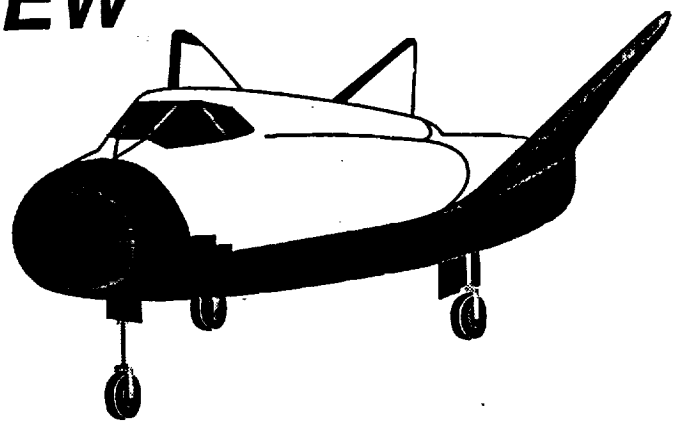
NASA
National Aeronautics and Space Administration

SPACE R&T OVERVIEW



Gregory M. Reck
Director for Space Technology
Office of Aeronautics and Space Technology

OAST

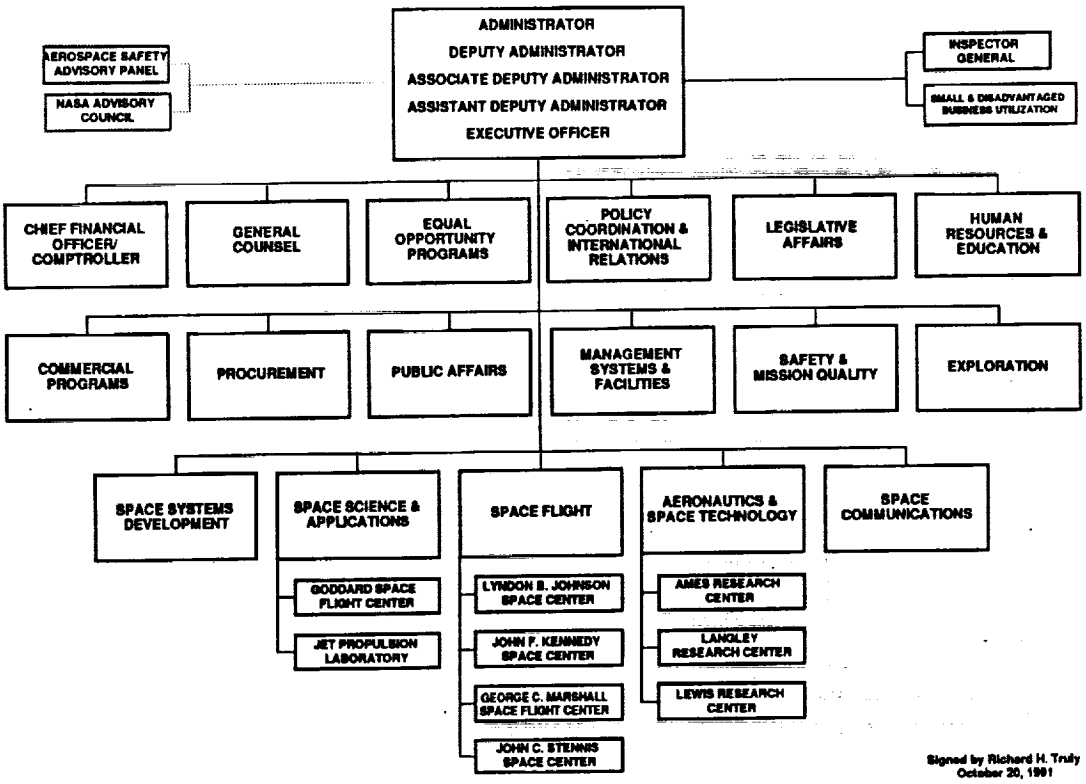
March 1992

SPACE RESEARCH & TECHNOLOGY OVERVIEW

OAST

- ORGANIZATION
- OBJECTIVES AND STRUCTURE
- PROGRAM ELEMENTS AND MILESTONES
- PLANNING AND RESOURCES
- ACCOMPLISHMENTS
- CENTER ROLES

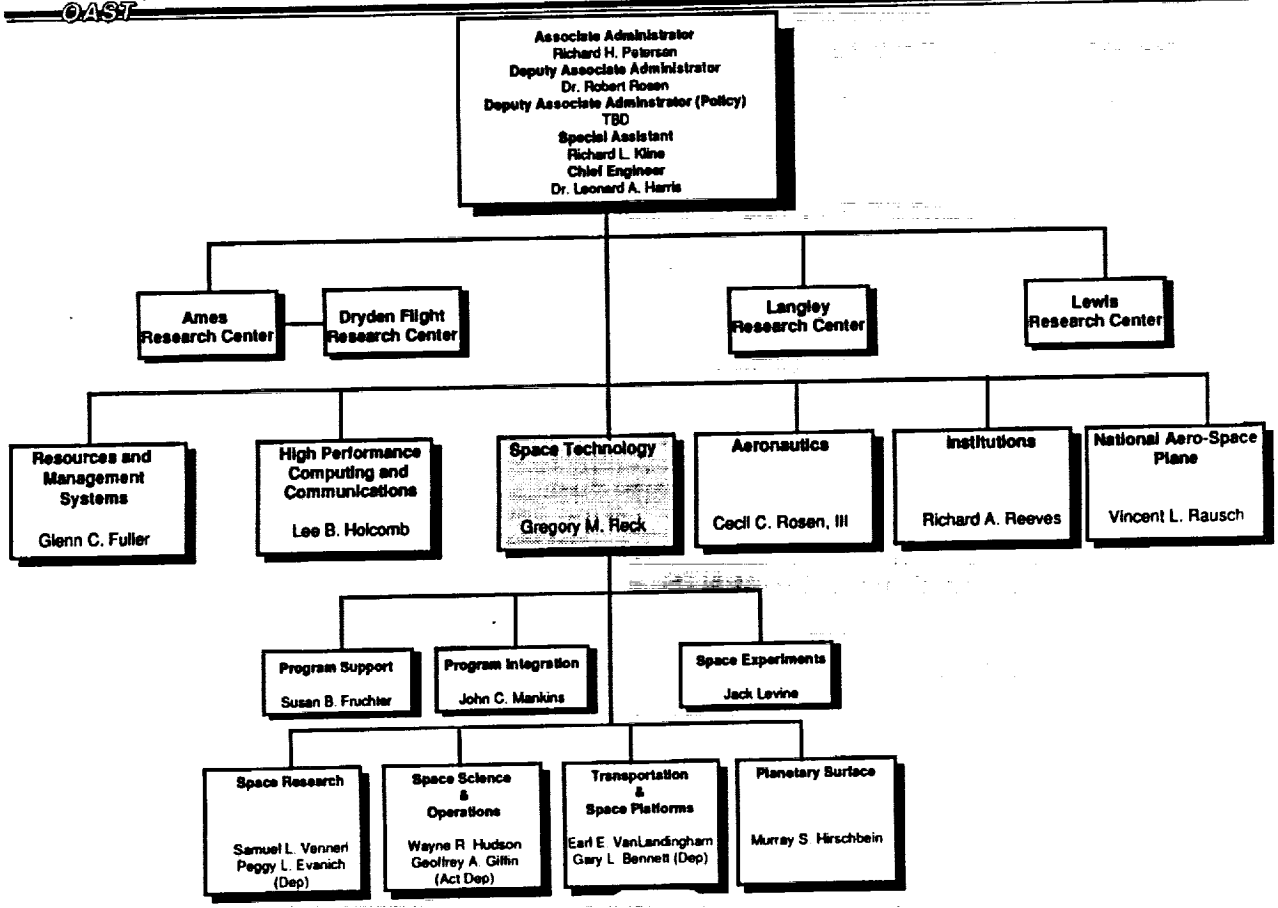
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION



