter/attack mission to compare a subset of air vehicle technologies using common metrics.

FY97: Demonstrate a mid-level complexity combat model for the fighter/attack mission.

FY98: Demonstrate advanced cost estimating tool incorporating engineering principles, to show affordability impacts of advanced S&T.

FY00: Extension of the TDA Tool to other families/Defense Technology Objectives completed.

Conceptual Aircraft System Design and Analysis Toolkit (CASDAT):

FY96: Completed user requirements definition and survey/analysis of available "best practices" for fixed wing vehicles conceptual design tools and methods.

FY97: Proof of concept CASDAT demonstration of state-of-the-art modular software architecture with interchangeable modules and user-friendly designer interface.

FY98: Initial operational capability of CASDAT system with modules to design and analyze revolutionary fixed wing vehicle concepts.

FY99: Full operational capability of CASDAT system with TDA tools integrated.

FY02: Transition of the Conceptual Aircraft System Design Analysis Toolkit to industry, academia, and government agencies for technology investment and strategy planning.

Notional Aircraft Design:

FY96: Down select to two final notional aircraft designs, representative of two classes of the families of aircraft identified in the DoD Technology Area Plan for Air Platforms. Identify and develop modules for tasks integration, payoff trade studies, and feasibility studies on Air Vehicles technologies. These modules will make up the Conceptual A/C System Design Analysis Toolkit.

FY97: Select final notional aircraft designs for the remaining classes of A/C identified in the DoD Technology Area Plan for Air Platforms. Develop architecture to integrate modules developed for the Conceptual A/C System Design Analysis Toolkit.

THRUST 2: AEROMECHANICS

User Needs

Advanced aeromechanics technologies yield extended range, enhanced maneuverability, and increased payload, while enhancing affordability, maintainability, and stealth. Substantial gains in military aircraft performance and reduced design complexity are realized by radically new configuration concepts.

The warfighter's needs addressed in this thrust have been identified in their Mission Area Plan (MAP) documents and the needs developed in the TPIPT forum:

- Air Combat Command's Counter Air requirements for improved range, maneuverability, and acceleration.
- Air Combat Command's Close Air Support/Interdiction requirements for reducing the range penalty for carrying external stores and developing the technology to provide a standoff fast reaction weapon.
- Air Force Special Operations Command's need for air vehicle technology to support planning for replacement of aging transport aircraft and to identify new aircraft with VSTOL capabilities.
- Air Force Space Command's Spacelift requirement to plan for replacement of the Space Shuttle in the next century.
- Aeronautical System Center (ASC) System Program Office's (SPO) technology needs for modern day aircraft, such as F-117, F-22, B-2, C-17 and technology for emerging concepts, such as JSF.

Goals

The goals of the Aeromechanics thrust are grouped into technical subthrusts of Aerodynamic Configuration Technology and Computational Fluid Dynamics to support future air vehicle goals. (See Figure A-1). The Aeromechanics Thrust will achieve the following goals by the year 2005:

I. 12% reduction (RED) in cruise drag
II. 15% increase (INC) in maneuvering lift/drag
III. 35% INC on payload range with weapons
IV. 25% INC in landing lift coefficient
V. 75% RED in nozzle weight
VI. 50% RED in nozzle signature
VII. 50% RED in nozzle acquisition costs
VIII. 30% RED in weapons integration signature
IX. 15% RED in tail drag
X. 30% INC landing approach lift
XI. 12% RED in take-off distance
XII. 50% RED duct/inlet weight volume
XIII. 10% RED design/performance cycle time

These goals are fully aligned with the Defense Technology Objectives in the Defense Technology Area Plan for Air Platforms

Major Accomplishments

- Completed wind tunnel phase of the Unsteady Aerodynamics Program, documenting the origin and strength of aerodynamic loads on vertical tails encountered at maneuvering flight conditions.
- Validated the performance of advanced compact inlet systems in a cooperative wind tunnel experiment with NASA, yielding data for low volume, low cost survivable inlets for subsonic and supersonic flight.
- Completed dem/val of a multi-body CFD computer code for analysis of store separation and system staging, with significant savings in operating complexity due to connection of computer-aided design (CAD) geometry with unstructured grid generation.
- Validated aero-performance of second generation lambda-wing experimentally to show the high lift design approach is consistent with both low observables and maneuverability.
- Completed development of interface method to couple computational fluid dynamic and computational structural dynamic analyses.
- Completed evaluation of extended range fighter technology sensitivities to identify high payoff concepts for detailed analysis.
- Accomplished preliminary installation analysis for pneumatic aero devices, showing potential for enhanced maneuverability and reduced drag due to downsizing/elimination of vertical tails.
- Collected the first known data set revealing the stability characteristics of a high speed boundary layer on a fully three dimensional shape, leading the way to reduction of heating due to high speed flight.

Changes from Last Year

The Computational Fluid Dynamics Subthrust was augmented by a closer alliance with the Advanced Diagnostics program, providing more

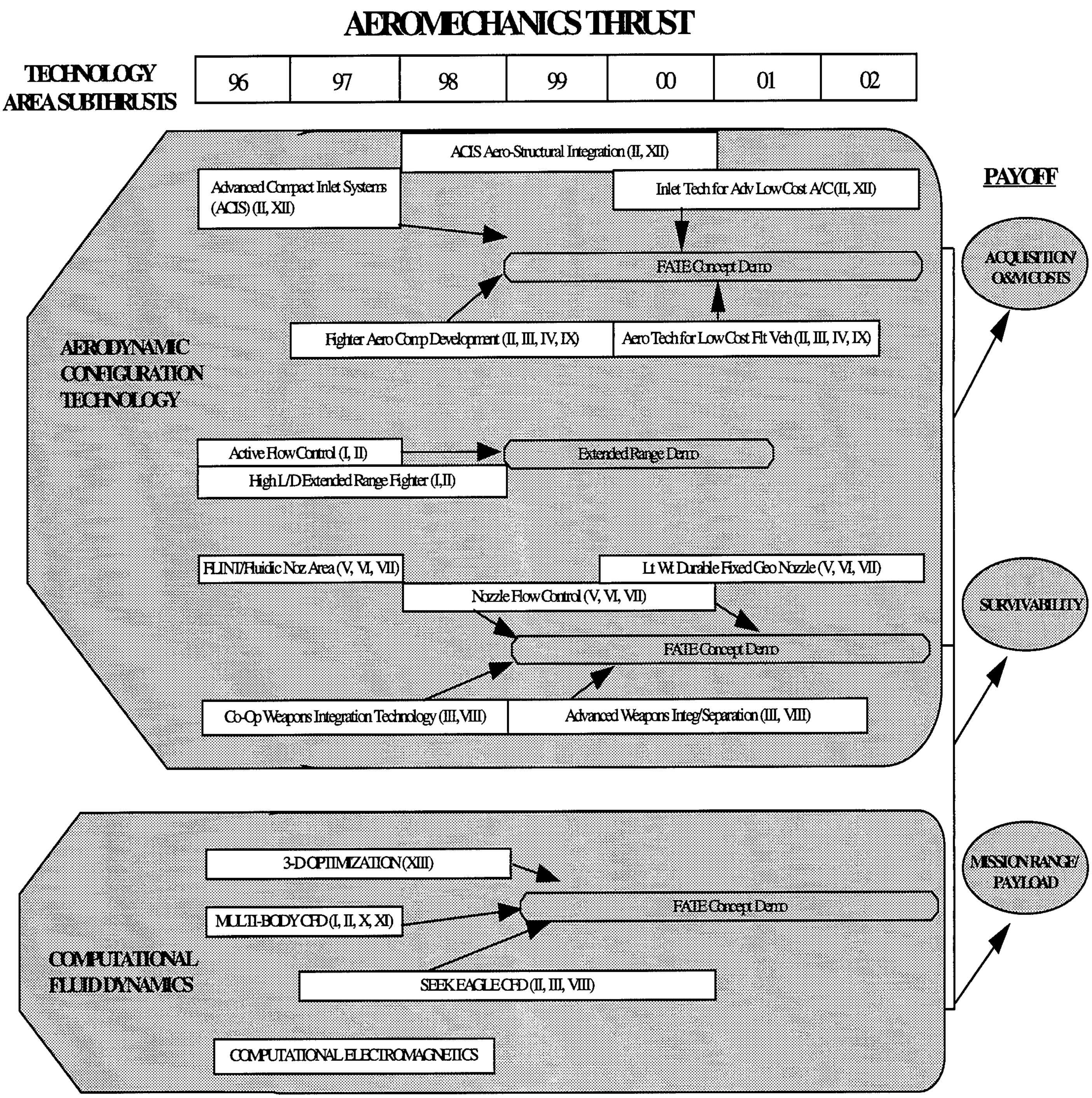


Figure A-1

timely response to the need for experimental validation of numerical methods.

Note: Roman numerals indicate linkages of milestones and goals; i.e. milestone contribution to goal (See Goals Section)

Aeromechanics 10 Air Vehicles

New World Vistas played a key role in the planing stages of our future programs. Aeromechanics plans to initiate a strong program of research and technology development in advanced configurations in a multidisciplinary approach. Furthermore, aeromechanics will support a vigorous program of research in flow control, aerodynamic design methods, and basic aerodynamics driven by the requirements of the advanced configuration program (Future Aircraft Technology Enhancements or **FATE**). A graphical representation is show in Figure A-1.

Milestones

The programs outlined in Figure A-1 are grouped in their respective subthrust area. The following program milestones further expand the Goals section into specific quantifiable events by fiscal year.

