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STRUCTURES AND DYNAMICS DIVISION RESEARCH AND TECHNOLOGY PLANS - FY-82

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National Aeronautics and Space Administration

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Hampton, Virginia 23665

STRUCTURES AND DYNAMICS DIVISION

RESEARCH AND TECHNOLOGY PLANS - FY 1982

By

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SUMMARY

The purpose of this paper is to present the Structures and Dynamics Division's research programs for FY 1982. The work under each branch/office is shown by RTR Objectives, Expected Results, Approach, Milestones, and FY 1981 accomplishments, where applicable. Logic charts show elements of research and rough relationship to each other. This information will be useful in program coordination with other government organizations in areas of mutual interest.

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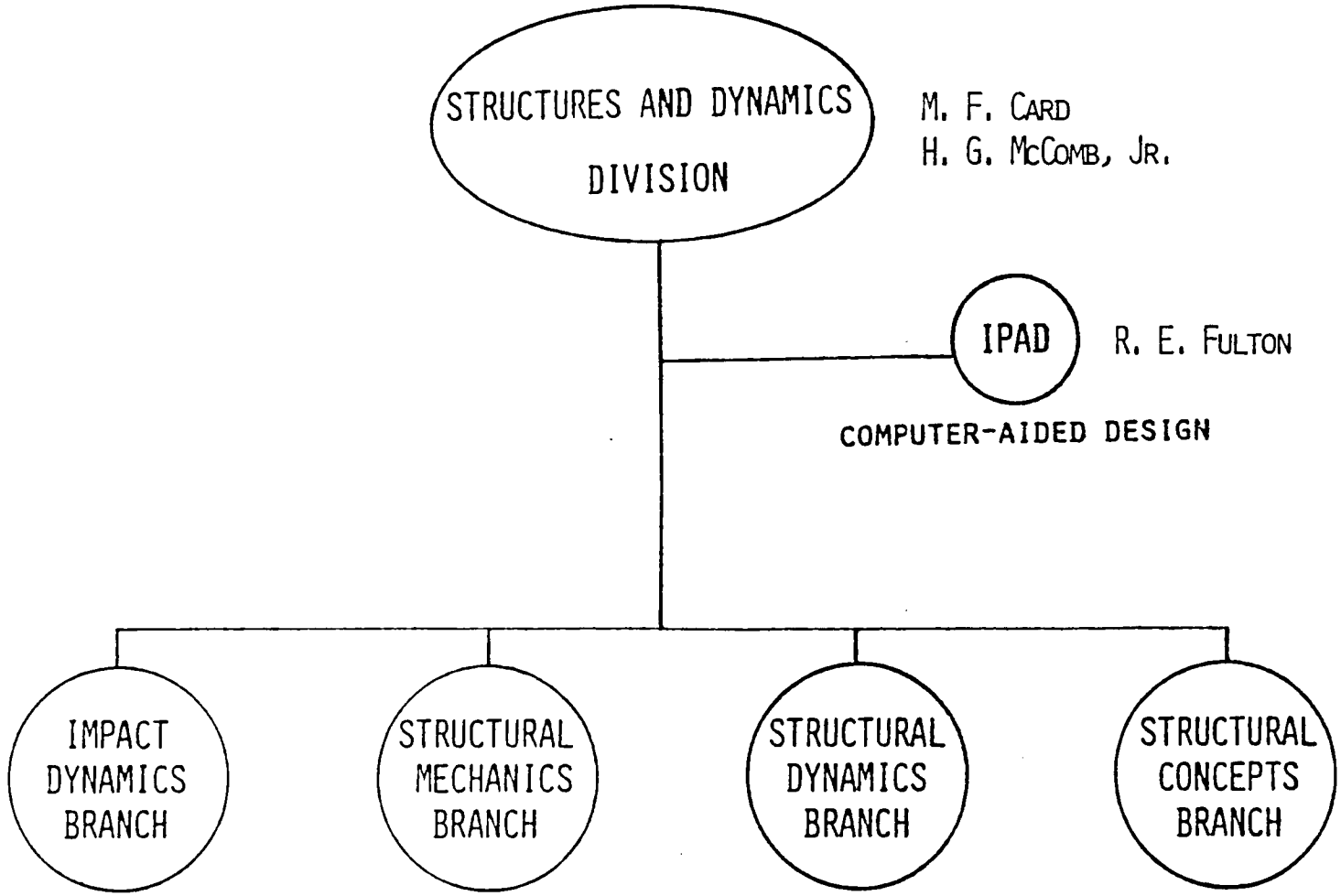
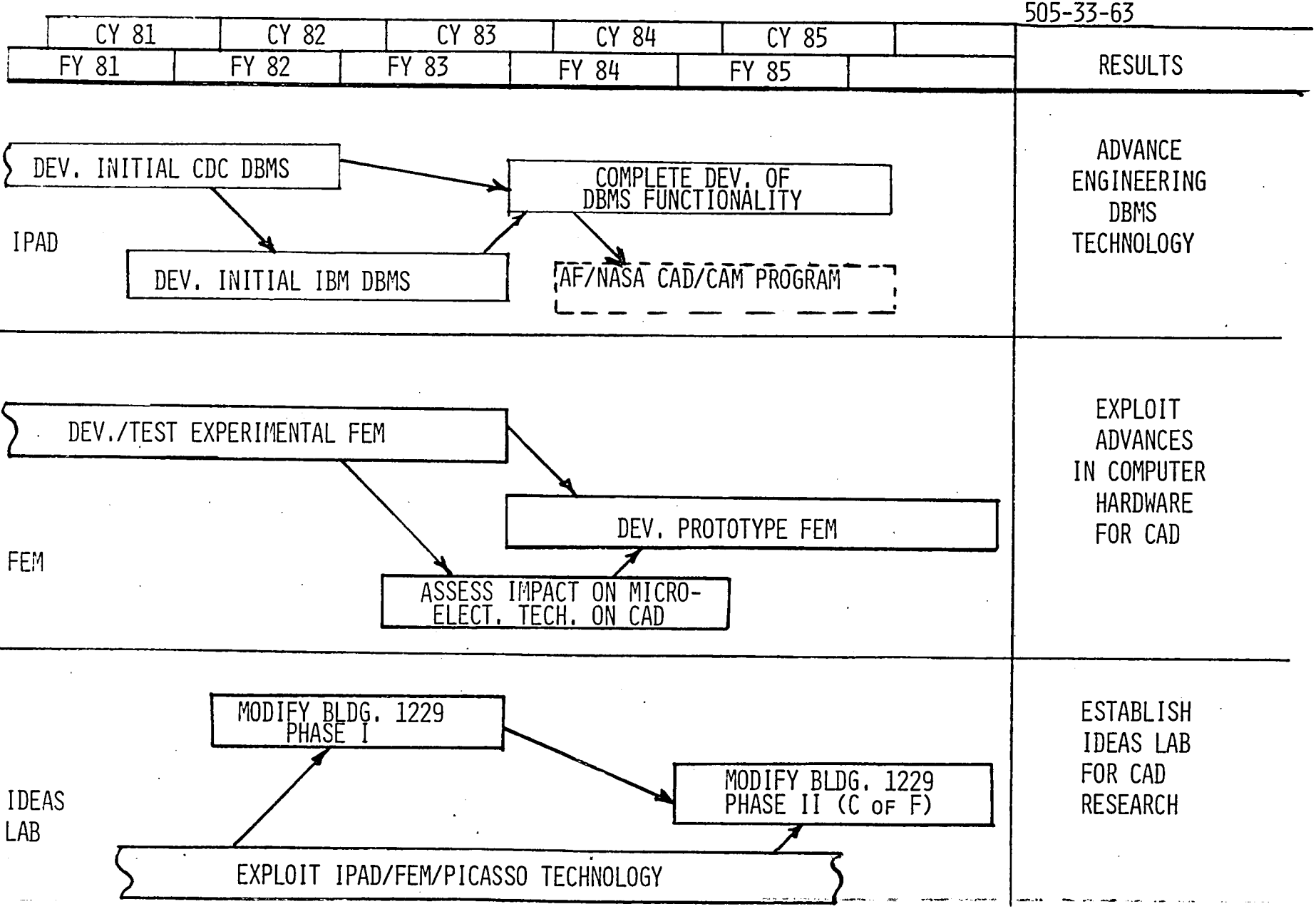