Signed by Richard H. Truly
October 20, 1991

OFFICE OF AERONAUTICS AND SPACE TECHNOLOGY

OAST



OFFICE OF AERONAUTICS AND SPACE TECHNOLOGY
FY 1992 BUDGET

OAST

($,M)

APPROP.	AERO	TRANSAT.	SPACE	TOTAL
R&D	574.2	5.0	309.3*	888.5
R&PM	273.1	16.1	138.4	427.6
CofF	42.3	-	-	42.3
SUBTOTAL	889.6	21.1	447.7	1358.4
RES. OPS. SUPP.				210.1
TOTAL				1568.5

* SPACE EXCLUDES MISSION STUDIES ($5.0M)

92-1038
Rev 2/26/92

SPACE R&T MISSION STATEMENT

OAST

OAST SHALL PROVIDE TECHNOLOGY FOR FUTURE CIVIL SPACE MISSIONS AND PROVIDE A BASE OF RESEARCH AND TECHNOLOGY CAPABILITIES TO SERVE ALL NATIONAL SPACE GOALS

- *IDENTIFY, DEVELOP, VALIDATE AND TRANSFER TECHNOLOGY TO:*
  - INCREASE MISSION SAFETY AND RELIABILITY
  - REDUCE PROGRAM DEVELOPMENT AND OPERATIONS COST
  - ENHANCE MISSION PERFORMANCE
  - ENABLE NEW MISSIONS
- *PROVIDE THE CAPABILITY TO:*
  - ADVANCE TECHNOLOGY IN CRITICAL DISCIPLINES
  - RESPOND TO UNANTICIPATED MISSION NEEDS

LBF4194B

INTEGRATED TECHNOLOGY PLAN FOR THE CIVIL SPACE PROGRAM

RESEARCH & TECHNOLOGY STRATEGY

OAST

FLIGHT PROGRAMS FORECAST

- **5-YEAR FORECAST INCLUDES**

'93 THRU '97: LIMITED NEW STARTS

- COMPLETION OF INITIAL SSF
- SOME SHUTTLE IMPROVEMENTS
- INITIAL EOS & EOSDIS
- SELECTED SPACE SCIENCE STARTS
- NLS DEVELOPMENT
- INITIAL SEI ARCHITECTURE SELECTION
- EVOLVING GEO COMMERCIAL COMMSATS
- MINOR UPGRADES OF COMMERCIAL ELVS

- **10-YEAR FORECAST INCLUDES**

'98 THRU '03: MULTIPLE NEW STARTS TO BE LAUNCHED IN 2003 THRU 2010

- SSF EVOLUTION/INFRASTRUCTURE
- FINAL SHUTTLE ENHANCEMENTS
- ADVANCED LEO EOS PLATFORMS/FULL EOSDIS
- MULTIPLE SPACE SCIENCE STARTS
- NLS OPERATIONS/EVOLUTION
- EVOLVING LAUNCH/OPERATIONS FACILITIES
- INITIAL SEI/LUNAR OUTPOST START
- DSN EVOLUTION (KA-BAND COMMUNICATIONS)
- NEW GEO COMMERCIAL COMMSATS
- NEW COMMERCIAL ELVS

- **20-YEAR FORECAST INCLUDES**

'04 THRU '11 MULTIPLE OPTIONS FOR NEW STARTS TO BE LAUNCHED IN 2009 THRU 2020

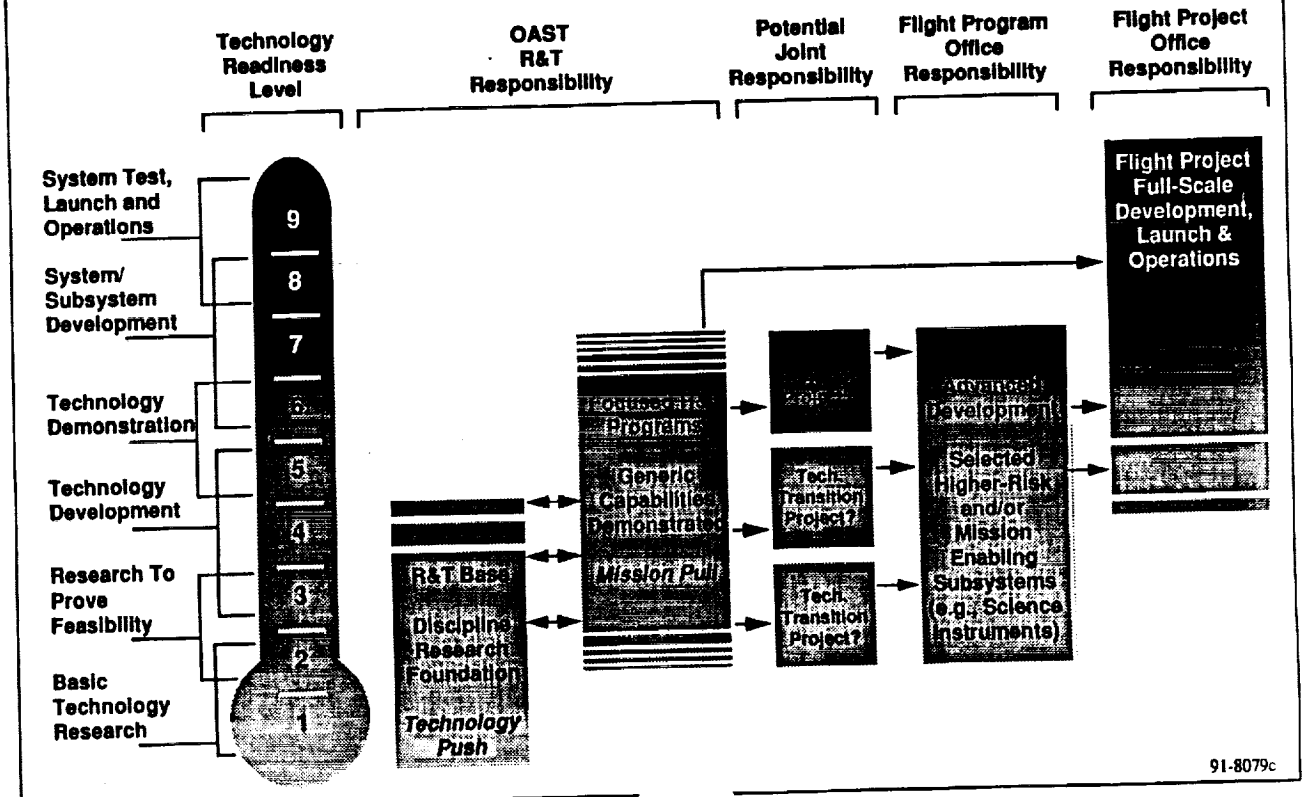
- SSF-MARS EVOLUTION
- BEGINNING OF AMLS/PLS DEVELOPMENT
- MULTIPLE SPACE SCIENCE STARTS
- DSN EVOLUTION (OPTICAL COMM)
- INITIAL MARS HLLV DEVELOPMENT
- EVOLVING LUNAR SYSTEMS
- MARS SEI ARCHITECTURE CHOSEN
- LARGE GEO COMMSATS
- NEW COMMERCIAL ELVS

LBF40305
(JCM-7692)

INTEGRATED TECHNOLOGY PLAN FOR THE CIVIL SPACE PROGRAM

TECHNOLOGY MATURATION STRATEGY

OAST



INTEGRATED TECHNOLOGY PLAN FOR THE CIVIL SPACE PROGRAM

SPACE RESEARCH & TECHNOLOGY

RESEARCH & TECHNOLOGY BASE

DISCIPLINE RESEARCH
- Aerothermodynamics
- Space Energy Conversion
- Propulsion
- Materials & Structures
- Information and Controls
- Human Support
- Space Communications

UNIVERSITY PROGRAMS

SPACE FLIGHT R&T

SYSTEMS ANALYSIS

CIVIL SPACE TECHNOLOGY INITIATIVE

SPACE SCIENCE TECHNOLOGY
- Science Sensing
- Observatory Systems
- Science Information
- In Situ Science
- Technology Flight Expts.