Aerodynamic Configuration Technology

FY97: Demonstrate fluidics technology for exhaust nozzle thrust vector and throat area control, with a substantial reduction in weight and cost over mechanical devices.

FY97: Complete development of low drag/low observable weapons pod/carriage concepts for increasing weapons payload and air vehicle ranges.

FY97: Complete experimental documentation of advanced low-cost, compact engine inlet designs to increase mission range of combat aircraft.

FY97: Complete study of high lift aerodynamic concepts to reduce take-off and landing distances for transport aircraft.

FY97: Develop air vehicle concepts and design criteria for advanced, affordable, intermediate range, manned and unmanned systems with fast reaction strike capability.

FY97: Complete wind tunnel tests of advanced low-cost compact inlet demonstrating performance required to increase mission range of combat aircraft.

FY98: Complete definition of aircraft aerodynamic characteristics which produce performance levels required for advanced SOF transports.

FY98: Complete concept design study for SOF transports, emphasizing low signature, efficient cruise, and short field operation. Wind tunnel data will validate critical performance estimates

FY98: Develop methods for reducing aeroacoustic damage in aircraft twin nozzle installations to increase nozzle service life.

FY99: Identify affordable extended range fighter configurations featuring advanced control effectors, efficient propulsion integration, and low drag weapons carriage.

FY99: Develop inlet surge loads analysis and structures integration for application to air vehicles with extremely high thrust-to-weight ratios.

FY99: Achieve a complete aerospace vehicle synthesis capability for design optimization of manned and unmanned air vehicles that will satisfy multimission tasks

FY00: Complete design application of pneumatic flow control devices for highly survivable fighter aircraft.

FY00: Develop a microelectromechanical device application for active control of boundary layer transition and separation, achieving high lift and low drag with minimum energy addition.

FY00: Develop optically smart skin system to measure velocities in the boundary layer above a curved surface, significantly reducing development costs for flight vehicles.

FY01: Produce lightweight low cost air vehicle concepts through innovative advanced aerodynamic configurations

FY01: Complete experimental database for extended range future aircraft technology demonstrator incorporating configuration elements conforming to requirements of minimum weight composite structure.

Computational Fluid Dynamics

FY98: Achieve wing-body design optimization for performance objectives such as speed or range using advanced computational fluid dynamic methods.

FY99: Extend flow simulation technique, using both numeric and experimental methods, to include space- and time-dependent solutions of the combined unsteady aerodynamic/structural problem, such as twin tail buffet.

FY01: Extend computational electromagnetics analysis method to permit application to cavities and full aircraft survivability evaluations.

FY02: Complete multidisciplinary design computer program to optimize aerodynamic characteristics for extended range.

FY02: Combine computational electromagnetic analysis with computational aerodynamic design optimization methods to produce rapid solutions for survivable fighter concept definitions.

THRUST 3: STRUCTURES

User Needs

The Structures Thrust supports the Air Force need for higher performance, longer life, and more affordable and survivable aircraft structures. New structural concepts and design techniques will exploit the latest materials, processes, and manufacturing technologies to produce more durable structures at lower weight and cost, "smart" structures that correct for fatigue and battle damage, and high-temperature structures for extreme environment flight. Mission Area Plan (MAP) needs addressed are:

- The Air Combat Command (ACC) needs improved range, higher readiness, increased performance and survivability, lower buffet vibration, and increased weapons accuracy, all at lower cost.
- The Air Mobility Command (AMC) needs improved field repairs, longer airframe lifetimes, and greater reliability with fewer inspections. AMC also needs improved aircraft economic service life, despite the effects of fatigue and corrosion.
- The Air Force Special Operations Command (AFSOC) needs higher reliability, combat availability, and lower vehicle signatures in short takeoff and landing operations on unprepared landing sites.
- The Air Education and Training Command (AETC) needs much more reliable airframes, with lifetimes as long as 100 years.
- The Air Force Space Command (AFSPC) needs weight-optimized structures for both the expendable and reusable spacelift systems.

Goals

The Structures Thrust goals are grouped into the following technology subthrust areas: Ensure Structural Integrity of Aging Aircraft, Integrate Structural Technology, Develop Extreme Environment Structures, and Develop Smart Structures (See Figure S-1). Some of the more specific goals for this thrust include:

I. Reduce aircraft structure fabrication costs by 40%, and operations and maintenance costs by 30% by the year 2005.
II. Improve reliability and combat readiness for ACC aircraft by suppressing vibration and increasing structural life by 20% for the engine exhaust impinged structure of the C-17, B-2 and F-117 by the year 2005.
III. Expand the combat capability of ACC aircraft by reducing the structural weight fraction of future fighter aircraft by 25% and cutting airframe design time by 30% by 2005.
IV. Reduce AMC operational and maintenance costs by extending the remaining economic lives of the Air Force fleet by 100% by the year 2005.
V. Reduce the structural weight fraction of military spaceplane vehicles to 0.1 by the year 2005, and develop more affordable, high-speed vehicle structures to enhance future global range for reconnaissance and strike for ACC and AFSPC.

These goals are fully aligned with the Defense Technology Objectives in the Defense Technology Area Plan for Air Platforms.

Major Accomplishments

- Integrated improved accuracy computer models into crack growth analysis, enabling the first time prediction of structural life in arbitrary stress fields and with residual stresses.
- Demonstrated ten-fold (to 100 hours from 10) increase in copper heat exchanger life for hypersonic vehicle engines.
- Completed fabrication of a reduced complexity (projecting an order of magnitude fewer parts) refractory composite primary structure for high speed systems.
- Generated a preliminary design of a structurally integrated nozzle for advanced fighter/attack aircraft, projecting a part count reduction of 50%, a support cost reduction of 90%, and a 10% weight reduction.
- Established Cooperative Research and Development Agreement (CRDA) for Automated Structural Optimization System (ASTROS) development, marketing and support.
- Completed demonstration of radar absorbing high temperature structure (700 °F); enhanced broadband RCS performance; extended fatigue life in extreme thermal acoustic environment by 40%.

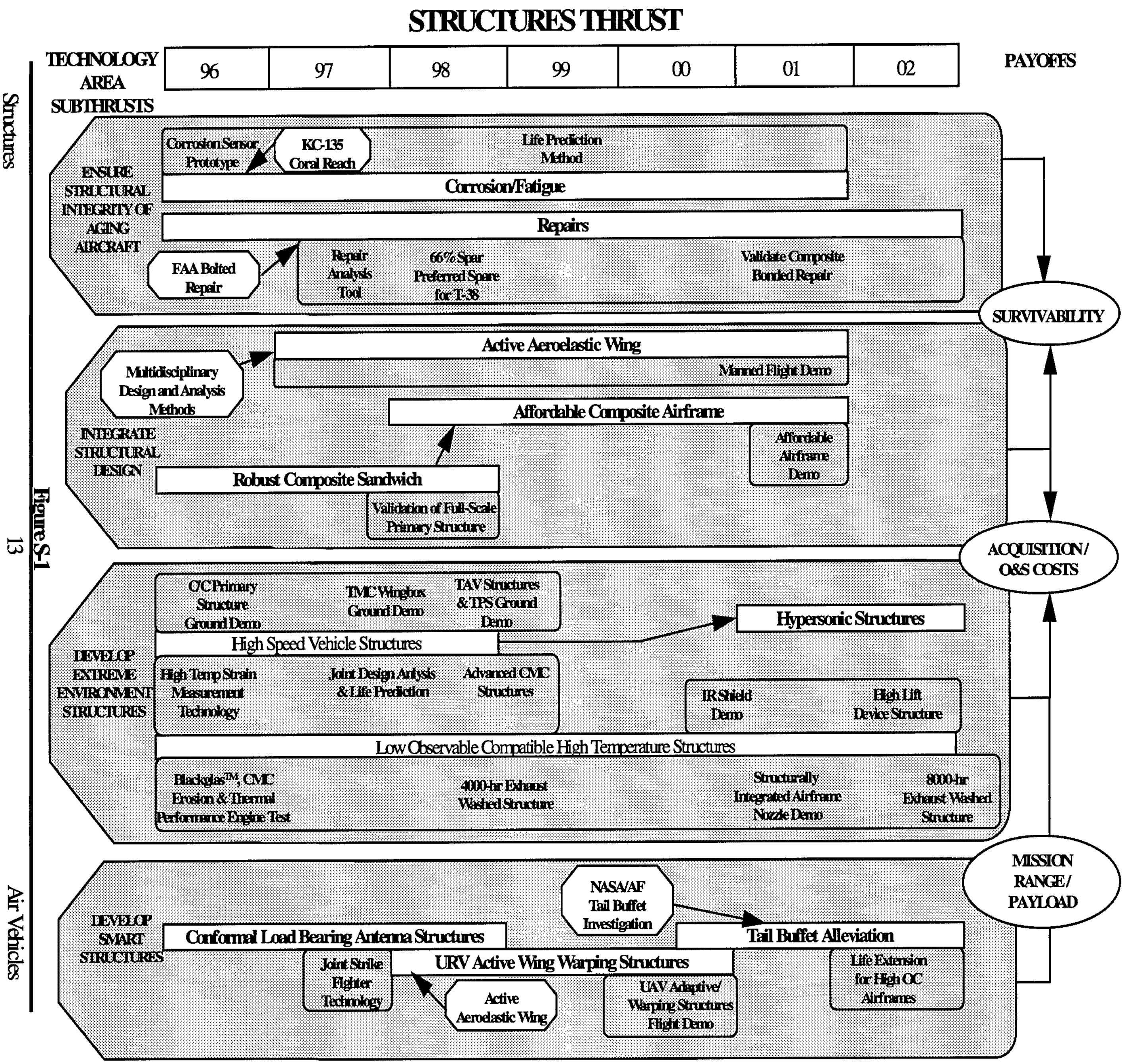


Figure S-1

Note: Roman numerals indicate linkages of milestones and goals; i.e. milestone contribution to goal (See Goals Section)

- Completed conceptual design of primary sandwich structure components that reduce weight by 20% and life cycle cost by 30% relative to conventional honeycomb sandwich structure.
- Completed fabrication of an advanced composite bonded wing section that demonstrates a 50% reduction in composite manufacturing cost and 25% reduction in support costs.
- Completed detail design analysis of a structural component that demonstrates first time structural health monitoring for aging operational aircraft.