II IPAD PROJECT OFFICE

COMPUTER AIDED DESIGN

510-54-13
505-33-63



II IPAD PROJECT OFFICE

RTOP 505-33-63 Design Methods
RTR 505-33-63-01 Computer-Aided Design

OBJECTIVE:

Assess and exploit advanced computational devices to improve efficiency for structural calculations. Define and demonstrate potential of large arrays of microprocessors operating in parallel for finite element analysis. Determine impact (implications) of specialized (dedicated) computer hardware on static, dynamic, thermal analysis in the optimization of structural analysis and design calculations.

EXPECTED RESULTS:

- o Simulate a large-scale finite element machine by the end of FY 1983
- o Develop a design for a large-scale prototype finite element machine by FY 1984
- o Establish by FY 1985 a highly flexible facility for research on and simulation of new, innovative and cost-effective methods for computer-aided analysis and design

APPROACH:

In-house investigation of combinations of PRIME-400 and VAX minicomputers and CDC 6000 series mainframe are being conducted to improve the efficiency of structural calculations. Approaches are being studied to determine the optimum utilization of the combined capabilities of a distributed set of computer hardware. Studies of applications of microprocessors to structural calculations will be performed, specifically, definition of key components of a finite element computational device based on microprocessors will be accomplished, and design and fabrication of a prototype finite element machine to demonstrate the hardware efficiency will be carried out.

MILESTONES:

- o Complete fabrication of 16-node boards, September 1981
- o Initiate applications on 16-node prototype, December 1981
- o Complete fabrication of 36-node boards, April 1982
- o Initiate applications on 36-node prototype, June 1982
- o Performance evaluation of FEM prototype, September 1982
- o Complete Phase 1 of IDEAS (Interactive Design/Analysis Simulation) Lab, July 1983

FY 1981 ACCOMPLISHMENTS:

- 4-node FEM operational

IPAD PROJECT OFFICE

RTOP 510-54-13 Integrated Programs for Aerospace-Vehicle Design (IPAD)
RTR 510-54-13-01 Integrated Programs for Aerospace-Vehicle Design (IPAD)

OBJECTIVE:

Develop the preliminary design of a full IPAD software system and implement a prototype system (denoted IPIP) for the total management of aerospace-vehicle design processes in the 1980's which will permit reductions in the design cycle time and cost.

EXPECTED RESULTS:

- o Release a preliminary version of phase one IPAD with enhanced data base management (DBM) by end of FY 1982
- o Release final version of phase one IPAD by end of FY 1983
- o Release preliminary version of phase two IPAD with network DBM by end of FY 1984
- o Release completed prototype IPAD system by end of FY 1985

APPROACH:

The prime contractor has established the requirements and preliminary design for a comprehensive integrated computer-aided design (CAD) system of the future. From this design will be developed a prototype engineering data management system to support aerospace design. Software design will consider more than one computer with an initial implementation focusing on one large computer complex. The approach used to develop and evaluate the software includes:

- identifying scenarios typical of major design tasks
- establishing performance criteria to be met for each scenario
- utilizing the software to conduct scenarios
- measuring achieved performance and improving software as necessary

Upon completion of sufficient evaluation, the software will be released to industry through ITAB

Supporting research under RTOP 505-33-63 will provide improved in-house capability in related computer-aided design areas. Consulting expertise will be provided by ICASE and GWU.

MILESTONES:

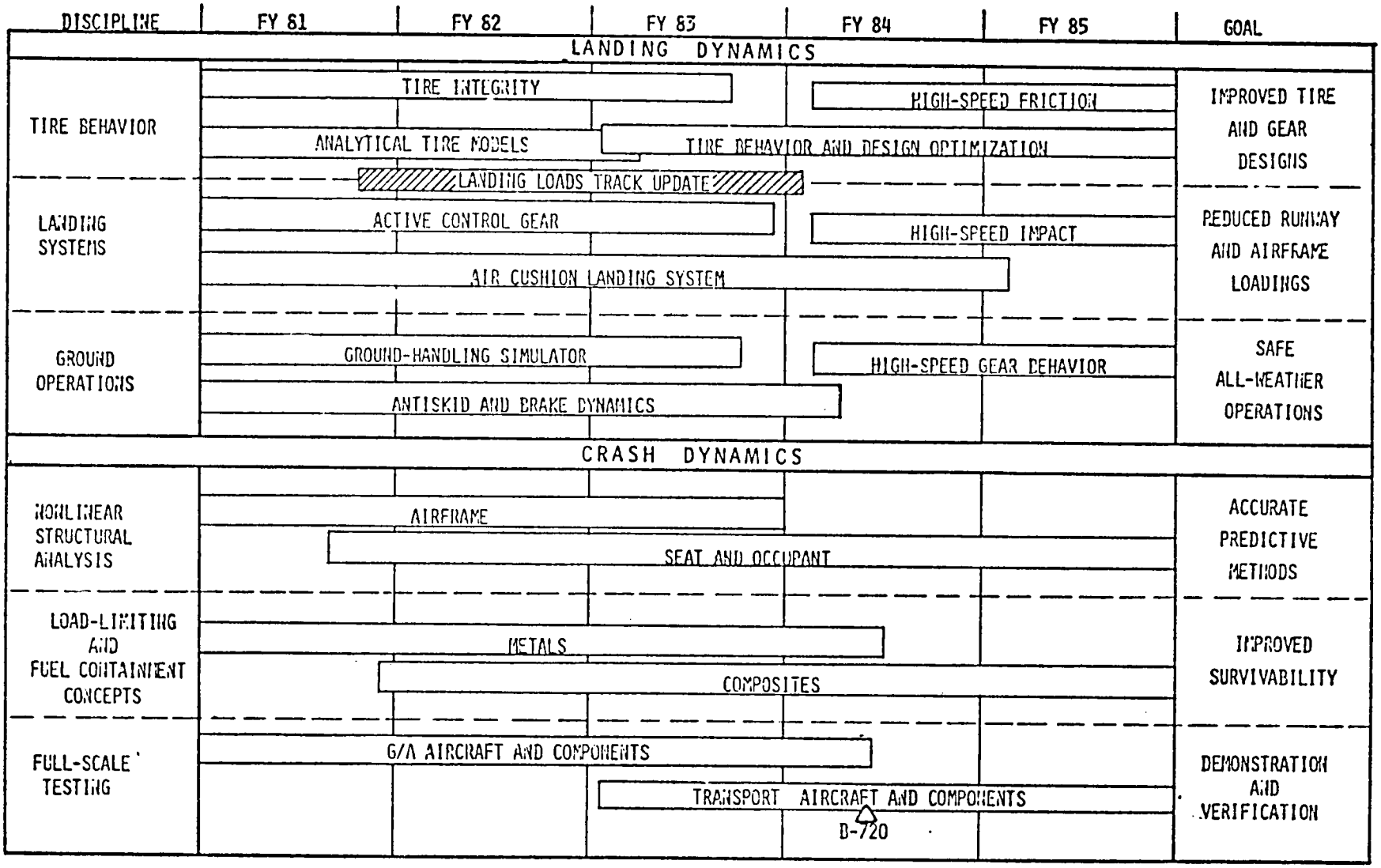
- Release of IPIP Version 2.5 for CDC computer, December 1981
- Joint AF/NASA Review of CAD/CAM data management approach, January 1982
- Release of enhanced IPIP with basic IPEX version for CDC computer, March 1982
- Preliminary design of IPIP for 2nd host computer, September 1982