PLANETARY SURFACE TECHNOLOGY
- Surface Systems
- Human Support
- Technology Flight Expts.

TRANSPORTATION TECHNOLOGY
- ETO Transportation
- Space Transportation
- Technology Flight Expts.

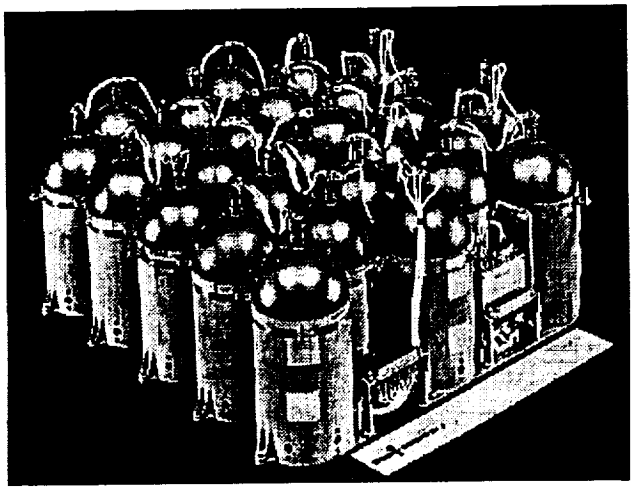
SPACE PLATFORMS TECHNOLOGY
- Earth-Orbiting Platforms
- Space Stations
- Deep-Space Platforms
- Technology Flight Expts.

OPERATIONS TECHNOLOGY
- Automation & Robotics
- Infrastructure Operations
- Info. & Communications
- Technology Flight Expts.

LBF40319

DISCIPLINE RESEARCH

CONCEIVE, DEVELOP AND VALIDATE NEW TECHNOLOGY CONCEPTS AND APPROACHES FOR ENHANCING OR ENABLING FUTURE SPACE MISSIONS, INCLUDING REVOLUTIONARY IMPROVEMENTS IN SPACE CAPABILITY



- **DISCIPLINE RESEARCH TECHNOLOGY**
  - **AEROTHERMODYNAMICS**
  - **SPACE ENERGY CONVERSION**
  - **PROPULSION**
  - **MATERIALS & STRUCTURES**
  - **INFORMATION & CONTROLS**
  - **HUMAN SUPPORT**
  - **ADVANCED COMMUNICATIONS**

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91-8064

INTEGRATED TECHNOLOGY PLAN FOR THE CIVIL SPACE PROGRAM

R&T Base Discipline Programs Content

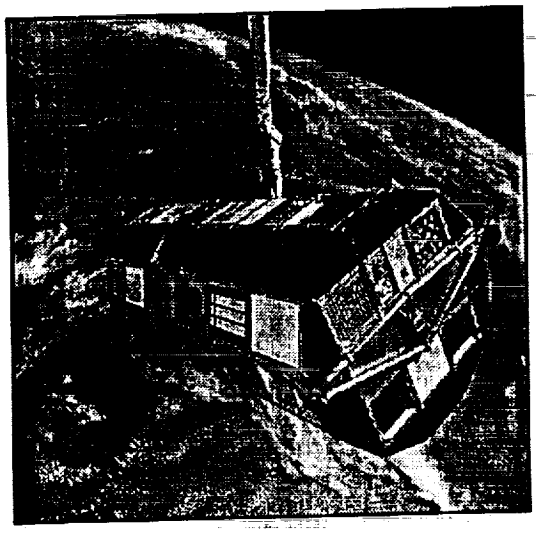
OAST

	BASE CAPABILITIES	ADVANCED TECHNOLOGIES	"BREAKTHROUGH" TECHNOLOGIES
Aerothermo-dynamics	Hypersonic Flowfield Sim.; Hypersonic Vehicle Synth.; Fundamental Data Bases	Flt. Environ. Instrument'n; Configuration Design/Optimiz.; Aerothermo. Design Tools	
Space Communications	Traveling Wave Tubes (TWTs); MMICs	KaBand TWT; Digital Switching Processors; Ground Terminals; Solid State MMIC Systems; Direct Broadcast (Audio)	Laser Comm. Components; Mobile Comm. Systems (Personal)
Space Energy Conversion	Photovoltaic Perf. Validation; Solar Dynamics Design/Analysis; Electrochemical Diagn./Models	Adv. Solar Cells (GaAs, In-P); Adv. Batteries (Rechg/Life); Thermoelectric Conv. Systems; Concentrators and Arrays; Solar Dynamics Conv. Systems; Power Mgt. & Distribution	Laser Power Components; Alkali Metal T-E Conversion; Diamond Film Pwr Electronics; Adv. Fuel Cells (LI/CO2); Liquid Sheet Radiators
Human Support	Extravehicular Activity Suit; Human Modeling (Cogn./Physical)	EVA Gloves; EMU Components; Life Support Models; PLSS Components; Interactive EVA Displays; Life Support Sensors/Cntrls	Visualization Research; AI Computer Associates; Virtual Reality Environments
Information and Controls	Electro-optic Mat's/Sensors	Advanced AI Research; Computational Controls; Software Develop. Tools	Micromachines; Photonics; Multiple Interactive Robots; Neural Networks; High-Temp Superconductors
Materials and Structures	Materials Synthesis; Space Durable Materials; Sp. Environ. Effects (Mat's); High Temp. TPS; Advanced Space Struct. Concepts; Tribology	Optics; High Precision Struct.; Durable Polymers; Mechanisms; Lg./Deployed Struct.; High Temp. Veh. Struct.; Extreme TPS; Debris Shielding	Intermetallics & Metal Matrix; Computational Materials; Adaptive Materials; Computational Chemistry; "Smart" Materials
Propulsion	Combustion Models/Diagn.; Internal Pump Flow CFD; Engine Analysis Expert Systems; Cryo. Fluid Modeling	Ion Thrusters; Water Resistojets; H-O Engines; Hydrogen Arcjets; Iridium-Rhenium Engine Liners; Propulsion Health Mgt.; MPD Thrusters	High Energy Density Propell.; Laser Rocket Propulsion; Superconduct Bearings; Electrodeless Thrusters (ECR); Fission/Fusion Propulsion

NOVEMBER 13, 1[illegible]
JCM 6P[illegible]

SPACE FLIGHT RESEARCH & TECHNOLOGY

PROVIDE FOR EXPERIMENT STUDIES, DEVELOPMENT AND SUPPORT FOR IN-SPACE FLIGHT RESEARCH AND VALIDATION OF ADVANCED SPACE TECHNOLOGIES

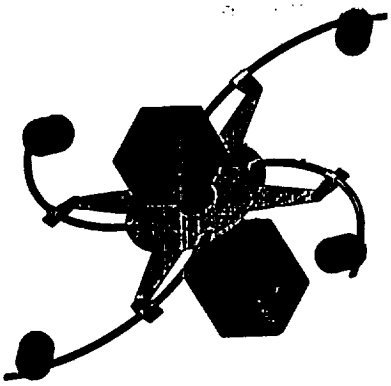


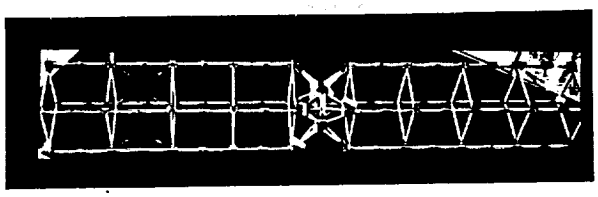
- IN-SPACE TECHNOLOGY EXPERIMENT PROGRAM (IN-STEP)
  - DESIGN, DEVELOP AND FLIGHT TEST INDUSTRY, UNIVERSITY AND NASA TECHNOLOGY FLIGHT EXPERIMENTS
- FLIGHT OPPORTUNITIES VIA
  - SPACE SHUTTLE
  - EXPENDABLE LAUNCH VEHICLES
  - SPACE STATION FREEDOM