Changes from Last Year

Increased emphasis has been placed on aging aircraft by the DoD and the Air Force. The Wright Laboratory Customer Focus Integrated Product Team (CFIPT) on Aging Systems is directly supported by our Aging Aircraft Subthrust, which is placing increased emphasis on life extension, including the development of corrosion sensing and monitoring systems. This will result in reduced costs of maintaining our aircraft fleets, whose ages in some cases are reaching 50 years or more.

Increased emphasis placed on New World Vistas areas of Global Mobility and Lethal/Sublethal Power Projection.

Milestones

The milestones, outlined in Figure S-1, are grouped in their respective subthrust areas. These milestones further expand the Goals section into more specific quantifiable goals by fiscal year.

Ensure Structural Integrity of Aging Aircraft

FY96: Develop proof-of-concept corrosion sensors to reduce the number, cost, and time of inspections for corrosion, and to provide greater reliability. This supports the needs of both AMC, ACC and AFSOC.

FY97: Develop an active suppression system for weapons bay acoustics to reduce vibration and increase the envelope and combat effectiveness of ACC aircraft.

FY97: Develop structural integrity analysis for bonded repairs to ensure airworthiness for repaired AMC aircraft.

FY98: Transition T-38 66% spar redesigned for service durability to AETC.

FY99: Develop service life/risk analysis to account for the effects of multiple site damage and corrosion fatigue interaction to provide AMC and AETC with longer-lifetime airframes.

FY00: Validate design tool for composite repair.

FY01: Improve life prediction and risk analysis for widespread fatigue damage.

FY02: Develop validated active control of weapon bay acoustics

Integrate Structural Design with other Aircraft Disciplines

FY96: Validate multi-disciplinary maneuver load control design methods to reduce gross weight of future ACC fighter aircraft by 10% for improved combat capability.

FY97: Complete static, survivability, and fatigue testing on a full-scale, low-cost, composite-bonded wing.

FY98: Complete full-scale validation of primary sandwich structure to support the ACC needs for improved range and payload.

FY01: Perform flight test demonstration of the active aeroelastic wing concept.

FY02: Complete affordable airframe demonstration.

Develop Extreme Environment Structures

FY96: Demonstrate durability of advanced superalloy heat exchangers for high speed vehicles.

FY96: Demonstrate durability of ceramic matrix composite structures for airframe aft fuselage.

FY98: Develop 4,000-hour supportable engine exhaust-impinged structure concepts for current and future aircraft.

FY99: Demonstrate the 0.1 structural mass fraction required for a military transatmospheric vehicle.

FY00: Reduce vehicle Infrared (IR) signatures 50% over non-actively cooled designs for extended survivability.

FY01: Demonstrate ceramic aircraft fuselage.

FY02: Demonstrate 8,000-hour exhaust impinged structural concepts.

Develop Smart Structures

FY96: Analytical modeling of smart structures.

FY97: Ground test piezoelectric tail buffet alleviation for structural life extension.

FY97: Ground test conformal load-bearing antenna structure to increase stealthiness for improved ACC operational effectiveness.

FY98: Wind tunnel demonstration of adaptive/warping structure for performance and maneuver.

FY99: Demonstrate adaptive/warping on a UAV structure for performance and maneuver.

FY01: Flight test demonstration of active smart structures.

THRUST 4: FLIGHT CONTROL

User Needs

The Flight Control Thrust focus is to advance technology in control system design methods and criteria, hardware and mechanization of that hardware, and piloted air vehicle simulation to meet our customers needs. Technology challenges include increased range, lethality, and survivability, accompanied by decreased costs and supportability requirements.

The customers needs addressed in this thrust have been identified in the following Mission Area Plan (MAP) documents:

- ACC's Theater Missile Defense requires technologies to attack/kill multiple targets on a single pass.
- ACC's Strategic Attack/Air Interdiction calls for increases in reliability while reducing system weight and supportability costs. Counter Air requires support equipment be minimized to reduce airlift requirements.
- Special Operations Command's (SOC) Provide Mobility of Forces in Denied Territory requires new long-range, low observable aircraft designed to fight deep in the battlefield.
- ACC's Counter Air requires weapon systems to operate in all environments on the ground and in the air (in all weather).
- Air Mobility Command's (AMC) Airlift calls for electric actuators and fiber optics for lighter, smaller actuation controls.
- AETC has the requirement to improve networking performance for training simulators.
- The WL Operational Requirements Technology Investment Plan identifies SOC, ACC, AMC and AETC needs for increased range, payload and maneuverability. It requires maintaining controlled flight at high AOA to improve survivability and flight safety.

Goals

The primary goals of the Flight Control Thrust are to reduce air vehicle design and development costs and to improve combat mission effectiveness. The Flight Control Thrust has aligned the following goals to National, Interservice, and Air Force user needs. These goals are grouped in technology areas of Design Methods and Criteria, Control Techniques and Applications, and Flight Control Technology Integration and Flight Simulation. The Flight Control Thrust will achieve the following goals for a class of baseline air vehicles (F-22, F-18, H/MC-130 and C-17) by the year 2005:

I. 30% reduction (RED.) in flight control development costs
II. 150 pound RED. in flight control hardware
III. 70% RED. in low visibility mission aborts
IV. 20% RED. in lifting / control surface drag
V. 50% RED. in cannot duplicate maint. actions
VI. 70% RED. in control related accidents
VII. Electric Actuation up to 30 HP
VIII.New capability: Self-Adaptive Control
IX. New Capability: LO Optical Air Data System

These goals are fully aligned with the Defense Technology Objectives in the Defense Technology Area Plan for Air Platforms.

Major Accomplishments

- Demonstrated Ada Software Integrated Development and Verification System to support ACC's need to reduce overhead for low rate production.
- Flight validated low horsepower electric actuators on left aileron of NASA F-18 in joint USAF, Navy, and NASA program. Supports ACC's need for increased survivability and decreased maintenance costs.
- Demonstrated advanced Fly-By-Light flight control system to support AMC's call for fiber optics for smaller, lighter controls.
- Developed preliminary control system architecture and candidate pilot/vehicle interface concepts for a two manned/four unmanned strike vehicle package to increase lethality and survivability.
- Completed and published robust, multivariable flight control design guideline handbook. Several airframe companies are successfully applying the techniques. Supports the goal of reducing development costs by 20%.
- Completed flight testing the Standard Evaluation Maneuver Set on NASA F-18. Showed the maneuvers were an excellent, repeatable way to evaluate agile aircraft flying qualities. Supports the goal of reducing flight control development costs by 20%.
- Identified aerodynamic control effector suites that enable effective control of vertical tailless