FY 1981 ACCOMPLISHMENTS:

- Released RIM to industry
- Prerelease of IPIP software for evaluation

III IMPACT DYNAMICS BRANCH

IMPACT DYNAMICS PROGRAM



III IMPACT DYNAMICS BRANCH

RTOP 505-41-33 General Aviation Materials and Structures
RTR 505-41-33-01 General Aviation Crash Dynamics

OBJECTIVE:

Develop methods for improving general aviation aircraft crashworthiness and occupant survivability

EXPECTED RESULTS:

- o Define and demonstrate improved statics and new dynamic seat test methods
- o Expand analytical capability of occupant/seat/restraints system simulation
- o Analytical and experimentally demonstrate load-limiting concepts for seat and fuselage structure

APPROACH:

By comparing advanced nonlinear methods with full-scale crash tests, a method of predicting the crash response will be developed. Energy absorption characteristics will be determined so that restraint systems can be developed that will increase potential occupant survivability by 50 percent.

MILESTONES:

- o Complete tests using improved static seat test method on conventional seat configurations, October 1981
- o Initiate correlation predictions of nonlinear dynamic behavior of conventional seats with test data using improved seat/occupant/restraint system computer program, December 1981
- o Conduct tests in vertical test apparatus on conventional seat configurations using new dynamic seat test pulse, March 1982
- o Fabricate and test (static and dynamic) 2nd generation load-limiting general aviation seats, March 1982

MILESTONES (Continued):

- Predict nonlinear loads in modified (load-limiting subfloor) pressurized Navajo aircraft under crash conditions, April 1982
- Conduct three general aviation rocket-assisted full-scale crash tests using pressurized Navajo with modified subfloor and energy-absorbing floor-mounted seats, May 1982
- Conduct full-scale crash test of metal honeycomb airplane, August 1982

FY 1981 ACCOMPLISHMENTS:

- Demonstrated capability of DYCAST to model load-limiting general aviation seats and subfloors crush behavior
- Identified representative floor crash pulses from general aviation full-scale crash tests
- Design, fabricate and install vertical test apparatus

IMPACT DYNAMICS BRANCH

RTOP 505-33-53 Loads, Aeroelasticity, and Structural Dynamics
RTR 505-33-53-05 Transport Crash Dynamics

OBJECTIVE:

To enhance passenger safety through improvement of analysis methods, airframe structural concepts, and seat/restraint system concepts for future aircraft under crash conditions

EXPECTED RESULTS:

- Develop a data base on composite structural behavior under crash loading conditions
- Determine definitive crash loads by full-scale testing

APPROACH:

Study contracts with the three leading transport aircraft manufacturers to define typical crash scenarios, identify injury causing subsystems, and define areas of needed research in crash dynamics have been completed. Follow-on contracts are being awarded to two of the three manufacturers to analytically model a B-720 transport under a prescribed crash scenario for comparison with data from a planned full-scale crash test in 1984. Design of an onboard data system to record the structural response of the B-720 during the proposed full-scale crash test is under study at LaRC. Procurement of electronic components and assembly will follow with aircraft sub-section impact testing to be used for evaluation and crashworthiness assessment. Contractual studies with Lockheed-California are underway to characterize the behavior of basic composite structural components under in-plane and out-of-plane tearing, crushing and compression loadings as well as wear due to abrasion. A workshop on the dynamic nonlinear finite element program DYCAST and the static nonlinear finite element program PLANS will be held at LaRC with the program DYCAST to be released to industry at that time. PLANS has already been released to COSMIC.

MILESTONES:

- Preliminary design of instrumentation package for onboard measurement of B-720 crash loads, January 1982
- Modify vertical test apparatus to provide variable deceleration capability, February 1982
- Analytical modeling of Boeing 720 by Boeing Commercial Airplane Company using DYCAST, March 1982

MILESTONES (Continued):

- o DYCAST workshop and release to industry, April 1982
- o Fabricate and conduct tearing, abrasion, crushing and shear test of composite coupons (LaRC/Lockheed-California Co.), June 1982

FY 1981 ACCOMPLISHMENTS:

- o Analytical modeling of Boeing 720 using DYCAST and KRASH for comparison with 720 full-scale crash test data
- o Modifying SOLMA to include finite element (DYCAST) multiseat and floor capability
- o Initiated composite coupon and element studies
- o Review of transport accident data completed; joint FAA/NASA B-720 crash test program initiated

IMPACT DYNAMICS BRANCH

RTOP 505-44-33 Aircraft Systems/Operating Efficiency Improvement
RTR 505-44-33-01 Aircraft Ground Performance

OBJECTIVE:

Advance the technology for safe, economical all-weather aircraft ground operations including the development of new landing systems

EXPECTED RESULTS:

- o Conduct tire integrity studies
- o Develop family of analytical tire models to facilitate tire and gear designs
- o Develop and validate software simulation of new landing gear concepts
- o Develop simulation capability to improve aircraft ground handling performance

APPROACH:

In research on tire behavior, the development of a family of analytical tire models will be completed and optimization procedures to facilitate computer-aided tire designs will be initiated. Analytical tire modeling efforts will be supported by tests at Wallops Flight Center using instrumented ground test vehicles to define the heat buildup and temperature distribution in the tire carcass.

Efforts on landing systems will include continuing studies of an active control system for a military aircraft to alleviate loads produced in damaged runways. Work on air cushion landing systems will continue with evaluations of braking and steering concepts and preliminary investigation of the behavior of such systems during operations on water.

In research on ground operations, the landing loads track test facility will be used in investigations of the effects of blown tires and failed wheels on aircraft runway performance. Brake dynamic characteristics, discovered in recent research, will be incorporated into antiskid computer simulations to support landing gear design and for application to aircraft ground-handling simulators.