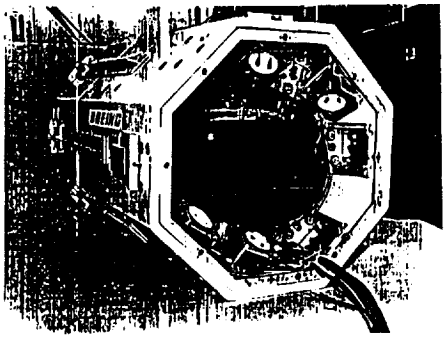
Office of Aeronautics and Space Technolog

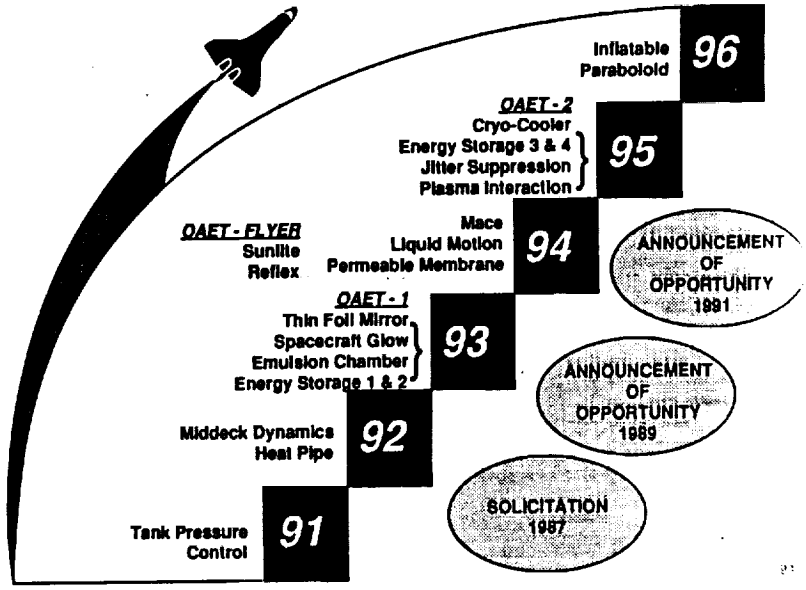
91-8063

IN-SPACE TECHNOLOGY EXPERIMENTS



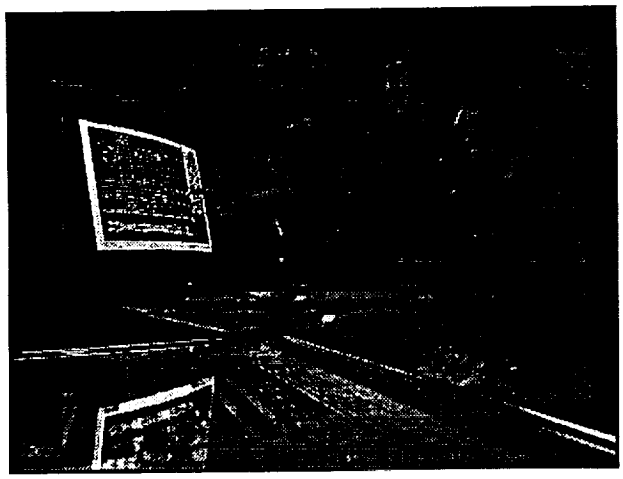






UNIVERSITY PROGRAMS

BROADEN THE CAPABILITIES OF THE NATION'S ENGINEERING COMMUNITY TO PARTICIPATE IN THE U.S. CIVIL SPACE PROGRAM THROUGH UNIVERSITY-BASED RESEARCH AND EDUCATION



- UNIVERSITY SPACE ENGINEERING RESEARCH CENTERS
  - FOSTER CREATIVE AND INNOVATIVE CONCEPTS OF FUTURE SPACE SYSTEMS
  - EXPAND THE NATION'S ENGINEERING TALENT BASE FOR RESEARCH AND DEVELOPMENT
- UNIVERSITY INVESTIGATORS RESEARCH
  - SPONSOR INDIVIDUAL RESEARCH ON HIGHLY INNOVATIVE SPACE TECHNOLOGY CONCEPTS AND APPROACHES
- UNIVERSITY ADVANCED DESIGN
  - FOSTER INTERDISCIPLINARY ENGINEERING DESIGN EDUCATION

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91-8061

UNIVERSITY SPACE ENGINEERING RESEARCH PROGRAM

UNIVERSITY-BASED CENTERS

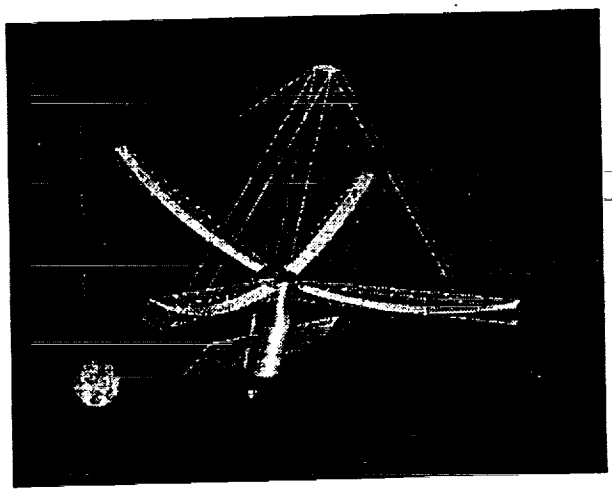
- ATTRACT AND RETAIN STUDENT AND INDUSTRY SUPPORT
- SUPPORT AND EXPAND THE NATION'S ENGINEERING TALENT BASE
- FOSTER INNOVATIVE, MULTI-DISCIPLINARY RESEARCH

- UNIVERSITY OF ARIZONA
  - Planetary Resources
- UNIVERSITY OF CINCINNATI
  - Propulsion Monitoring Systems
- UNIVERSITY OF COLORADO, BOULDER
  - Space Construction
- UNIVERSITY OF IDAHO
  - VLSI hardware
- MASSACHUSETTS INSTITUTE OF TECHNOLOGY
  - Controlled Structures Technology
- UNIVERSITY OF MICHIGAN
  - Space TeraHertz Sensing Technologies
- NORTH CAROLINA STATE AT RALEIGH & NORTH CAROLINA AGRICULTURAL & TECHNICAL STATE UNIVERSITIES
  - Mars Mission Technologies
- PENNSYLVANIA STATE UNIVERSITY
  - Propulsion
- RENSSELAER POLYTECHNIC INSTITUTE
  - Robotics

91-2118

SYSTEMS ANALYSIS

CONDUCT INTERDISCIPLINARY SYSTEM STUDIES TO IDENTIFY AND PRIORITIZE NEW TECHNOLOGY REQUIREMENTS AND OPPORTUNITIES AND DEVELOP MODELING AND ANALYSIS TOOLS



- FOCUSED PROGRAMS
  - IDENTIFY CRITICAL TECHNOLOGY ISSUES OF FUTURE MISSION CONCEPTS
    - TRANSPORTATION
    - SPACE SCIENCE
    - SPACE PLATFORMS
    - SPACE EXPLORATION
    - OPERATIONS
- BREAKTHROUGH
  - IDENTIFY BENEFITS OF HIGHLY INNOVATIVE SPACE TECHNOLOGY IDEAS AND SPACE APPLICATIONS OF NEW TECHNOLOGY FRONTIERS
- EXTERNAL
  - SUPPORT SPACE COMMERCIALIZATION
  - IMPROVE USE OF INDUSTRY INDEPENDENT R&D (IRAD)
  - PLAN FOR MULTI-AGENCY PROGRAMS

Office of Aeronautics and Space Technology

91-8065

INTEGRATED TECHNOLOGY PLAN FOR THE CIVIL SPACE PROGRAM

SPACE RESEARCH & TECHNOLOGY

RESEARCH & TECHNOLOGY BASE

DISCIPLINE RESEARCH
- Aerothermodynamics
- Space Energy Conversion
- Propulsion
- Materials & Structures
- Information and Controls
- Human Support
- Space Communications

UNIVERSITY PROGRAMS

SPACE FLIGHT R&T

IN SPACE TECHNOLOGY EXPTS

SYSTEMS ANALYSIS

CIVIL SPACE TECHNOLOGY INITIATIVE

SPACE SCIENCE TECHNOLOGY
- Science Sensing
- Observatory Systems
- Science Information
- In Situ Science
- Technology Flight Expts.