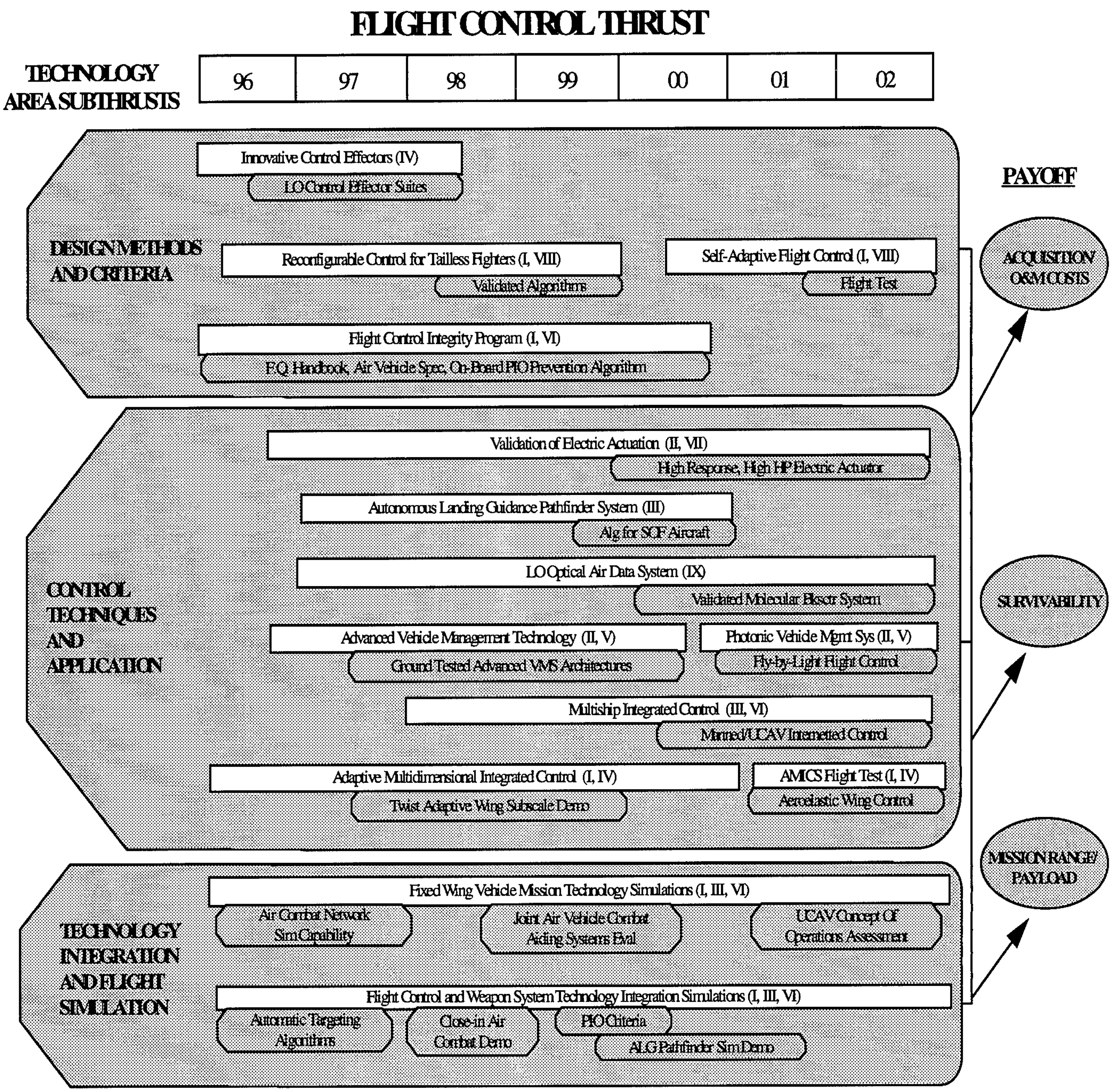


Figure FC-1

Note: Roman numerals indicate linkages of milestones and goals; i.e. milestone contribution to goal (See Goals Section) fighter aircraft. Supports the goal of reducing aircraft weight, drag, and radar cross section.

- Conducted air combat technology assessment simulation to validate high off-boresight weapons launched with helmet mounted displays from thrust vectored aircraft. Supports ACC's need to attack/kill multiple targets on a single pass.

Changes from Last Year

Changes from last year include the separation of the Unified PIO Program into several interrelated projects to accommodate budget limitations and delays, and restrictive in-flight simulator schedules. Changes also include a 1 year slip in the electrohydrostatic and electromechanical actuators flight test from 1995 to 1996. Another change is the addition in 1996 of a dual-use effort to accelerate development in optical air data plus addition of a cooperative research and development activity to flight test modular, low cost vehicle management system for unmanned vehicles. The milestone for FY96 to demonstrate virtual strike warfare environment was not accomplished due to AF JAST funding cut. The milestone for the transatlantic network simulation demonstration was changed from FY97 to FY98 due to MOU signing delays. We also doubled the size of our reconfigurable flight control program and accelerated the schedule of our Multiship Integrated Control Program to emphasize New World Vistas technology development.

Milestones

The programs outlined in Figure FC-1 are grouped in their respective subthrust area. The following program milestones further expand the Goals section into specific quantifiable events by fiscal year.

Design Methods and Criteria

FY97: Complete wind tunnel testing and signature evaluation of new low-drag control effectors for future strike aircraft. This technology supports ACC's need to improve survivability.

FY97: Complete VISTA/F-16 PIO simulation and flight test to evaluate ability of ground-based and in-flight simulator facilities to accurately predict PIO. Supports ACC's, AMC's, and AFSOC's need to reduce development costs and TDA goal to reduce control related accidents by 70%.

FY98: Complete revision of Flying Qualities Standard and Handbook, MIL-STD-1797B to support ACC's need for controlled flight at high AOAs to increase survivability.

FY99: Complete study of flow control effector technology for high L/D transports to support AMC's need for increased range.

FY00: Complete development of reconfigurable control algorithms for tailless aircraft. Supports ACC's need to improve survivability.

FY01: Complete VISTA flight test of tailless, reconfigurable control algorithms. Supports ACC's need to improve survivability.

FY02: Complete wind tunnel tests of flow control technology for high L/D transports to support AMC's need for increased range.

Control Techniques and Applications

FY97: Complete flight experiment on NASA DC-8 of innovative, molecular backscatter air data sensor to support ACC's need for reduced signature.

FY98: Develop interface control documentation and software specifications for Multiship Integrated Control to support ACC's and AFOSR's need for increased survivability and New World Vistas emphasis on unmanned air vehicles.

FY99: Develop control system design methodology that integrates lightweight, flexible structures and advanced control techniques. This supports ACC, AMC, and AFSOC's needs for reduced weight and low observability.

FY00: Flight validate high horsepower Intelligent Pump Electric Actuator on flight critical control surface in joint USAF and NASA electric program. Supports the ACC's and AMC's need to improve actuation reliability and supportability.

FY01: Complete limited flight test demonstration of fundamental Multiship Integrated Control capabilities covering ground operations, take-off and recovery, rendezvous, and autonomous operations to support New World Vistas emphasis on uninhabited combat air vehicles.

FY02: Flight validate high horsepower Electro-Hydrostatic Actuator on flight critical control surface to reduce aircraft weight while improving survivability, reliability, and maintainability for ACC, AMC, and SOCOM.

Flight Control Technology Integration and Flight Simulation

FY97: Validate VISTA aircraft thrust vectoring simulation to support flight test effort.

FY98: Demonstrate transatlantic, networked air vehicle combat simulation. Supports AETC's need to improve networking performance.

FY99: Demonstrate the Uninhabited Combat Air Vehicle (UCAV) assessment simulation. Supports New World Vistas emphasis on unmanned air vehicles.

THRUST 5: PILOT VEHICLE INTERFACE

User Needs

The Pilot Vehicle Interface Thrust provides technology solutions to user needs stated in Mission Area Plans, Mission Need Statements, and Operational Requirement Documents of Air Force Operational Commands. Additionally, this thrust addresses requested support from Air Force System Centers, Air Logistic Centers, and other agencies such as ARPA, NASA, the Defense Mapping Agency, NIST, and industry. Its primary goal is to develop, evaluate and integrate effective, affordable information display, and decision-aid technologies that reduce acquisition and support costs, enhance mission effectiveness, and increase survivability for current and future aircraft systems to fulfill Air Force operational requirements. The thrust is interdirectorate, comprised of Pilot/Vehicle Interface (PVI) technology in the Flight Dynamics Directorate, and Display Avionics in the Avionics Directorate. In addition, much of the work is carried out in conjunction with Armstrong Laboratory and the Joint Cockpit Office. In addition to the Air Vehicles TAP, reports are also made in the Human Systems Interface section of the DoD TAP. The programs carried out in this thrust address 103 operational deficiencies that include:

- Air Combat Command: reduced operation and support costs, all-weather operations, real-time information, reduced crew workload, improved situation awareness, alternate control devices, rapid mission replanning, laser-hardened cockpit capabilities, helmet-mounted display information, on-board and off-board sensor information fusion, and improved, reliable multi-function displays.
- Air Mobility Command: increased reliability and maintainability, reduced crew workload, all-weather operations, improved cockpit avionics integration, improved intraformation positioning information, inflight mission planning and autonomous precision approach/landing capability
- Air Education and Training Command: reduced operation and support costs, advanced display technologies, and support of weapon system training.
- Air Force Special Operations Command: advanced displays, improved night vision capabilities, reduced support costs, laser-hardened cockpit capabilities, reduced crew tasking, autonomous precision landing capability, enhanced imagery support, and integrated mission planning.