MILESTONES:

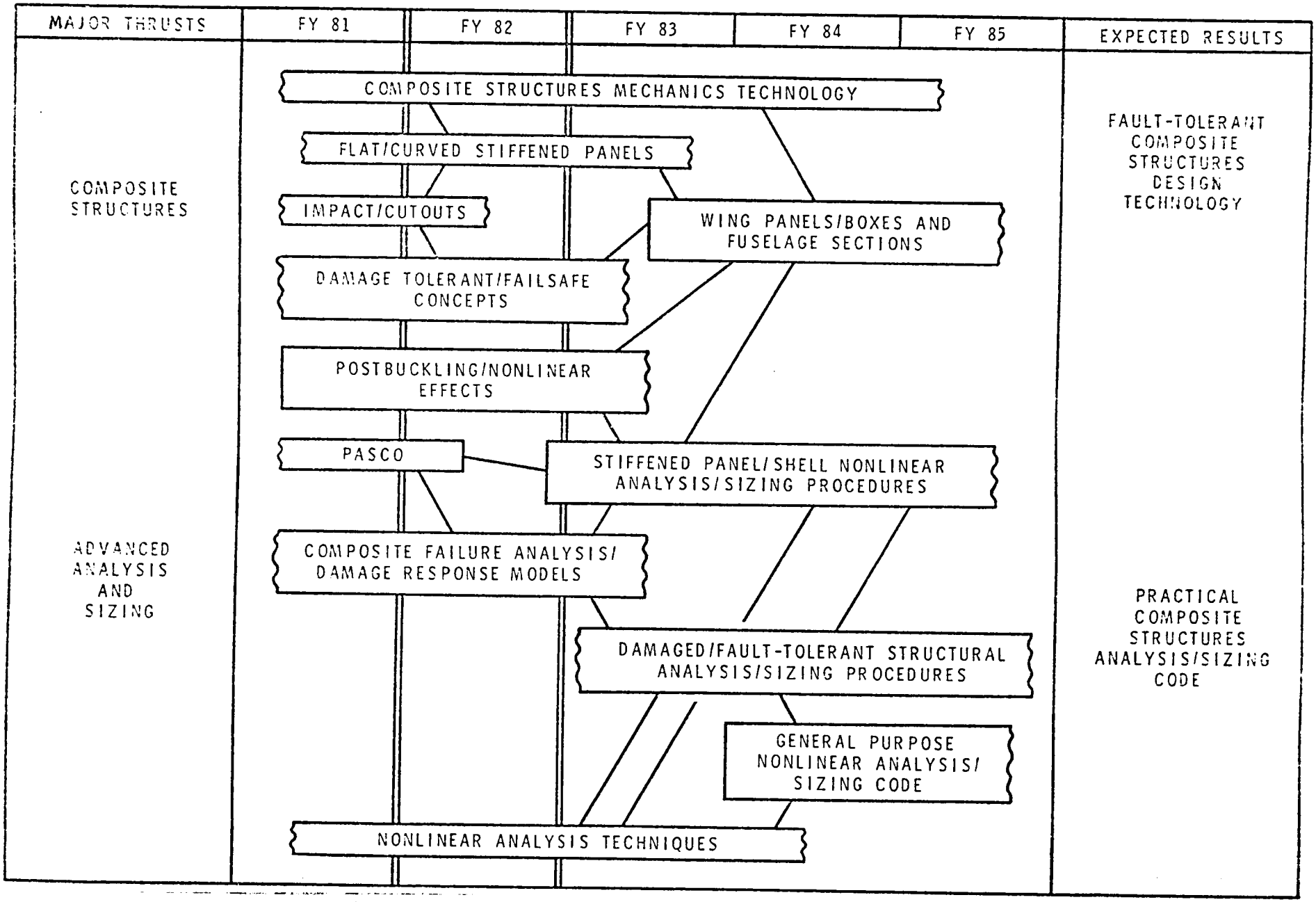
- o Incorporate brake dynamic characteristics into antiskid computer simulations, October 1981
- o Publish results from tire thermal studies, February 1982
- o Extend ground-handling simulation of B-737 to include brake and antiskid hardware, April 1982
- o Initiate study to predict water spray pattern from tires operating on flooded surfaces, May 1982
- o Conduct tests on water with scale model A-4D with Air Cushion Landing System (ACLS); complete evaluation of ACLS braking and steering concepts, June 1982
- o Document development of efficient, mixed formulation finite element tire model, August 1982
- o Hold tire modeling workshop, September 1982
- o Publish summary report on design and performance of aircraft antiskid braking systems, September 1982
- o Conduct full-scale and model studies as needed to support track update

FY 1981 ACCOMPLISHMENTS:

- o Formulated tire blowout test program with industry
- o Tire free-roll thermal analysis refined and experimentally validated
- o Two finite element tire models developed and verifed
- o Completed landing simulation of F-4 with active control gear
- o Initiated full-scale studies to verify ACLS analysis and evaluate braking steering concepts
- o Initiated hardware procurements to enhance ground handling simulator
- o Completed study of brake dynamics

IV STRUCTURAL MECHANICS BRANCH

STRUCTURAL MECHANICS



IV STRUCTURAL MECHANICS BRANCH

RTOP 505-33-33 Composites
RTR 505-33-33-06 Composite Structures Design Technology

OBJECTIVE:

Develop mechanics technology required for design of efficient, fault-tolerant advanced-composite aircraft structural components subject to combined loads, impact, postbuckling effects and local discontinuities

EXPECTED RESULTS:

- Achieve 50 percent improvement in design ultimate compression strains in composite components by end of FY 1982
- Understand mechanics of buckling and the effects of flaws on strength prediction, and determine resin properties critical to damage tolerance by end of FY 1983
- Understand effects of faults and impact damage on stiffened fuselage panels subject to combined loads and develop sizing methods and fault-tolerant concepts by end of FY 1984

APPROACH:

The advanced structural concepts and configurations that exploit the advantages of composites as well as advanced design methods for advanced composite flat and curved panels and stiffened shell structures will be developed. Compression, tension, shear and combined loads representative of aircraft primary wing and fuselage components will be considered. Methods will be developed for predicting strength, buckling and stiffness of composite components including the effects of foreign-object damage, cutouts and postbuckling. An experimental data base will be established for composite airframe structural components including damage, cutouts and postbuckling and correlated with analytical predictions.

MILESTONES:

- Complete preliminary postbuckling study of flat and curved stiffened compression panels, March 1982
- Evaluate effect of stacking sequence on compression strength of finite width composite plates with holes, August 1982

MILESTONES (Continued):

- Evaluate effect of holes and impact damage on curved composite compression panels, September 1982
- Complete preliminary postbuckling study of composite shear webs, September 1982

FY 1981 ACCOMPLISHMENTS:

- Complete preliminary study of stiffened compression panels
- Complete preliminary study of damage arrestment concepts
- Complete screening tests of alternate matrix materials and identify mechanical properties that affect damage tolerance
- Complete subcomponent test program for pressurized-fuselage panel specimen

STRUCTURAL MECHANICS BRANCH

RTOP 505-33-33 Composites
RTR 505-33-33-11 Advanced Analysis Techniques

OBJECTIVE:

Develop structural analysis and sizing methods for predicting and designing for nonlinear behavior of aerospace structures including postbuckling phenomena and ultimate strength

EXPECTED RESULTS:

- Conduct preliminary assessment of weight saving that can be achieved by exploiting postbuckling strength of composite structural panels by end of FY 1983
- Develop nonlinear algorithms for postbuckling, reduced degree-of-freedom and time integration analysis, and improve nonlinear methods for predicting ultimate strength of composite structures by end of FY 1984
- Develop efficient pilot nonlinear analysis and sizing procedure for structural components by end of FY 1984

APPROACH:

Using combinations of in-house research, contracts, and grants, develop and assess analytical techniques for studying the buckling and nonlinear response of composite aerospace structures. Compare that response with failure criteria, also to be developed and assessed, to predict the ultimate strength of aerospace structures. Develop and assess structural sizing algorithms that can be combined with these analysis techniques and failure criteria to produce procedures for sizing composite aerospace structures that undergo large, complex, nonlinear deformations.