PLANETARY SURFACE TECHNOLOGY
- Surface Systems
- Human Support
- Technology Flight Expts.

TRANSPORTATION TECHNOLOGY
- ETO Transportation
- Space Transportation
- Technology Flight Expts.

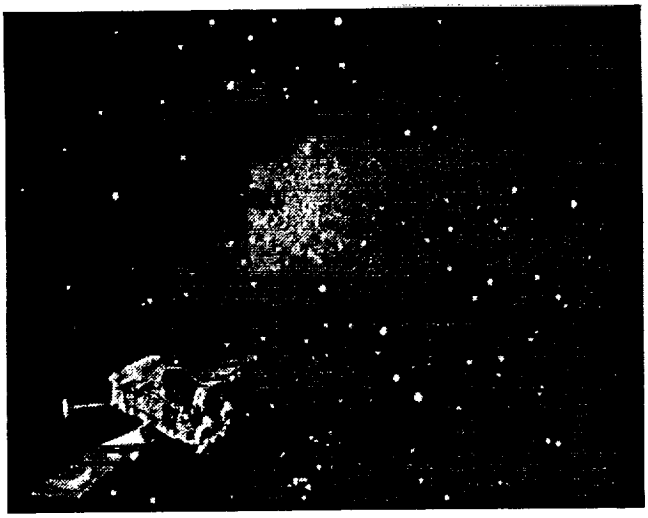
SPACE PLATFORMS TECHNOLOGY
- Earth-Orbiting Platforms
- Space Stations
- Deep-Space Platforms
- Technology Flight Expts.

OPERATIONS TECHNOLOGY
- Automation & Robotics
- Infrastructure Operations
- Info. & Communications
- Technology Flight Expts.

LBF403

SCIENCE TECHNOLOGY

DEVELOP ADVANCED INSTRUMENT, OBSERVATION, INFORMATION, AND IN SITU MEASUREMENT TECHNOLOGIES TO MAXIMIZE THE RETURN FROM NASA SPACE AND EARTH SCIENCE MISSIONS OVER THE NEXT TWENTY YEARS



- **EXPAND CAPABILITY AND REDUCE COSTS THROUGH DISCIPLINARY ADVANCEMENTS WHICH INCREASE SCIENCE INFORMATION RETURN AND SPACECRAFT PERFORMANCE**
  - **INSTRUMENT**
  - **OBSERVATION**
  - **DATA & INFORMATION**
  - **IN SITU MEASUREMENT**
- **ENABLE THE NEXT GENERATION OF SPACE SCIENCE MISSIONS**
  - **ASTROPHYSICS**
  - **SOLAR SYSTEM EXPLORATION**
  - **SPACE PHYSICS**
  - **EARTH SCIENCE**
  - **LIFE SCIENCES/MICROGRAVITY**

91-8046

Office of Aeronautics and Space Technology

SCIENCE TECHNOLOGY

INSTRUMENT

- IR Detectors
- Active Microwave
- Optoelectronics
- Submillimeter Detectors
- High Energy Detectors
- Passive Microwave
- Laser Sensors
- Sensor Readouts

OBSERVATION

- Cryocoolers
- Micro Precision CSI
- Precision Pointing
- Telescope Systems
- Sensor Optics

IN SITU MEASUREMENT

- Sample Acquisition, Analysis, and Preservation
- Probes and Penetrators

DATA & INFORMATION

- Data Archives
- Information Visualization

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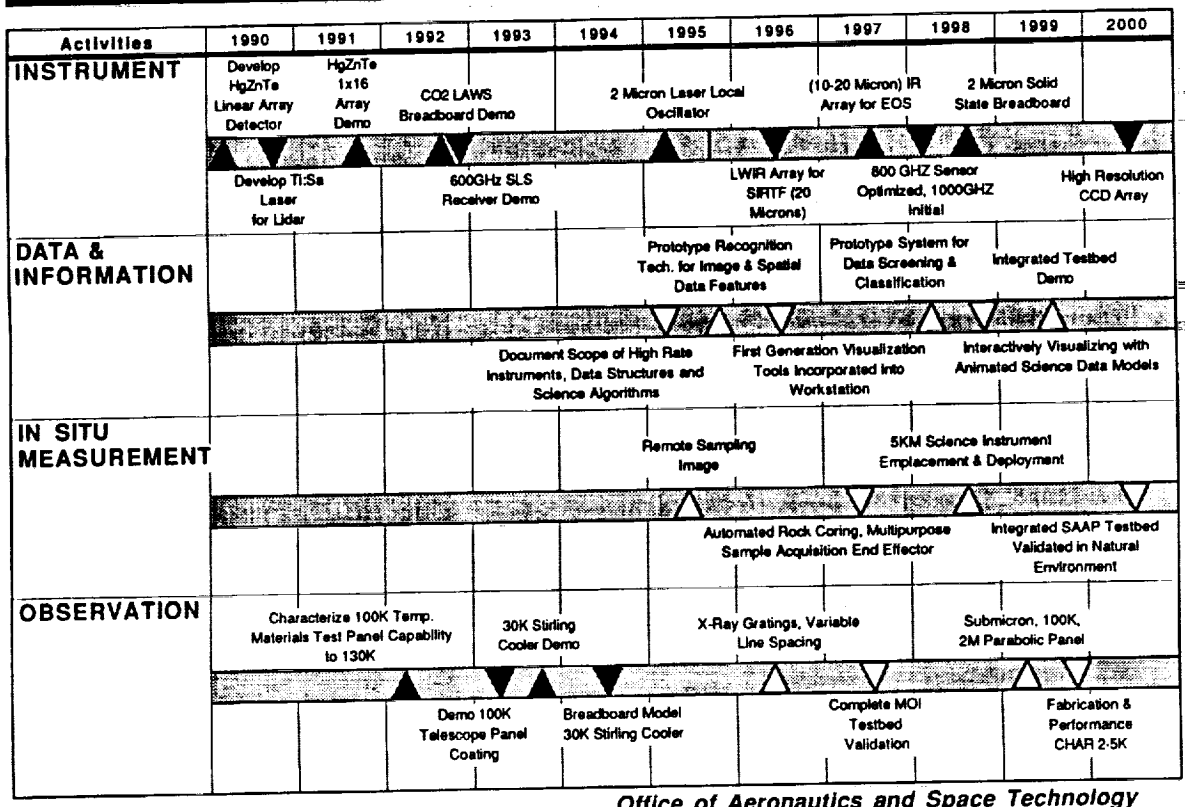
91-8047

SPACE SCIENCE MILESTONES



▲ Indicates Funded
△ Indicates NonFunded

Office of Aeronautics and Space Technology

PLANETARY SURFACE TECHNOLOGY

PROVIDE KEY TECHNOLOGIES FOR ROBOTIC AND MANNED PLANETARY SURFACE EXPLORATION SYSTEMS INCLUDING CAPABILITIES FOR AN OUTPOST ON THE MOON AND EXPLORATION OF THE PLANET MARS

- **INCREASE RELIABILITY AND REDUCE RISK; REDUCE DEVELOPMENT AND OPERATIONS COST; AND ENABLE NEW AND INNOVATIVE CAPABILITIES IN THE AREAS OF:**
  - **ADVANCED SURFACE SYSTEM OPERATIONS ON THE MOON AND MARS**
  - **TECHNOLOGIES FOR HUMAN SUPPORT DURING VERY LONG DURATION PILOTED MISSIONS IN DEEP-SPACE AND ON PLANETARY SURFACES**