Goals

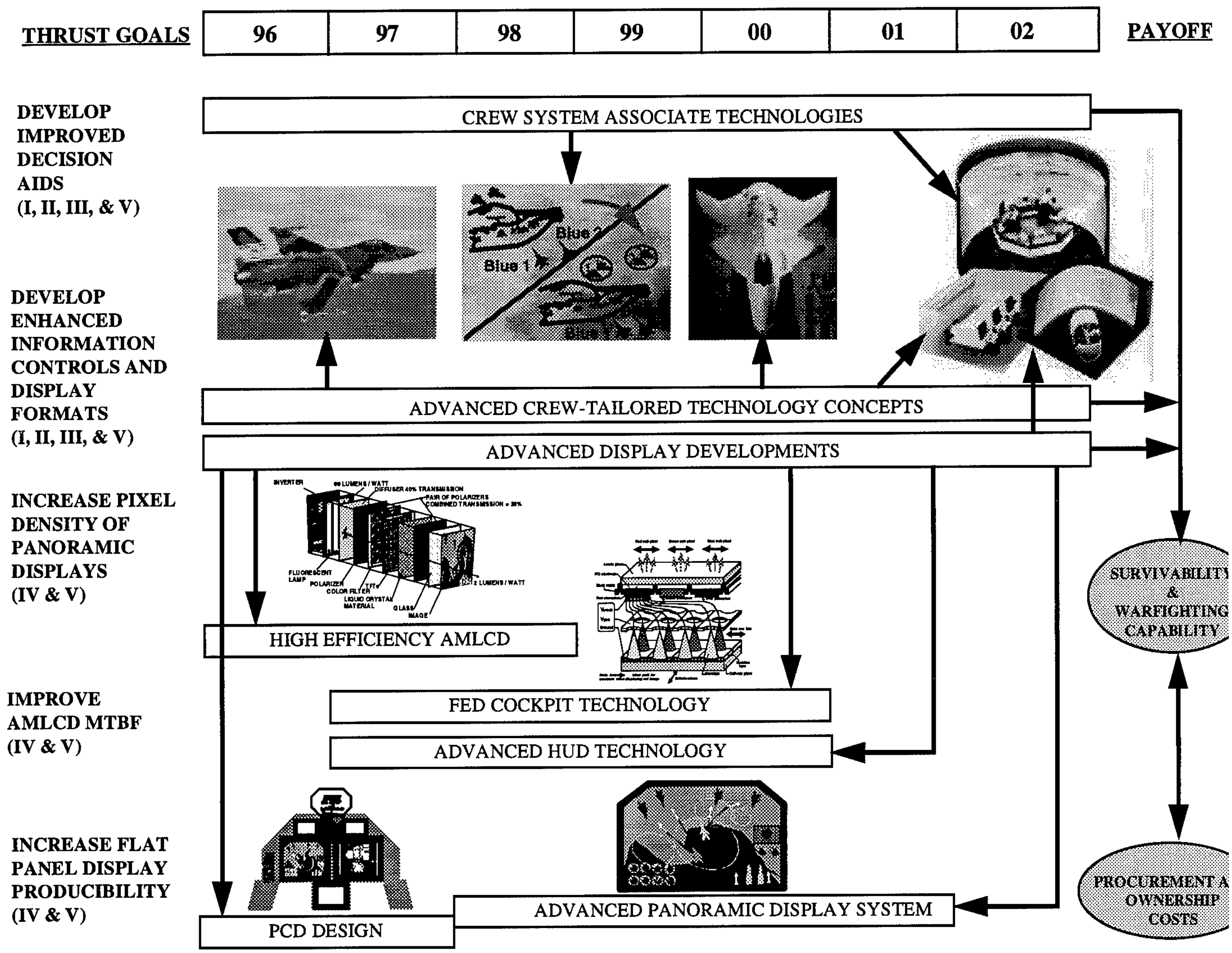
The Pilot Vehicle Interface Thrust goals support the Human Systems Interface DoD Technology Area Plan (DTAP) goals and will be achieved by the year 2005. The goals are:

I. Develop innovative PVIs and decision aids that improve situation awareness and reduce crew workload by 60% compared to F-15E type missions.
II. Demonstrate enhanced crew-tailored, high workload crew systems for single-seat strike aircraft which lowers weight by 5,000 pounds, compared to the F-15E.
III. Develop crew system to support the reduction of the two-seat (F-15E) fighter/attack to one seat.
IV. Develop large area, high definition, high situational awareness (SA) Active Matrix Liquid Crystal (AMLCD), Digital Micromirror Device (DMD), Gas Plasma (GP), Field Emissive Device (FED), and flat panel displays for form, fit, function retrofit (F^3R) to existing aircraft and use in advanced aircraft. These displays will be fully sunlight readable and enabling a 30-100 fold mean-time-between-failure (MTBF) improvement over today's electromechanical (EM) and cathode ray tube (CRT) displays.
V. Develop an uninhabited combat air vehicle (UCAV) operator station that enables a single operator to control up to four UCAVs in air-to-air or air-to-ground missions.

Major Accomplishments

- Developed an improved air-to-air targeting decision aid.
- Simulated off-board, real-time information for in-flight route planning.
- Successfully tested a missile trajectory prediction algorithm.
- Established an agreement with the Defense Mapping Agency for the investigation of symbologies for electronic landing approach charts.
- Established joint work with NASA to perform speech recognition flight tests using an OV-10A aircraft to test effects of G forces and noise. Developed and transitioned an improved crew-

PILOT VEHICLE INTERFACE THRUST



Note: Roman numerals indicate linkages of milestones and goals; i.e. milestones contribution to goal (See Goal Section)

Figure PVI-1

vehicle interface for the GBU-15 in the F-15E aircraft.
- Tested 2-D audio and helmet-mounted display for improved threat awareness in fighter aircraft.
- Enabled certification of the head-up display as a primary flight instrument.
- Established baseline head-up display symbology for autonomous landing guidance.
- Demonstrated and transitioned font evaluation tool to the F-22 system program office.
- Commercialized the high definition Digital Micromirror Device (DMD) technology. Selected as Display Technology of the Year by the Society for International Display (SID).
- Demonstrated a glass panel alignment and sealing system for rapid FED production.
- Demonstrated laser photolithography for high density microtip fabrication for FED displays.
- Demonstrated a full color red-green-blue (RGB) Solid State Laser Light Source that will enable the development of sunlight readable displays.
- Demonstrated a three color organic LED source for military display applications.
- Developed a temperature-compensated, 8 bit column driver for a-Si and CdSe AMLCDs.
- Developed a high resolution 1280 x 1024 pixel, polysilicon AMLCD for projection display systems.
- Successfully demonstrated new screen technology for high brightness compact laser display systems.

Changes from Last Year

Based on the New World Vistas Study, Wright Laboratory has instituted a significant push in uninhabited combat air vehicles and we have therefore initiated projects and set goals in that area.

A technology transition project in situation assessment has been started. This is a joint program with the Aeronautical Systems Center.

Milestones

Crew System Associate Technologies

FY97: Demonstrate inflight route replanning for rapid response to threats, enabling 20% more mission completions and higher survivability.

FY98: Demonstrate dynamic function allocation; integrate with cockpit evaluation system for pilot-in-the-loop part-task testing.

FY99: Demonstrate commercial inflight mission planning capability, integrated with ground-based management systems.

FY99: Flight test new knowledge-based air-to-air target assignment.

FY00: Demonstrate decision aids, coupled with advanced displays and controls, to enable the F-15E strike mission to be done with one crew member.

FY01: Develop decision aids that will enable a single UCAV operator to control up to four UCAVs in an air-to-air or air-to-ground scenario.

FY02: Demonstrate a full-mission capability of UCAV operator station.

Advanced Crew-Tailored Technology Concepts

FY97: Demonstrate air-to-air mission using cockpit voice control giving the pilot 80% more eyes-up time during combat situations.

FY97: Demonstrate tactical situation display with sensor fusion, increasing single-pass target kills by 20%.

FY99: Develop UCAV operator interface.

FY00: Improve integration of tactical situation displays, symbology, and information fusion to increase target kills by 50%.

FY01: Achieve 40% improvement in situational awareness with no-eyewear 3-D displays that will enable embedded cockpits and full laser protection.

FY01: Develop information controls and display formats that will enable a single UCAV operator to control up to four airships in an air-to-air or air-to-ground scenario.

Unique, Innovative and Improved Hardware for Display Systems

FY97: Demonstrate laser based Planar Optic Display (POD) system for B-52 aircraft.

FY97: Demonstrate a 2-million pixel density for panoramic cockpit display.

FY97: Demonstrate 10,000-hour improved MTBF over current AMLCDs and 10,000 units per year with 10% yield for AMLCDs.

FY97: Demonstrate a high resolution/definition front panel UCAV mission operator display station.

FY98: Demonstrate technology for 2-fold increase optical efficiency of AMLCDs and demonstrate 15,000-hour MTBF improvement over current displays.

FY98: Demonstrate a high resolution/definition front panel UCAV mission operator display station.

FY99: Demonstrate 3-million pixel density for panoramic display.

FY99: Develop advanced micro machined display engine (AMMDE) with 100,000 + hours MTBF.

FY00: Demonstrate compact, high brightness > 300 FL Heads Up Display (HUD) using diffractive optical elements and high brightness FED.

FY00: Develop high speed graphics processor to enable UCAV vehicle operations.

THRUST 6: VEHICLE SUBSYSTEMS

User Needs

The Vehicle Subsystems Thrust focuses on technology developments to decrease aircraft weight, increase mission range, reduce cost of ownership, and enhance survivability and safety, thus increasing warfighting capability. We act as catalysts to transition our technology outside DoD applications. This thrust develops technologies that address many of the subsystems issues associated with an air vehicle. These technologies include transparency systems, tires, wheels, brakes, landing gear struts, fire suppression, combat damage reduction, ground turnaround, escape systems-flight science, precision airdrop, thermal management, and component integrity.

The following requirements have been extracted from Mission Area Plans, Technology Planning Integrated Product Team documentation and other sources of requirements information through the Wright Laboratory Product Technology Plan.

AIR MOBILITY COMMAND

- Birdstrike resistant transparencies.
- Improved airdrop accuracy.
- Better battle damage repair concepts.
- Cost effective weapon system availability.
- Reduced manufacturing and support costs.
- Improved reliability, maintainability, and supportability built into all components.

AIR COMBAT COMMAND

- Reduced manufacturing and support costs.
- Improved reliability, maintainability, and supportability built into all components.
- Airframe components that are easily repaired on the flightline.
- Enhanced battle damage repair concepts.
- Increased number of landings per F-16 tire.
- Need for maintenance diagnostics.
- Birdstrike resistant transparencies with through-the-canopy ejection.

AIR EDUCATION & TRAINING COMMAND

- Birdstrike resistant transparencies with through-the-canopy ejection.
- Reduced manufacturing and support costs.
- Improved reliability, maintainability, and supportability built into all components.

AIR FORCE SPECIAL OPERATIONS COMMAND

- Improved airdrop accuracy.
- Reduced Manufacturing and support costs.
- Improved reliability, maintainability, and supportability built into all components.
- Improved environmental control system.
- Reduced aircraft weight and drag.

Goals

The Vehicle Subsystems goals are grouped in technology areas of Ground Operations, Aircraft Survivability, Aircrew Safety, and Thermal Energy Management. Reduced manufacturing and support costs, and improved reliability, maintainability and supportability are an integral part of each of these areas. The goals listed below are targeted toward F-15, F-16, and F-22 class aircraft and will be accomplished by 2005.