MILESTONES:

- Develop structural sizing capability with collapse constraints, January 1982
- Develop and evaluate reduction methods for nonlinear transient analysis, March 1982
- Assess weight savings potential for buckled-skin designs for composite panels, August 1982
- Introduce an accurate advanced analysis procedure based on generalized Newton's method into a prototype nonlinear analysis code, September 1982

FY 1981 ACCOMPLISHMENTS:

- Complete development of and validate a finite-width, flawed laminate failure prediction technique
- Demonstrate use of mixed finite elements with reduced basis method
- Demonstrate general computational capability using reduced basis techniques (STAGS)
- PASCO panel analysis and sizing code being distributed to U.S. aerospace companies and workshop held

STRUCTURAL MECHANICS BRANCH

RTOP 534-03-13 Composite Primary Aircraft Structures--Key Technology
RTR 534-03-13-42 Failsafe Composite Structures

OBJECTIVE:

Develop structures technology and damage containment concepts required for the design of efficient, damage-tolerant advanced-composite aircraft structural components subject to combined loads, impact, local discontinuities and nonlinear effects

EXPECTED RESULTS:

- Develop and verify fault-tolerant damage-containment concepts for heavily-loaded wing structure by end of FY 1984

APPROACH:

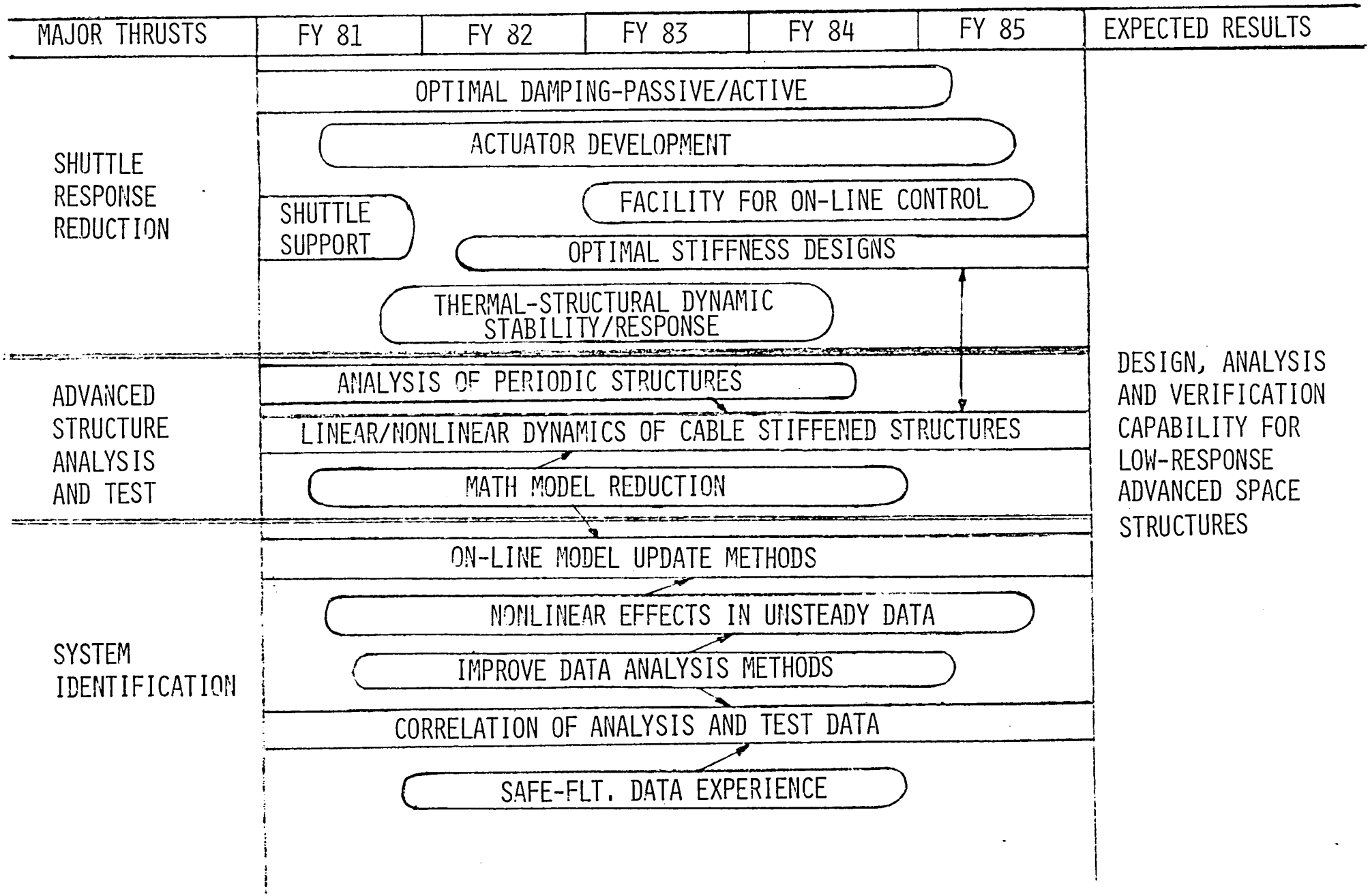
Damage-tolerant structural concepts and configurations will be developed for low-strain fuselage components with buckled skins and high-strain buckling-resistant wing components. Compression, tension, shear and combined loads representative of aircraft primary structures will be considered. Methods will be developed for predicting strength and response characteristics of damage-tolerant structural concepts including the effects of damage, cutouts, postbuckling and internal pressure. Failure mechanisms will be identifed and analytical procedures will be verified by testing structural components of the appropriate size.

MILESTONES:

- Initiate analytical study of stiffened composite fuselages with buckled skin, March 1982
- Initiate testing of large composite stiffened fuselage panels subjected to combined loads, April 1982
- Initiate design of damage-tolerant wing compression components, September 1982

V STRUCTURAL DYNAMICS BRANCH

DYNAMICS OF ADVANCED SPACE STRUCTURES



V STRUCTURAL DYNAMICS BRANCH

RTOP 506-53-43 Advanced Space Structures
RTR 506-53-43-03 STS Dynamics

OBJECTIVE:

Develop and validate improved analysis and test methods for the prediction, verification and reduction of space transportation systems and payload structural response in dynamic environments

EXPECTED RESULTS:

- Establish by FY 1983 improved methods for dynamic (modal survey, environmental) testing of space vehicles

APPROACH:

Methods for automated improvement of finite element models with the use of vibration test data will be studied. The influence of nonlinearities on results of vibration data analysis techniques will be investigated through analyses and experiments with controlled nonlinearities. Exploration of the effects of noise and of various methods for obtaining free-decay data on the Ibrahim Time Domain data analysis method will be conducted to arrive at guidelines for practical applications.

MILESTONES:

- Initiate tests of nonlinear torsional structure, November 1981
- Identify damping matrices from test data, September 1982

FY 1981 ACCOMPLISHMENTS:

- Development of automated method for improving finite element models using vibration test data
- Completed application of time domain data analysis to LDEF

STRUCTURAL DYNAMICS BRANCH

RTOP 506-53-43 Advanced Space Structures
RTR 506-53-43-04 Dynamics of Large Space Structures

OBJECTIVE:

Develop validated capability to predict and control structural dynamic responses of large flexible space structures to disturbances arising from control and thermal sources

EXPECTED RESULTS:

- Develop and validate by FY 1984 methods for predicting and reducing the response of large flexible space structures

APPROACH:

For studies of the dynamics of large flexible space structures, coordinated test and analysis programs will be performed, first on elementary structures, then more complex structures for realistic demonstration of analysis, test and control concepts. Tests and analyses will be performed on an elementary beam mounted in the 16.7-meter vacuum chamber which has been modified to permit thermal inputs to structural specimens. Structural-thermal stability and structural dynamic-thermal response analyses and tests will be correlated. Actuator optimum size and location for damping dynamic responses is being investigated in an elementary beam and grillage analysis and test program. Desirable actuator characteristics are being determined under a grant. These thermal and damping studies on elementary structures will lead to a demonstration of analysis and test capability with a more complex structure which will be tested using the 16.7-meter thermal vacuum chamber. In another series of analyses and tests, methods for prediction of the dynamic response of novel structures such as tension stiffened/stabilized antenna concepts will be developed. Development/acquisition of analysis tools which employ elements which are described with accurate transcendental functions will be pursued. These tools will be demonstrated on a cable-stiffened column and a cable-stiffened hexagonal structure. Optimum design of structures using concepts from optimal control theory will be developed and demonstrated on these cable-stiffened structures. A large test article will be built and tested to demonstrate these analysis and design concepts on a realistic structure. Analytically, methods for reduction of the size of mathematical models for efficient use in loads, stability and control analyses will be developed.