PLANETARY SURFACE TECHNOLOGY

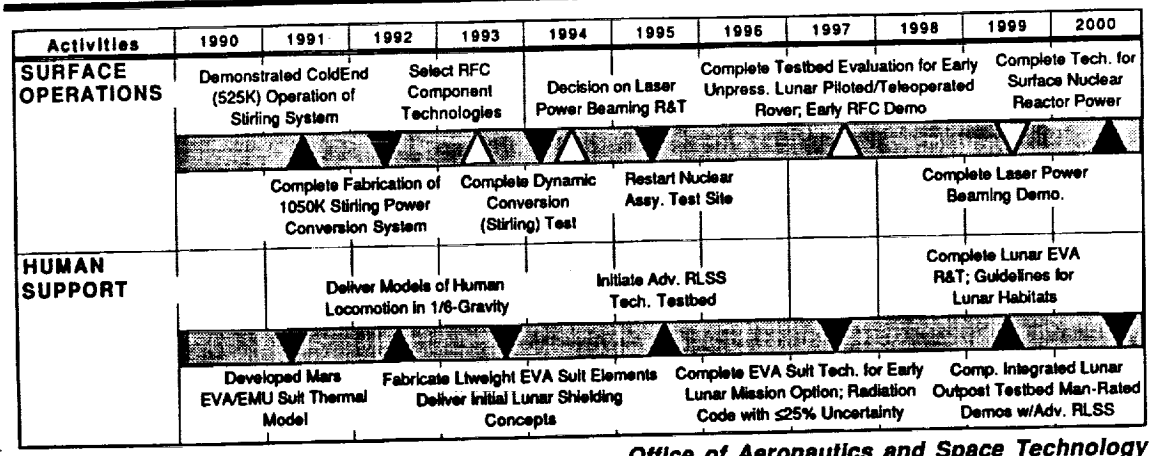
SURFACE SYSTEMS

- Space Nuclear Power
- In Situ Resource Utilization
- Planetary Rover
- High Capacity Power
- Surface Power and Thermal Management
- Surface Habitats & Construction
- Laser-Electric Power Beaming

HUMAN SUPPORT

- Regenerative Life Support
- Radiation Protection
- Extravehicular Activity Systems
- Exploration Human Factors
- Artificial Gravity
- Remote Medical Care Systems

PLANETARY SURFACE MILESTONES



▲ Indicates Funded
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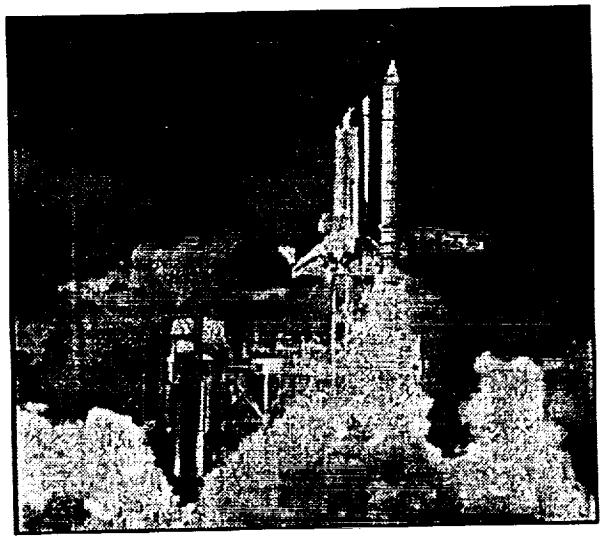
Office of Aeronautics and Space Technology

TRANSPORTATION TECHNOLOGY

PROVIDE TECHNOLOGIES THAT SUBSTANTIALLY INCREASE OPERABILITY, IMPROVE RELIABILITY, PROVIDE NEW CAPABILITIES, WHILE REDUCING LIFE CYCLE COSTS



- ENHANCE SAFETY, RELIABILITY, AND SERVICEABILITY OF CURRENT SPACE SHUTTLE
- PROVIDE TECHNOLOGY OPTIONS FOR NEW MANNED SYSTEMS THAT COMPLEMENT THE SHUTTLE AND ENABLE NEXT GENERATION VEHICLES WITH RAPID TURNAROUND AND LOW OPERATIONAL COSTS
- SUPPORT DEVELOPMENT OF ROBUST, LOW-COST HEAVY LIFT LAUNCH VEHICLES
- DEVELOP AND TRANSFER LOW-COST TECHNOLOGY TO SUPPORT COMMERCIAL ELV's AND UPPER STAGES
- IDENTIFY AND DEVELOP HIGH LEVERAGE TECHNOLOGIES FOR IN-SPACE TRANSPORTATION, INCLUDING NUCLEAR PROPULSION, THAT WILL ENABLE NEW CLASSES OF SCIENCE AND EXPLORATION MISSIONS

Office of Aeronautics and Space Technolog

TRANSPORTATION TECHNOLOGY

SHUTTLE ENHANCEMENT

- SSME Improvements
- Durable Thermal Protection Systems
- Improved Health Monitoring
- Light Structural Alloys
- Lidar-Based Adaptive Guidance & Control

NEXT GENERATION MANNED TRANSPORTS

- Configuration Assessment
- High Frequency, High Voltage Power Management/Distribution Systems
- LOX/LH2 Propellant for OMS/RCS
- Maintenance-free TPS
- Advanced Reusable Propulsion
- GPS-Based Autonomous GN&C
- Composites & Advanced Lightweight Metals
- Vehicle-Level Health Management For Autonomous Operations

HEAVY-LIFT CAPABILITY

- Advanced Fabrication (Forming & Joining)
- STME Improvements
- On-Vehicle Adaptive Guidance & Control
- Systems & Components for Electric Actuators
- Health Monitoring for Safe Operations
- AL-LI Cryo Tanks

LOW-COST COMMERCIAL

- Alternate Booster Concepts
- Advanced Cryogenic Upper Stage Engines
- Low-Cost Fab./Automated Processes/NDE
- Continuous Forging Processes for Cryogenic Tanks
- Fault-Tolerant, Redundant Avionics

IN-SPACE TRANSPORT

- High-Power Nuclear Thermal & Electric Propulsion
- High Performance, Multiple Use Cryogenic Chemical Engine
- Highly Reliable, Autonomous Avionics
- Low Mass, Space Durable Materials
- Long-Term, Low-Loss Management of Cryogenic Hydrogen
- Autonomous Rendezvous, Docking & Landing
- Aeroassist Technologies

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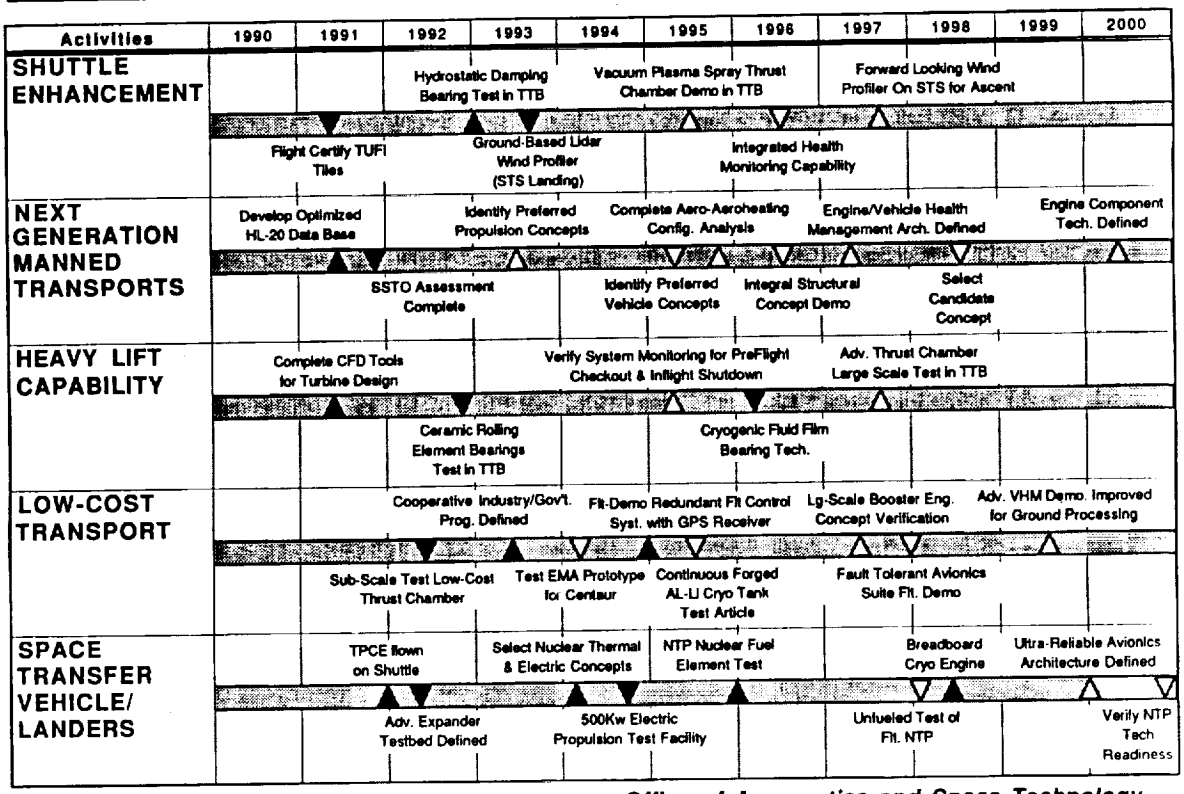
91-8066