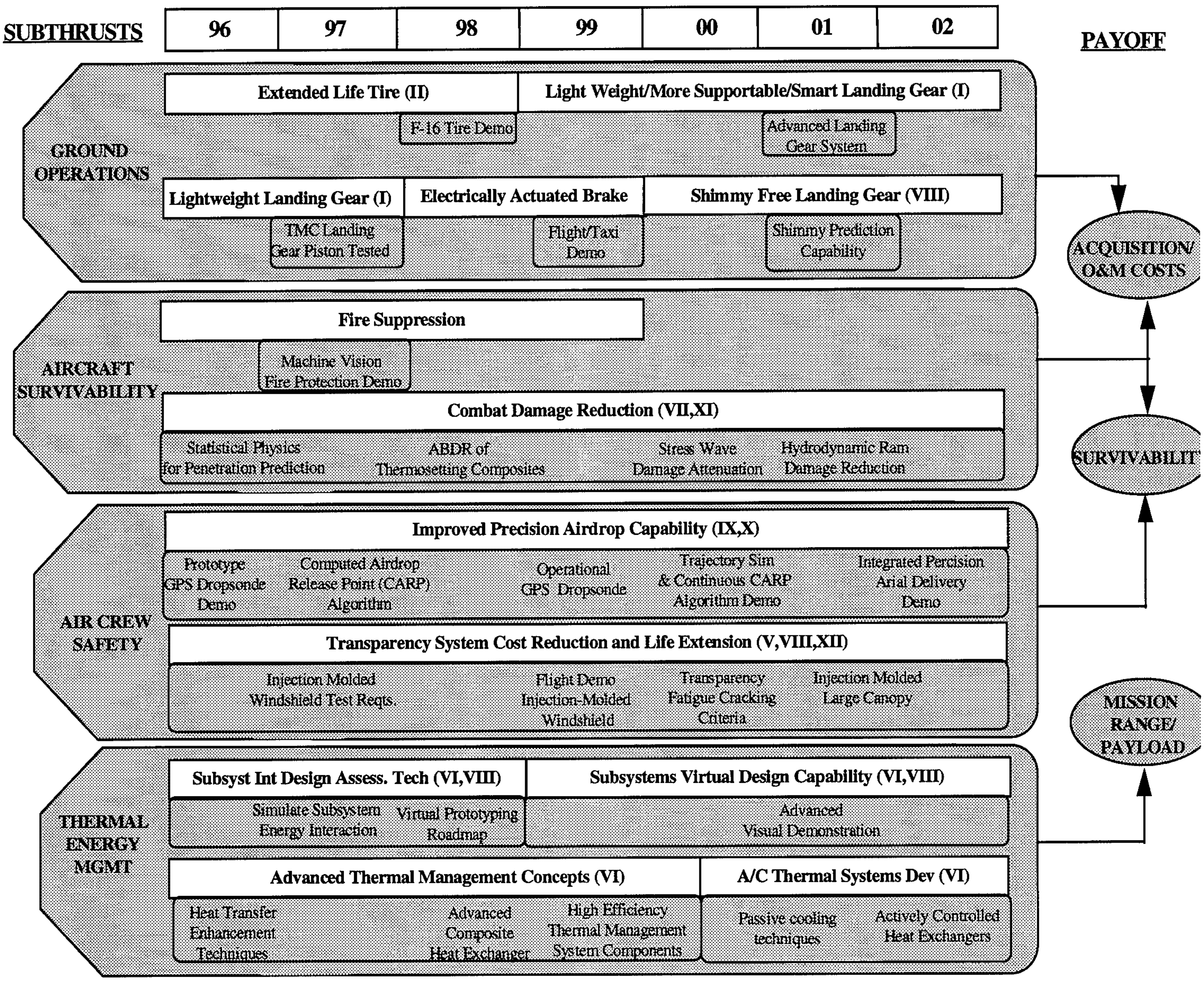
I. 40% red. in landing gear weight.
II. 175% incr. in tire life.
III. 4X incr. in energy efficiency.
IV. 60% incr. in ejection seat stability.
V. 50% red. in transparency O&M costs.
VI. 20% red. in energy management subsystems wt.
VII. 25% red. in combat composite damage size.
VIII. 20% red. in airframe component design time.
IX. 75% incr. in air drop accuracy.
X. 50% red. in on/off loading manpower.
XI. 15% red. in armor weight.
XII. 30% incr. in windshield ballistic protection.

These goals are fully aligned with the Defense Technology Objectives in the Defense Technology Area Plan for Air Platforms.

Major Accomplishments

- Defined new techniques for birdstrike avoidance.
- Implemented B-1B windshield redesign to extend life and reduce cost.
- Mission compatible birdstrike resistant transparencies transitioned to production for F-15, F-16, T-38, and F-18.
- Demonstrated injection molding process for low cost transparencies.

VEHICLE SUBSYSTEMS THRUST



Note: Roman numerals indicate linkages of programs and goals; i.e. program contribution to goal (See Goals Section)

Figure VS-1

- Established test method for dust erosion.
- Validated birdstrike-resistant head-up display for F-15 and F-22.
- Established a first-principles-based definition of the ballistic limit for vulnerability assessment.
- Demonstrated solid propellant gas generator fire extinguisher.
- Designed, built, installed advanced engine fire simulator.
- Developed and demonstrated quantitative environmental prediction models.
- Demonstrated an F-16 electromechanical brake system with performance superior to the current system.

Changes from Last Year

The effort to validate technology for low cost injection molded transparencies has moved into the flight demonstration phase. Reprioritized Thermal Energy Recovery funding into aircraft component development research because of higher potential payoffs. A new effort was started in FY96 entitled Thermal Component Development. In response to the New World Vistas study, the Precision Containerized Aerial Delivery System program will start in FY97.

Milestones

The programs and milestones, outlined in Figure VS-1, are grouped in their respective subthrust areas. These milestones further expand the Goals section into more specific quantifiable events by fiscal year.

Ground Operations

FY97: Fabricate and install specialized test equipment to demonstrate extended life of new tire design/test technology.

FY98: Demonstrate an F-16 tire with double the number of landings of current tires.

FY99: Complete flight/taxi testing of F-16 Electrically Actuated Brake system.

FY00: Complete experimental validation of landing gear shimmy model.

FY02: Complete final design and fabrication of TMC KC-10 centerline landing gear.

Aircraft Survivability

FY97: Demonstrate weapons-bay survivability from a ballistic impact munition.

FY97: Transition first principles-based algorithms into the Advanced Joint Effectiveness Model (AJEM) vulnerability code.

FY97: Demonstrate machine vision overheat and fire detection for dry bays.

FY98: Develop methods for Aircraft Battle Damage Repair (ABDR) of thermosetting composites.

FY99: Develop composite laminate failure criteria.

FY00: Develop stress wave damage attenuation methods for composite laminates.

FY01: Develop hydrodynamic ram damage reduction criteria.

Aircrew Safety

FY97: Validate B-1 low cost/long life windshield

FY97: Flight test/measure electrostatic discharge

FY98: Flight demo injection molded windshield.

FY98: Demonstrate transparency material recycling.

FY98: ACES II ejection seat stability concept demonstrated.

FY99: Ground demo injection molded canopy/radome.

FY99: GPS dropsonde operational prototype system completed.

FY00: Demonstrate 20% birdstrike cost reduction.

FY00: Transparency with tailored optics for Helmet Mounted Display (HMD).

FY01: Design criteria to prevent transparency fatigue cracking.

FY01: Computed Air Release Point algorithm validated through flight testing.

FY02: Integration of LO/LASER/Durability coating

FY02: Demonstrate 40% birdstrike cost reduction.

FY02: Integrated precision aerial delivery system validated.

Thermal Energy Management

FY97: Define technologies to model, simulate, and assess aircraft subsystem energy interactions.

FY98: Fabricate advanced composite material heat exchanger.

FY99: Validate high-efficiency thermal management system concepts.

FY01: Demonstrate passive cooling techniques as an alternative design for aircraft thermal management.

FY01: Demonstrate high intensity heat-transfer techniques to effectively miniaturize heat exchangers.

FY02: Demonstrate full-scale, actively controlled heat exchangers.

THRUST 7: AIR BASE TECHNOLOGY

User Needs

The following user needs have been identified in Mission Need Statements, Statements of Need, Operational Requirement Documents, from ACC and AMC, and DoD Energy Policy Directive documents.

- Air Force Bare Base Systems: The Air Force needs an integrated, expanded, and enhanced bare base systems capability to facilitate and support contingency operations, force projection efforts, and air combat operations.
- Sustainable Air Base Utility Systems: A critical requirement exists for rapid repair kits, increased sustainability, and improved damage assessment capabilities to operate airbase utility systems for both peacetime and wartime operations.
- Bare Base/Backup Power Systems: The bare base power system is required during expedient construction and operation of airbase facilities for contingency force beddown and expedient post attack recovery of vital airbase facilities, whereas the backup power system is used primarily during commercial power outages.
- Energy Usage Reduction in DoD installations: Reduce facility energy consumption 20% by FY00 and boost industrial energy efficiency 20% by FY00 over 1985 levels.
- New Generation of Firefighting and Crash Rescue Systems: Identifies needs for improved firefighting systems.
- Replacement of Halogenated Fire Extinguishing Agent: Identifies a need to find a replacement agent for Halon 1301 used in current fire suppression systems that protect vital computer systems and electronic equipment in command and control facilities.