MILESTONES:

- Complete tests of cable-stiffened column, November 1981
- Complete mode survey and begin closed-loop tests on grillage, December 1981

MILESTONES (Continued):

- Begin tests and analyses of hexagonal cable-stiffened structure, January 1982
- Begin tests of beam in 16-meter thermal-vacuum chamber, June 1982

FY 1981 ACCOMPLISHMENTS:

- Development of actuator for active control
- Prediction and verification of vibrations and buckling of pretensioned stayed column
- Increased efficiency of time integration techniques

STRUCTURAL DYNAMICS BRANCH

RTR 506-62-69-01 Solar Array Flight Experiment (SAFE)

OBJECTIVE:

To obtain video taped optical observations of the solar array flight experiment during orbital flight test. To use TV/image processing based on photogrammetry to obtain time histories of structural response. To process these time histories to obtain SAFE structural dynamic characteristics.

EXPECTED RESULTS:

- o Comparison of flight results with analytical predictions of the solar array dynamics
- o To prove techniques for remote measurement/detection of dynamics of large flexible structures

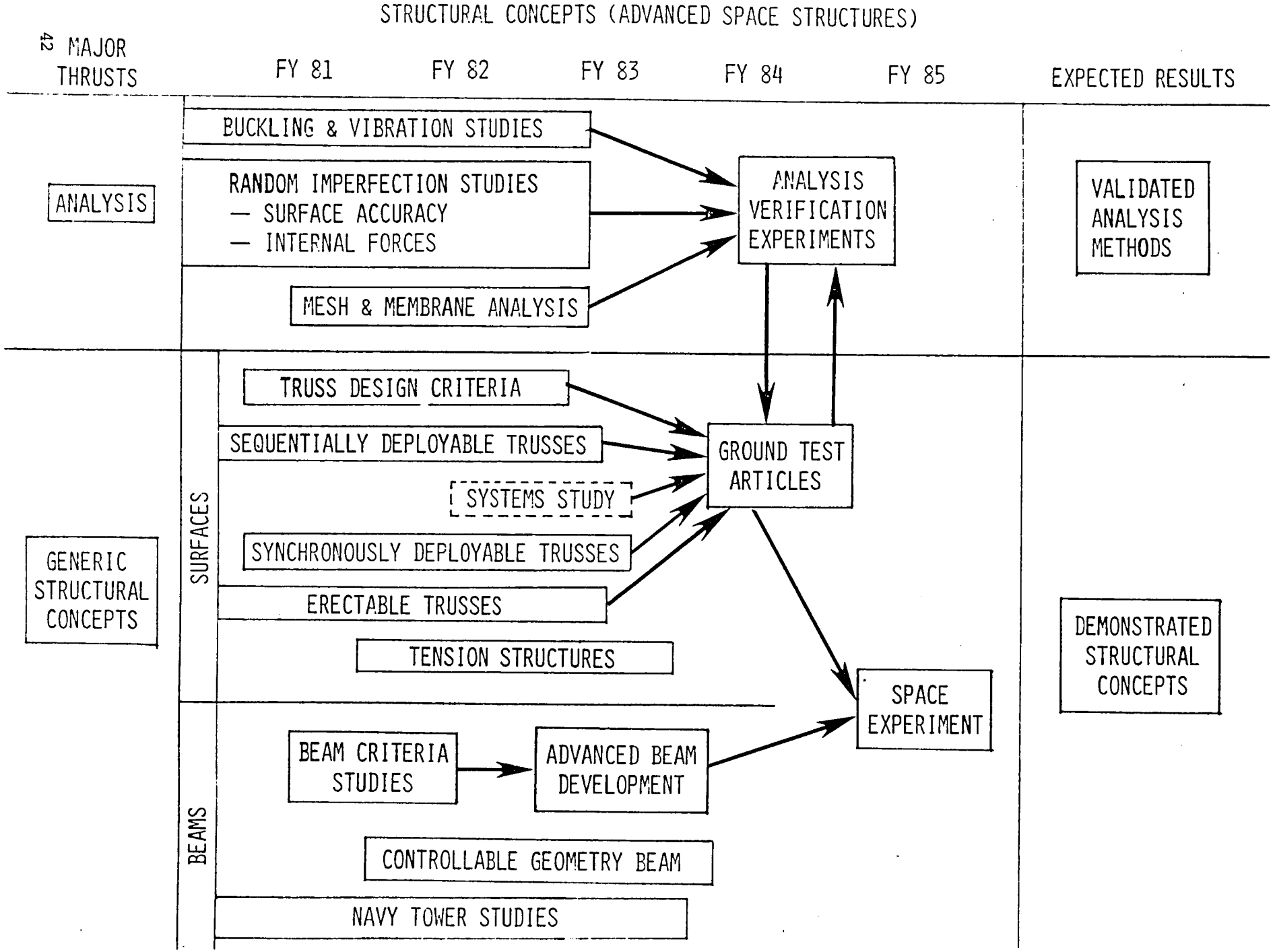
APPROACH:

The Solar Array Flight Experiment (SAFE) is a joint effort with the MSFC Solar Electric Propulsion Solar Array Flight Experiment. Existing shuttle closed circuit television will be used to obtain video taped optical observations of a set of passive targets located on the SAFE during the flight test. LaRC will develop and demonstrate a laboratory prototype measurement system and data analysis method. To obtain estimates of response magnitudes existing and improved mathematical models of the SAFE structure will be used with a simplified orbiter representation and force inputs from the shuttle vernier controls will be used for transient vibration analyses. After the flight, video tapes will be analyzed to obtain vibration characteristics of the array.

MILESTONES:

- o Studies of math model and excitation techniques, November 1981
- o Simulation studies of modal responses, February 1982
- o Select system identification techniques, April 1982
- o Develop software for system identification techniques, November 1982
- o Demonstration with multichannel system, December 1982-February 1983
- o Flight tapes available, July 1983

VI STRUCTURAL CONCEPTS BRANCH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VI STRUCTURAL CONCEPTS BRANCH

RTOP	506-53-43	Advanced Space Structures
RTR	506-53-43-01	Advanced Space Structures Concepts
	506-53-43-52	Navy Emergency VLF Antenna Tower Design Study

OBJECTIVE:

Develop structural concepts and associated design technology required for future large space structures

EXPECTED RESULTS:

- Establish, by the end of 1983, structural concepts, deployment schemes, and packaging techniques that will permit planar structures on the order of 100 to 200 meters in size to be carried into orbit in one shuttle flight and automatically deployed
- Establish erectable concepts and assembly methods for structures of 100 m to 1000 m in size by end of FY 1985
- Validated analysis and design capability for large spacecraft by end of FY 1984
- Establish feasibility of controllable geometry "serpentine" beams by FY 1984

APPROACH:

In the structural concepts area for large space structures, folding and packaging techniques for very lightweight deployable structures will be investigated. The effects of using very slender members to achieve high packaging efficiency will be evaluated. A truss structure will be constructed for static and dynamic tests to confirm theoretical predictions. Design efforts will be focused on studies of a large, faceted antenna concept. Studies of achievable accuracy in construction, and deployable concepts will be investigated. Conceptual studies including hardware development will be conducted on new deployable structural members and structural configurations. The major emphasis of this effort will be focused on providing highly controlled and reliable deployments. Exploratory studies will be made of introducing multiple actuation devices into the structure such that its geometry can be controlled at will. Initial efforts will be on a controlled geometry boom.