TRANSPORTATION MILESTONES

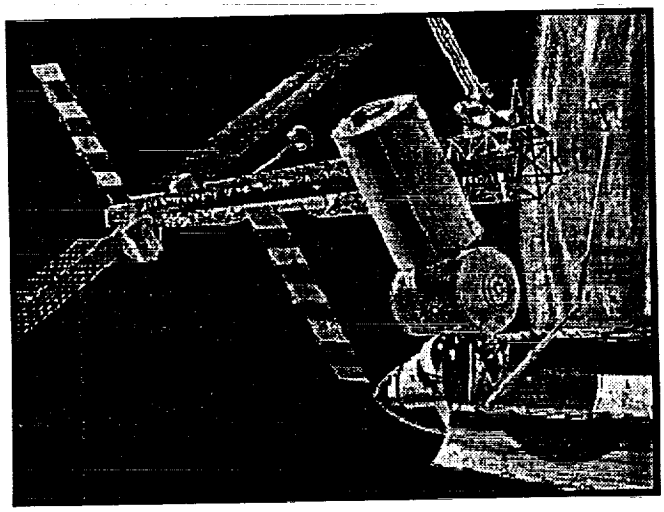


▲ Indicates Funded
△ Indicates NonFunded

Office of Aeronautics and Space Technology

SPACE PLATFORMS TECHNOLOGY

DEVELOP TECHNOLOGIES TO INCREASE ON-ORBIT MISSION EFFICIENCY AND DECREASE LIFE CYCLE COSTS FOR FUTURE MANNED AND UNMANNED SCIENCE, EXPLORATION & COMMERCIAL MISSIONS.



- DEVELOP TECHNOLOGIES THAT WILL DECREASE LAUNCH WEIGHT AND INCREASE THE EFFICIENCY OF SPACE PLATFORM FUNCTIONAL CAPABILITIES
- DEVELOP TECHNOLOGIES THAT WILL INCREASE HUMAN PRODUCTIVITY AND SAFETY OF MANNED MISSIONS
- DEVELOP TECHNOLOGIES THAT WILL INCREASE MAINTAINABILITY AND REDUCE LOGISTICS RESUPPLY OF LONG DURATION MISSIONS
- IDENTIFY AND DEVELOP FLIGHT EXPERIMENTS IN ALL TECHNOLOGY AND THRUST AREAS THAT WILL BENEFIT FROM THE UTILIZATION OF SSF FACILITIES

Office of Aeronautics and Space Technology

91-8052

SPACE PLATFORMS TECHNOLOGY

EARTH-ORBITING PLATFORMS

- Structural Dynamics
- On-Orbit Non-Destructive Evaluation Techniques
- Space Environmental Effects
- Power Systems
- Thermal Management
- Advanced Information Systems

SPACE STATIONS

- Regenerative Life Support
- Integrated Propulsion and Fluid Systems Architecture
- Extravehicular Mobility
- Telerobotics
- Artificial Intelligence

SPACE-BASED LABORATORY AND TESTBED

- Exploit Microgravity and Crew Interactive Capability to Advance and Validate Selected Technologies

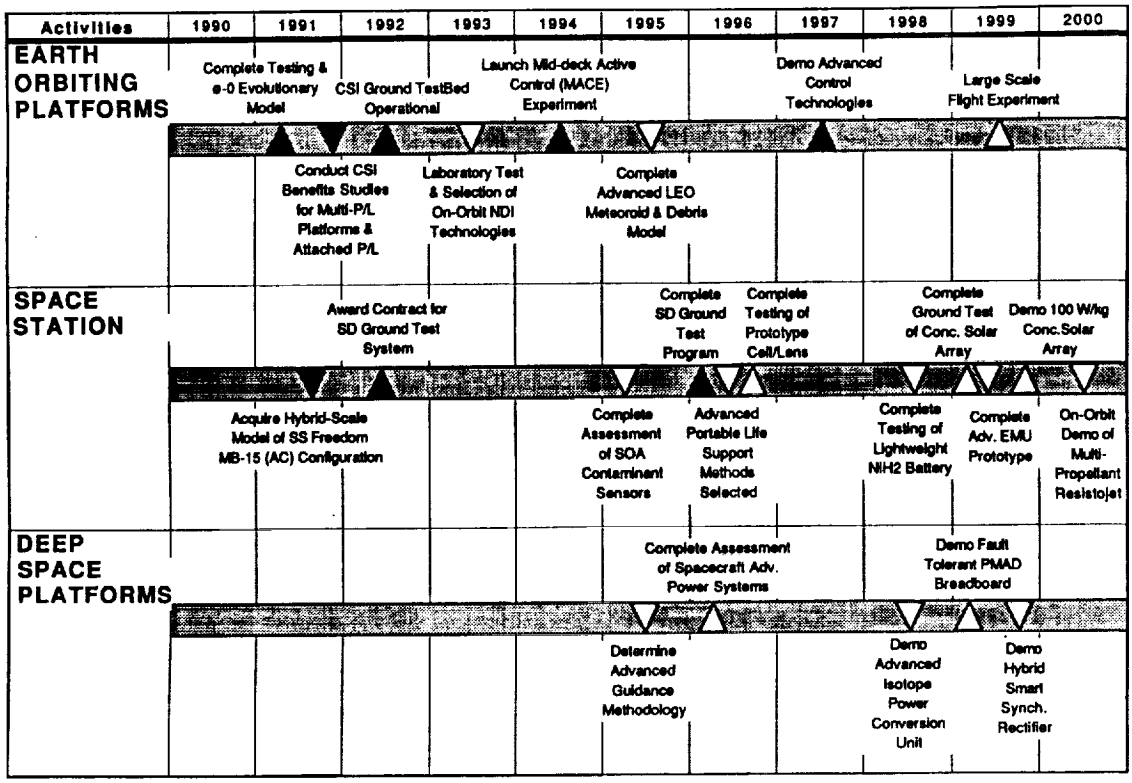
DEEP-SPACE MISSIONS

- Power and Thermal Management
- Propulsion
- Guidance, Navigation and Control

Office of Aeronautics and Space Technology

91-8053

SPACE PLATFORMS MILESTONES



▲ Indicates Funded
△ Indicates NonFunded

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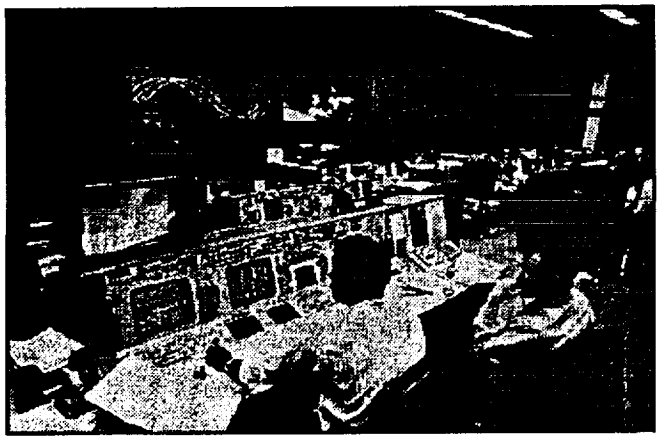
OPERATIONS TECHNOLOGY