Goals

The goals of this thrust are grouped into the technology subthrust areas of Energy, Fire Fighting and Pavements and Facilities. The goals listed below will be accomplished by FY03.

I. Develop mobile energy and utility systems to support Air Force's Global Reach Global Power doctrine.

II. Develop innovative technologies to reduce energy and utility systems operating and maintenance costs.

III. Develop improved fire fighting agents, equipment, and techniques to protect weapon systems against current and emerging operational and wartime fire threats.

IV. Develop advanced fire fighter protective equipment and training systems to increase AF fire fighting effectiveness and safety.

V. Develop on-site expedient hardening, underground petroleum oil lubricants (POL) and munitions storage methods, and methods for bare base planning and applications.

VI. Develop new pavement materials and advanced composite material applications for contingency operations.

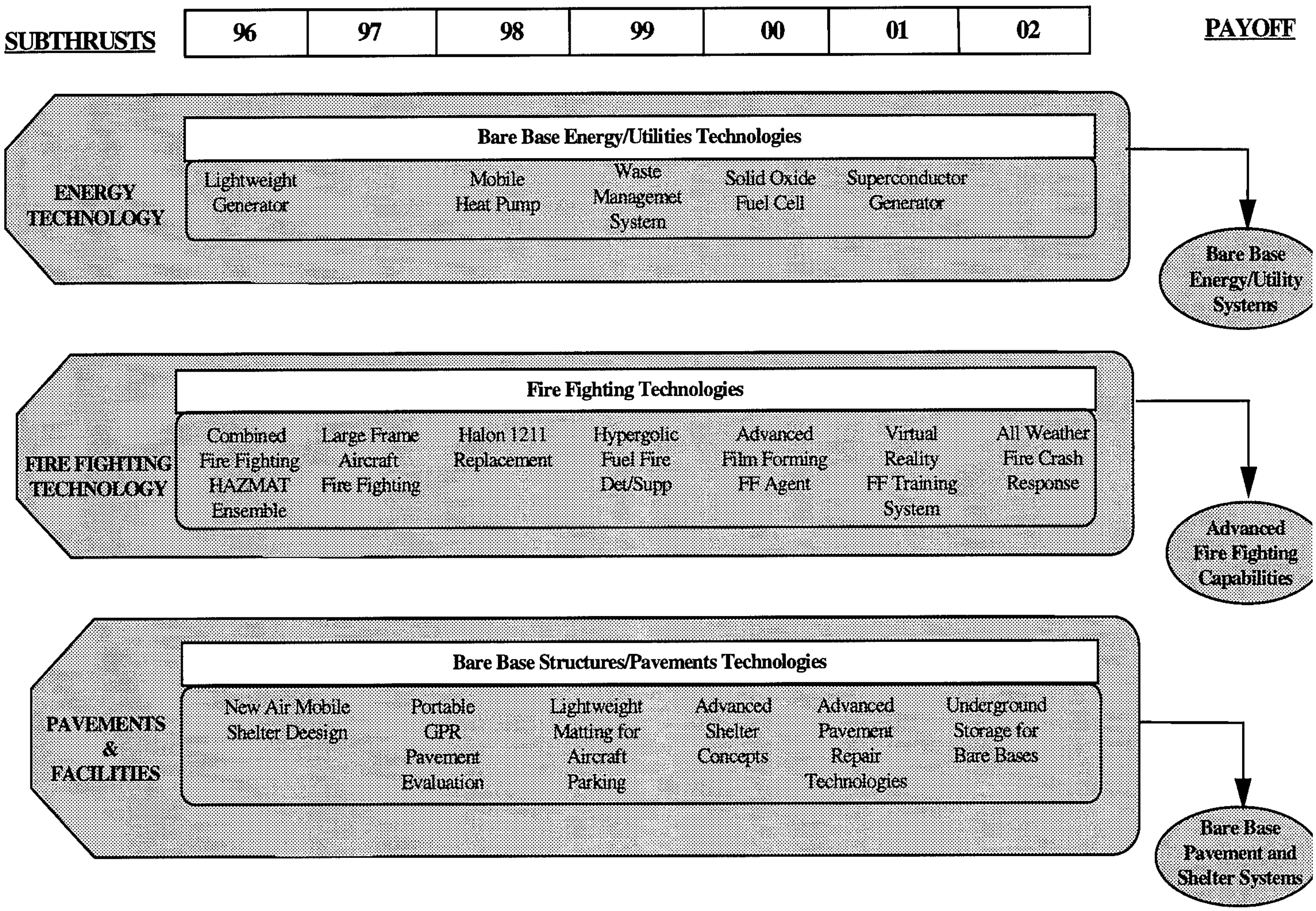
VII. Develop new transportable shelters and chemical/biological processing for bare bases.

These goals are fully aligned with the Defense Technology Objectives in the Defense Technology Area Plan for Materials and Processes.

Major Accomplishments

- Fabricated a proof-of-concept lightweight generator set using recent advances in rotary engine, permanent magnet, and high speed switching technologies.
- Completed design of an acoustic cycle mobile heat pump that uses an induced pressure wave, allowing single-phase refrigerants such as helium to achieve both thermodynamic heating and cooling.
- Confirmed feasibility of using energy contents of waste fuels by burning in boilers while meeting environmental concerns.
- Identified Phosphonitrilics as high potential second generation candidates for drop-in replacement for Halon 1211 used in the 150lb flightline fire extinguishers.

AIR BASE TECHNOLOGY THRUST



Note: Roman numerals indicate linkages of programs and goals; i.e. program contribution to goal (See Goals Section)

Figure ABT-1

- Demonstrated Combined Fire Fighting Hazardous Material Ensemble for use in intense heat (3,000°F) and highly energetic chemical spill environments.
- Completed development of a solvent blend to replace Butyl Carbitol, a toxic component of Aqueous Film Forming Foam fire fighting agent.
- Tested and evaluated an advanced rolling weight deflectometer capable of providing continuous data on pavement conditions and load carry conditions.
- Demonstrated successful composite reinforcement techniques for concrete elements using full scale explosive tests.
- Develop a lightweight, low volume deployable power generator.

Changes from Last Year

Integrated Energy Management & Control Systems and Efficient Utility Equipment Concept projects were zero funded due to low priority ranking by user communities and budget cuts.

Milestones

The milestones, outlined in Figure ABT-1, are grouped in their respective subthrust areas. These milestones further expand the Goals section into more specific quantifiable events by fiscal year.

Energy Technology

FY97: Develop design criteria for more efficient and easily assembled bare base utilities.

FY98: Develop a lightweight, high efficiency acoustic mobile heat pump unit.

FY99: Develop a mobile solid oxide fuel cell for bare base power applications.

FY00: Develop an environmentally acceptable deployable waste management system.

FY01: Develop a superconductive power generator for bare base uses.

Fire Fighting

FY97: Demonstrate enhanced large frame aircraft fire fighting capabilities.

FY97: Validate ultra-fast water deluge fire detection/suppression system for DoD munitions plants.

FY98: Demonstrate replacement for Halon 1211.

FY99: Demonstrate a hypergolic fuel fire detection/suppression system.

FY00: Exploratory development of a more effective, fully biodegradable film forming foam fire suppressant.

FY01: Demonstrate a virtual reality fire fighting training system.

FY02: Demonstrate a day-night all weather emergency response fire crash rescue capability.

Pavements & Facilities

FY97: Develop a new family of portable shelters.

FY98: Complete Ground Penetrating Radar (GPR) pavement evaluation technology for contingency airfields.

FY98: Develop lightweight revettment systems used with in-theater materials for bare base shelters and parked aircraft.

FY99: Develop transportable lightweight matting for aircraft parking and advanced pavement repair materials.

FY00: Develop advanced concepts for the bare base storage of POL and munitions.

FY01: Develop the capability to enter/egress/ process in a chemical/biological environment.

GLOSSARY

ACC	Air Combat Command
ABDR	Aircraft Battle Damage Repair
ACTCC	Advanced Crew Tailored Cockpit Concepts
ACTIVE	Advanced Controls Technology for Integrated Vehicles
AETC	Air Education Training Command
AFMC	Air Force Materiel Command
AFOSR	Air Force Office of Scientific Research
AFSOC	Air Force Special Operations Command
AFSPC	Air Force Space Command
AJEM	Advanced Joint Effectiveness Model
AMC	Air Mobility Command
AMLCD	Active Matrix Liquid Crystal Display
AMMDE	Advanced Micro Machined Display Engine
AOA	Angle-of-Attack
ARPA	Advanced Research Projects Agency
ASC	Aeronautical Systems Center
ASTROS	Automated STRuctural Optimization System
CAD	Computer Aided Design
CFD	Computational Fluid Dynamics
CFIPT	Customer Focus Integrated Product Team
CIACS	Close-In Air Combat Supremacy
CRDA	Cooperative Research & Development Agreement
CRT	Cathode Ray Tube
CSAT	Crew System Associate Technology
DEA	Data Exchange Agreement
DMD	Digital Micromirror Device
DoD	Department of Defense
DTAP	DoD Technology Area Plan
EPAD	Electrically Powered Actuation Design
EM	Electromechanical
FAA	Federal Aviation Agency
FATE	Future Aircraft Technology Enhancements
FCS	Flight Control System
FED	Field Emissive Device
FF	Fire Fighting
FI	Flight Dynamics Directorate
F^3R	Form, Fit, Function Retrofit
FWV	Fixed Wing Vehicle
FY	Fiscal Year
GP	Gas Plasma
GPR	Ground Penetrating Radar
GPS	Global Positioning System
HAZMAT	Hazardous Material
HMD	Helmet Mounted Display
HOBS	High Off-BoreSight
HQ	Headquarters
HUD	Heads Up Display
HyTech	Hypersonic Technology Program
IEA	Information Exchange Agreement
INS	Inertial Navigation System
IPT	Integrated Product Team
IR	Infrared
JAST	Joint Advanced Strike Technology
J/IST	JAST Integrated Subsystem Technology
LaRC	Langley Research Center
LCC	Life Cycle Costs
LO	Low Observable
MAJCOM	Major Command
MAP	Mission Area Plan
MDD	Multi-Disciplinary Design
MOA	Memorandum of Agreement
MOD	Ministry of Defense
MOU	Memorandum of Understanding
MTBF	Mean-Time-Between-Failures
NASA	National Aeronautics & Space Administration
NASA DFRC	NASA Dryden Flight Research Center
NIST	National Institute of Standards & Technology