MILESTONES:

- o Initiate deployable truss contract, October 1981
- o Establish in-house 100 m truss antenna design, November 1981
- o Initiate variable geometry boom contract, December 1981
- o Complete variable geometry boom computer simulation, March 1982
- o Document neutral buoyancy simulation for erecting truss structures, May 1982
- o Complete variable geometry test boom, September 1982
- o Complete 36-element slender strut truss test article, September 1982

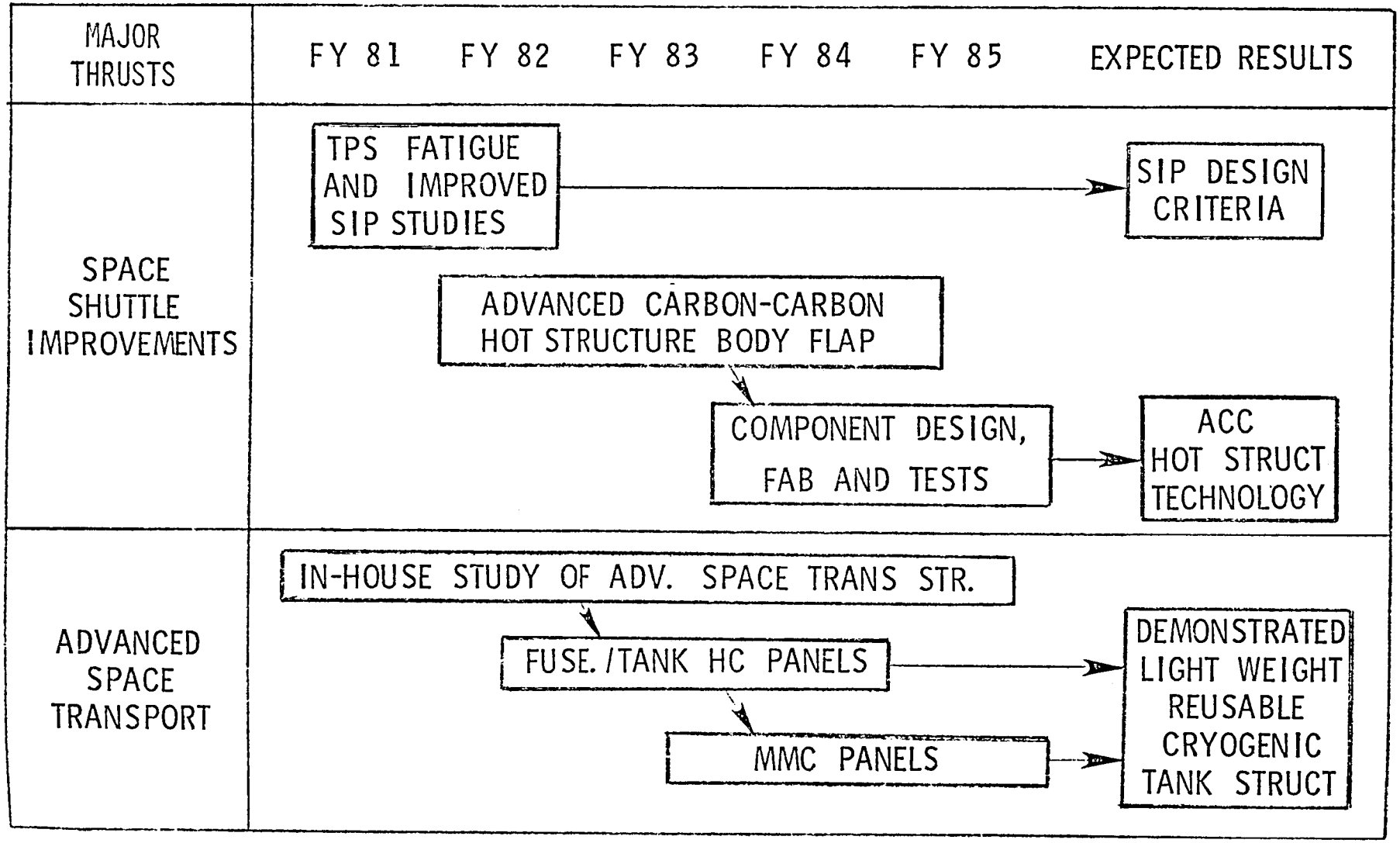
FY 1981 ACCOMPLISHMENTS:

- o Linear buckling and vibration analysis completed
- o Initial random finite element analysis developed for surface errors
- o Linear RMS error analysis completed for triangular facets
- o Primary design drivers identified and quantified for truss slender struts
- o Spherical surface geometry analysis complete and small scale working model developed for sequential deployable truss
- o Parabolic surface geometry analysis and initial joint designs complete for synchronously deployable truss
- o Neutral buoyancy assembly studies of 38-element truss complete
- o Tension structures parametric study complete for an inflatable reflector surface
- o Bending stiffness and packaging requirements quantified for antenna applications in beam criteria studies

FY 1981 ACCOMPLISHMENTS (Continued):

- o Potential concepts identified and models being made for controllable geometry beam
- o Parameter studies complete and telescoping tower identified as highly packageable quick erect tower for Navy tower studies

STRUCTURAL CONCEPTS (TRANSPORTATION SYSTEMS)



NASA

STRUCTURAL CONCEPTS BRANCH

RTOP	506-53-43	Advanced Space Structures
RTR	506-53-43-02	Advanced Space Transportation Structures
RTR	307-02-02-03	Advanced Carbon-Carbon (ACC) Structural Joints Study
RTOP	506-53-33	Thermal Protection Systems for Earth-to-Orbit STS
RTR	506-53-33-06	Advanced Concepts for Nonmetallic TPS

OBJECTIVE:

Perform research and development through analysis and test of efficient high temperature structural concepts critical to the design of future space transportation systems

Perform research and development through analysis, fabrication and tests of various structural joint concepts to provide this critical technology needed for future fabrication of large hot structures of advanced carbon-carbon (ACC)

Develop structural concepts which increase the useable lifetime of nonmetallic TPS

EXPECTED RESULTS:

- o Develop concepts for hot ACC body flap designs and component tests by mid-FY 1985
- o Define and provide test data of effective tankage structure for advanced STS by FY 1986

APPROACH:

In studies of structural concepts for advanced transportation systems, panel and joint components of integral tank sandwich structure will be fabricated on contract. The structure will have 2219 T-87 aluminum alloy face sheets and titanium alloy core. Joints will be of brazed and welded construction. Sufficient test components will be fabricated to identify and solve fabrication problems and to provide specimens for fatigue, static tension, and panel stability tests. Concept scale-up will be performed during the following year leading to tests of a cylindrical tank structure of representative construction. An in-house Langley study of future space transportation requirements will be initiated leading to a definition of research needs for efficient structural concepts applicable for us in proposed advanced systems.

APPROACH (Continued):

For ACC an in-house conceptual design and analysis study will provide concepts and guidance to a contractor who will perform a preliminary design, analysis, and fabrication of test articles. These test articles will be tested in-house.

To provide a guide for the acceptable stiffness range of SIP material, a series of tests to determine strain-to-failure of densified LI-900 RSI will be performed. This information will be used with an existing analysis which relates the strain in the RSI to applied thermal and mechanical deformations of the inner mold line of the orbiter as a function of SIP stiffness to determine acceptable SIP stiffness levels at several locations on the orbiter.

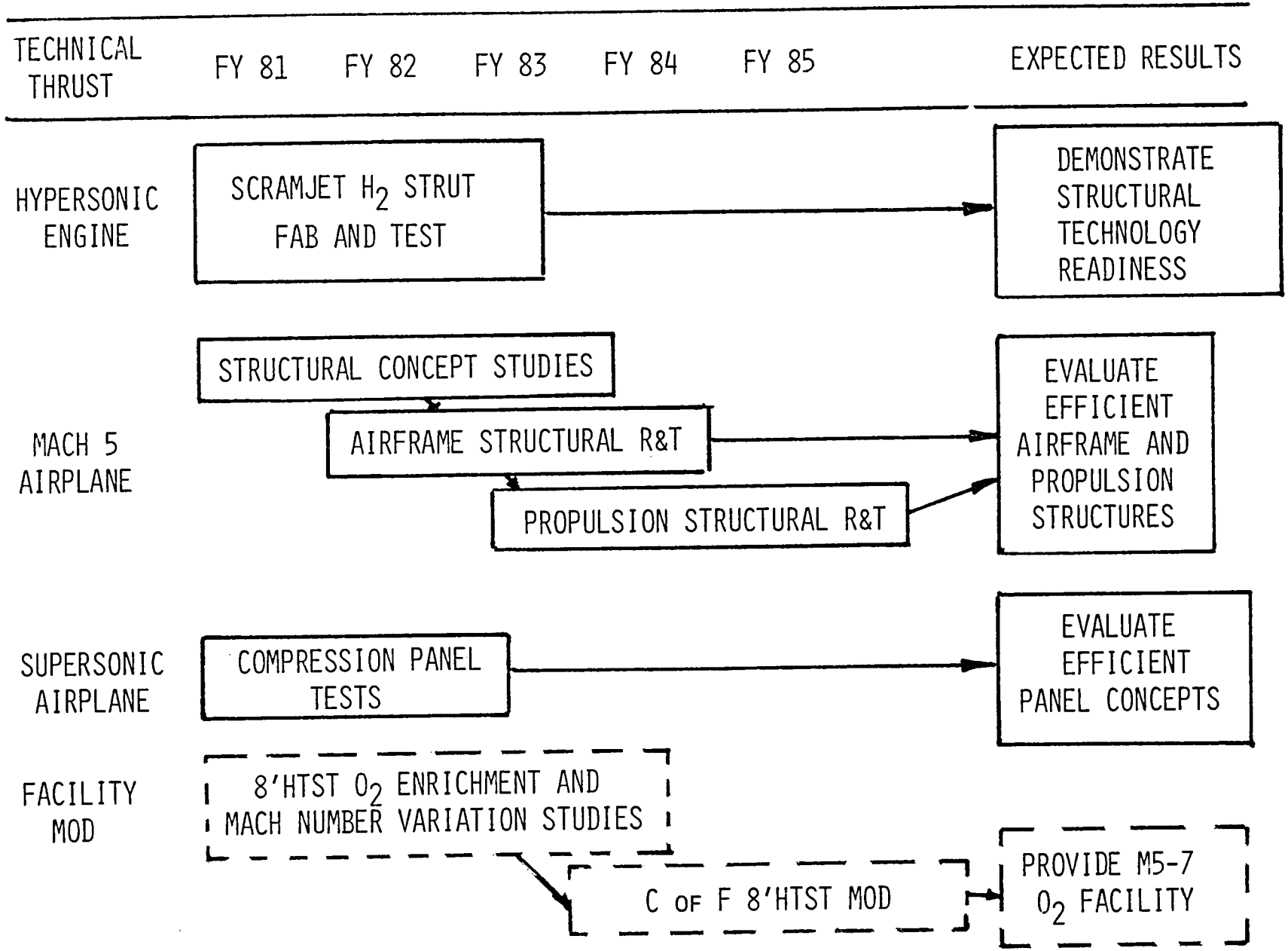
MILESTONES:

- o Establish densified RSI strain-to-failure, December 1981
- o Initiate sandwich structure fabrication contract, January 1982
- o Define permissible range of Strain Isolator Pad stiffness, March 1982
- o Initiate contract to study fastener concepts for ACC hot structure, April 1982
- o Complete initial definition of advanced space transportation system, June 1982
- o Initiate test of sandwich structure, August 1982

FY 1981 ACCOMPLISHMENTS:

- o Complete random fatigue tests of undensified tile
- o Investigate failure mode of densified TPS under dynamic random loads
- o Complete 3-D stress analysis of tile/SIP
- o Determine strength of stiffness properties of densified RSI
- o Initiate study of structural application of ACC
- o Initiate structural integration studies of 2nd generation STS

STRUCTURAL CONCEPTS (AERO)



STRUCTURAL CONCEPTS BRANCH

RTOP 505-33-73 High-Temperature Aeronautical Structures
RTR 505-33-73-07 High-Temperature Structural Concepts

OBJECTIVE:

Develop and evaluate engine and airframe structural concepts appropriate for aircraft which cruise in the supersonic to hypersonic flight regime

EXPECTED RESULTS:

- Demonstrate fabricability and determine thermal/structural performance of H_2 cooled scramjet fuel injector strut by end of FY 1983
- Complete fabrication and test of lightweight compression panel concepts for supersonic aircraft by end of FY 1983
- Define and provide test data of effective structural concepts and thermal management techniques for airframe and JP/LCH_4 ramjets for Mach 4-5 aircraft by end of FY 1986

APPROACH:

Fabrication of the scramjet engine strut is scheduled for completion and delivery during FY 1982. The strut test program will begin upon receipt of the test article.

Study programs for various critical structural components of high-speed aircraft will continue leading to fabrication of specific structural elements for engine, fuselage, and wing components. Development of joining techniques for high-temperature material systems appropriate for high-speed aircraft will continue in-house.

Depending on support level available, fabrication of titanium structural panels with Boron/Aluminum selective reinforcement will be pursued under contract and tested in-house.

MILESTONES:

- Initiate titanium curved-cap panel fabrication contract, December 1981
- Welded and diffusion bonded Ti 6-2-4-2 testing complete, March 1982

MILESTONES (Continued):

- o Delivery of scramjet strut, July 1982
- o Complete weight-strength analysis of curved-cap panel, August 1982

FY 1981 ACCOMPLISHMENTS:

- o Contractor revising fabrication plans for H_2 cooled strut
- o Preliminary design for JP fueled Mach 5 aircraft complete
- o Creep problems and brittle behavior identified for lid bond process of Ti 6-2-4-2
- o Ti Honeycomb with insulated lower structure identified for wing structural concepts
- o Curved cap panel concept identified for fuselage structural concept

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15. Supplementary Notes

16. Abstract

The purpose of this paper is to present the Objectives, Expected Results, Approach, and FY-82 Milestones for the Structures and Dynamics Divisions's research programs. FY-81 accomplishments are presented, where applicable. This information will be useful in program coordination with other government organizations in areas of mutual interest.

17. Key Words (Suggested by Author(s))
Computer-aided design; IPAD; General aviation/transport crash dynamics; Aircraft ground performance; Composite structures; Failure analysis; Space vehicle dynamics; Large space structures

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