GLOSSARY (Continued)

ODDR&E	Office of the Director for Defense Research & Engineering
ORTIP	Operational Requirements Technology Investment Plan
P&W	Pratt & Whittney
PIO	Pilot Induced Oscillation
POD	Planar Optic Display
PVI	Pilot/Vehicle Interface
RCS	Radar Cross Section R&D
	Research and Development
RDT&E	Research Development Test & Evaluation
RGB	Red-Green-Blue
SA	Situational Awareness
SAB	Scientific Advisory Board
S&T	Science & Technology
SID	Society for International Display
SOC	Special Operations Command
SOF	Special Operations Forces
SPO	System Program Office
TAFT	Today's Aircraft Flying Tomorrow
TAP	Technology Area Plan
TAV	Transatmospheric Vehicle
TDA	Technology Development Approach
TEO	Technology Executive Officer
TMC	Titanium Matrix Composite
TMP	Technology Master Plan
TPIPT	Technology Planning Integrated Product Team
TRP	Technology Reinvestment Program
TPS	Thermal Protection System
TTO	Technology Transition Office
UAV	Unmanned Air Vehicle
UCAV	Unmanned/uninhabited Combat Air Vehicle
USSOCOM	US Special Operations Command
UTA	Unmanned Tactical Aircraft
V&V	Validation & Verification
VHOBS	Very High Off BoreSight
VISTA	Variable-Stability In-Flight Simulator Test Aircraft
VSTOL	Vertical/Short Take Off/Landing
WL	Wright Laboratory
WVR	Within Visual Range

TECHNOLOGY MASTER PROCESS OVERVIEW

Part of the Air Force Materiel Command (AFMC) mission deals with maintaining technological superiority for the U.S. Air Force by:

- Discovering and developing leading-edge technologies.
- Transitioning mature technologies to system developers and maintainers.
- Inserting fully developed technologies into our weapon systems and supporting infrastructure.
- Transferring dual-use technologies to improve economic competitiveness.

To ensure this mission is effectively accomplished in a disciplined, structured manner, AFMC has implemented the Technology Master Process (TMP). The TMP is AFMC's vehicle for planning and executing an end-to-end technology program on an annual basis.

The TMP has four distinct phases, as shown in Figure 1:

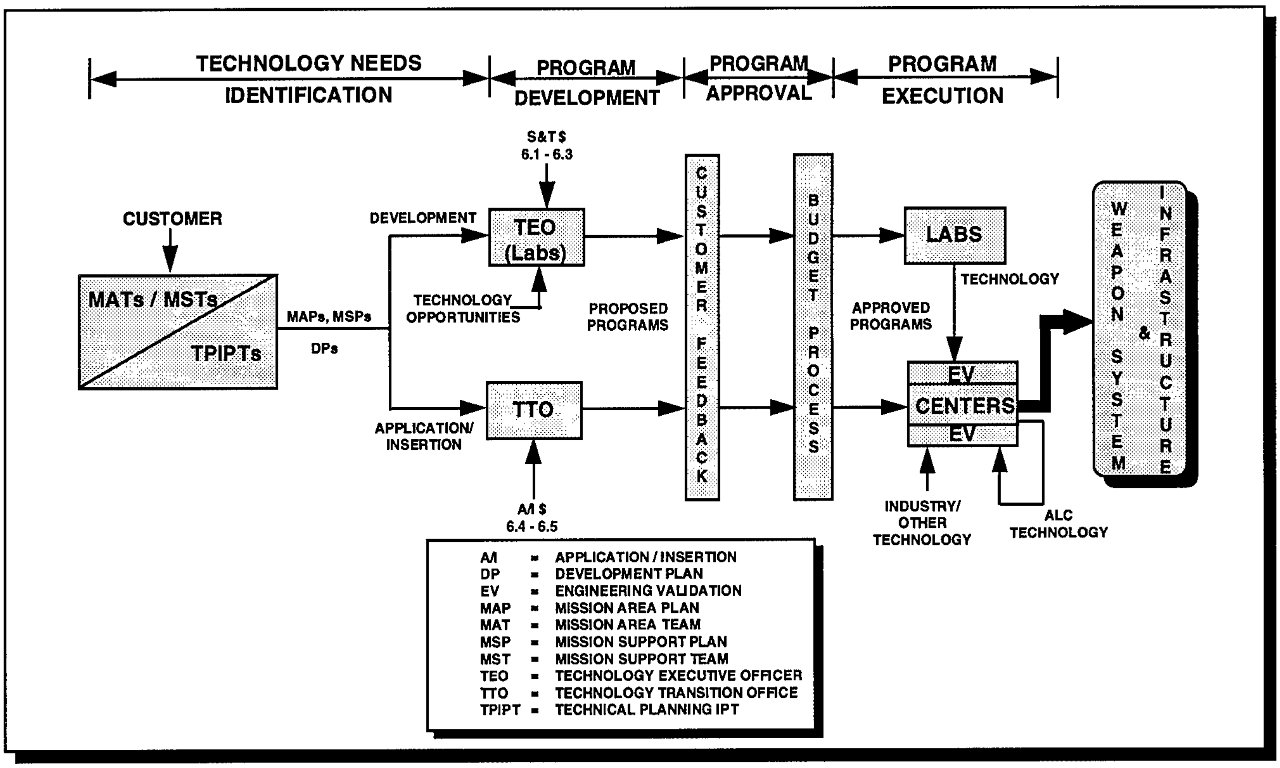


Figure 1 - Technology Master Process

- Phase 1, **Technology Needs Identification**–Collects customer-provided and customer-prioritized technology needs associated with both weapon systems, product groups and supporting infrastructure, then identify them by the need to develop new technology or apply/insert emerging or existing technology. These needs are derived in a strategies-to-task framework via the user-driven Modernization Planning Process.

- Phase 2, **Program Development**–Formulates a portfolio of dollar-constrained projects to meet customer-identified needs from Phase 1. The Technology Executive Officer (TEO), with the laboratories, develops a set of projects for those needs requiring development of new technology, while the Technology Transition Office (TTO) orchestrates development of a project portfolio for those needs which can be met by the application/insertion of emerging or existing technology.

- Phase 3, **Program Approval**–Reviews the proposed project portfolio with the customer and obtains approval for the portfolio through the budgeting process. The output primary products of Phase 3 are the authorizations and appropriations, required by the laboratories and application/insertion programs, to execute their technology projects.

- Phase 4, **Program Execution**–Executes the approved S&T program and technology application/insertion program within the constraints of the Congressional budget and budget direction from higher headquarters. The products of Phase 4 are validated technologies that satisfy customer weapon system and infrastructure deficiencies.

Additional Information

Additional information on the Technology Master Process is available from HQ AFMC/ STR, DSN 787-6777/8764, (513) 257-6777/8764.

INDEX

INDEX (Continued)

INDEX (Continued)

AIR VEHICLES TECHNOLOGY AREA PLAN TEAM

DIRECTOR: **Dr. G. Keith Richey, Flight Dynamics Directorate**

CHIEF MANAGING EDITORS: **Mr. Harold M. Vazquez, Mr. Thomas C. Hummel**
Integration Technology Division

TECHNOLOGY THRUST INTEGRATED PRODUCT TEAM LEADERS:

THRUST 1	INTEGRATION TECHNOLOGY	Lt Col Richard J. Almassy
THRUST 2	AEROMECHANICS	Mr. Dennis Sedlock
THRUST 3	STRUCTURES	Dr. Donald B. Paul
THRUST 4	FLIGHT CONTROL	Mr. Dave P. LeMaster
THRUST 5	ADVANCED COCKPITS	Dr. John M. Reising
THRUST 6	VEHICLE SUBSYSTEMS	Mr. Richard E. Colclough
THRUST 7	AIR BASE SYSTEMS	Mr. Ed Alexander

AUTHORS/MAJOR CONTRIBUTORS:

VISIONS/OPPORTUNITIES	Dr. G. Keith Richey Dr. Thomas M. Weeks, Sr. Mr. Thomas C. Hummel
INTRODUCTION	Mr. Harold M. Vazquez
INTEGRATION TECHNOLOGY THRUST	Lt Col Richard Almassy Mr. Thomas C. Hummel
AEROMECHANICS THRUST	Mr. Valentine Dahlem, III
STRUCTURES THRUST	Mr. Jerome Pearson
FLIGHT CONTROL THRUST	Mr. David K. Bowser
ADVANCED COCKPITS THRUST	Dr. John M. Reising
VEHICLE SUBSYSTEMS THRUST	Maj. Frank Smith
AIR BASE TECHNOLOGY THRUST	Mr. Ed Alexander