DEVELOP AND DEMONSTRATE TECHNOLOGIES TO REDUCE THE COST OF NASA OPERATIONS, IMPROVE THE SAFETY AND RELIABILITY OF THOSE OPERATIONS, AND ENABLE NEW, MORE COMPLEX ACTIVITIES TO BE UNDERTAKEN



- THE OPERATIONS THRUST SUPPORTS THE FOLLOWING MAJOR ACTIVITIES:
  - IN-SPACE OPERATIONS
  - FLIGHT SUPPORT OPERATIONS
  - GROUND SERVICING AND PROCESSING
  - PLANETARY SURFACE OPERATIONS
  - COMMERCIAL COMMUNICATIONS
- THE FOLLOWING TECHNOLOGY AREAS ARE INCLUDED:
  - AUTOMATION & ROBOTICS
  - INFRASTRUCTURE OPERATIONS
  - INFORMATION & COMMUNICATIONS
  - FLIGHT EXPERIMENTS

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OPERATIONS TECHNOLOGY

AUTOMATION & ROBOTICS

- Mission Control Support
- Planning & Scheduling
- Ground Servicing & Support Roles
- In-Space Teleoperation & Telerobotics

INFRASTRUCTURE OPERATIONS

- In-Space Assembly & Construction
- Space Processing & Servicing
- Training & Human Factors
- Ground Test & Processing
- Flight Control & Space Operations

INFORMATION & COMMUNICATIONS

- Space Data Systems
- Ground Data Systems
- Commercial Satellite Communications
- Photonics Systems
- High Rate Communications

FLIGHT EXPERIMENTS

- Commercial Satellite Communications
- Optical Communications

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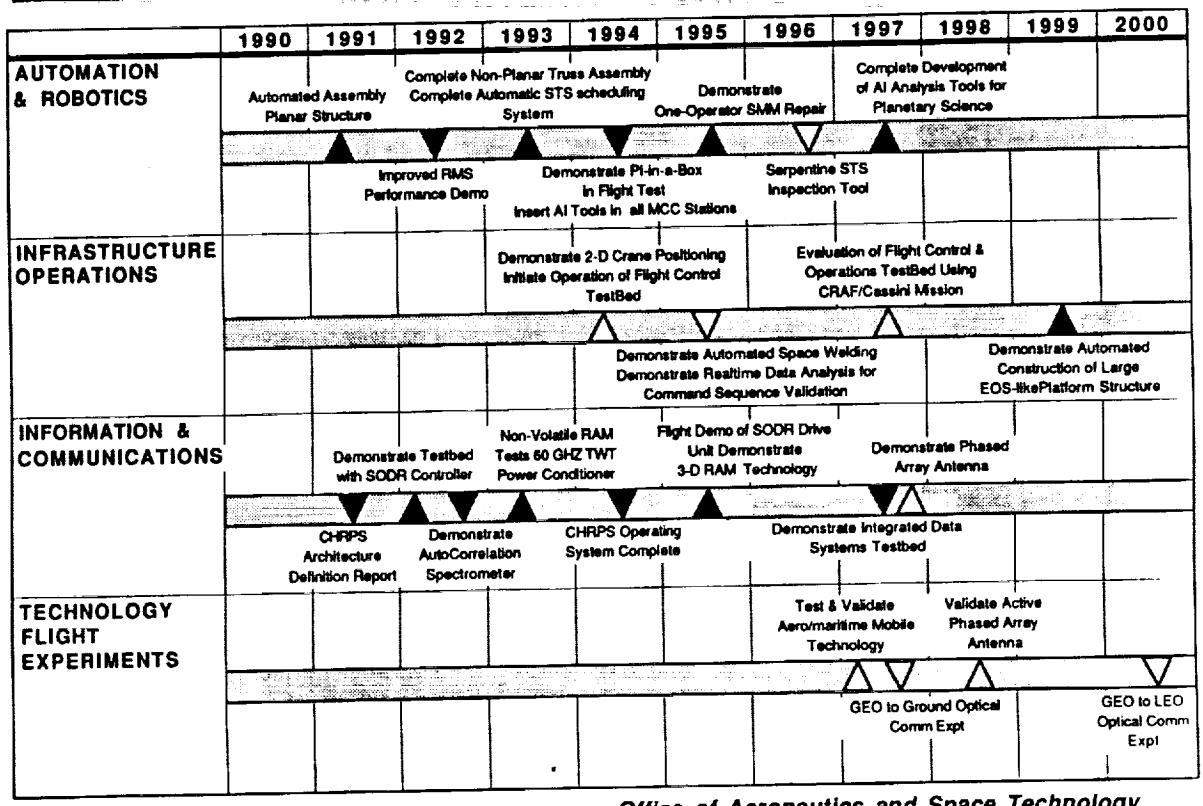
OPERATIONS MILESTONES



▲ Indicates Funded
△ Indicates NonFunded

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INTEGRATED TECHNOLOGY PLAN FOR THE CIVIL SPACE PROGRAM

Strategic Plan ITP: CSTI Element Categorization

OAST

	HIGHEST PRIORITY ◊◊◊			2nd-HIGHEST PRIORITY ◊◊			3rd-HIGHEST PRIORITY ◊		
Space Science Technology	Submillimeter Sensing	Direct Detectors	Active µwave Sensing	Sample Acq., Analysis & Preservation	Passive Microwave Sensing	----	Optoelectrncs Sensing & Processing	Probes and Penetrators	----
		Sensor Electronics	Laser Sensing						
	Cooler and Cryogenics	Microprecision CSI	Telescope Optical Systems	Data Archiving and Retrieval	Data Visualization and Analysis	----	Precision Instrument Pointing	Sensor Optical Systems	----
Planetary Surface Technology	Radiation Protection	Regenerative Life Support (Phys-Chem.)	Space Nuclear Power (SP-100)	High Capacity Power	Planetary Rovers	Surface Habitats and Construction	Exploration Human Factors	----	Artifical Gravity
	----	----	Extravehicular Activity Systems	Surface Solar Power and Thermal Mgt.	In Situ Resource Utilization	Laser-Electric Power Beaming	Medical Support Systems	----	----
Transportation Technology	ETO Propulsion	Nuclear Thermal Prop.	Aeroassist/ Aerobraking	Transfer Vehicle Avionics	ETO Vehicle Avionics	ETO Vehicle Structures & Materials	Autonomous Rendezvous & Docking	COHE	Auxiliary Propulsion
		Aeroassist Flight Expt							
	Cryogenic Fluid Systems	Advanced Cryo. Engines	Low-Cost ETO Transport	Nuclear Electric Propulsion	CONE	----	Autonomous Landing	TV Structures and Cryo Tankage	HEAb
Space Platforms Technology	Platform Structures & Dynamics	Platform Power and Thermal Mgt.	Zero-G Life Support	Platform Materials & Environ. Effects	Station-Keeping Propulsion	----	Spacecraft On-Board Propulsion	Earth-Orbiting Platform Controls	Advanced Refrigerator Systems
	----	----	Zero-G Advanced EMU	Platform NDE-NDI	Deep-Space Power and Thermal	----	Spacecraft GN&C	Debris Mapping Experiment	----
Operations Technology	Space Data Systems	High-Rate Comm.	Artificial Intelligence	Ground Data Systems	Optical Comm Flight Expt	Flight Control and Operations	Space Assembly & Construction	Space Processing & Servicing	Photonics Data Systems
					Flt. Telerobotic Servicer/DTF-1				
	----	CommSat Communicat'ns	TeleRobotics	Operator Syst./Training	Navigation & Guidance	CommSat Communicat'ns Flight Expts	----	Ground Test and Processing	----

LBF40343 FIII

INTEGRATED TECHNOLOGY PLAN FOR THE CIVIL SPACE PROGRAM

FY 1992 Program ITP: CSTI Element Categorization

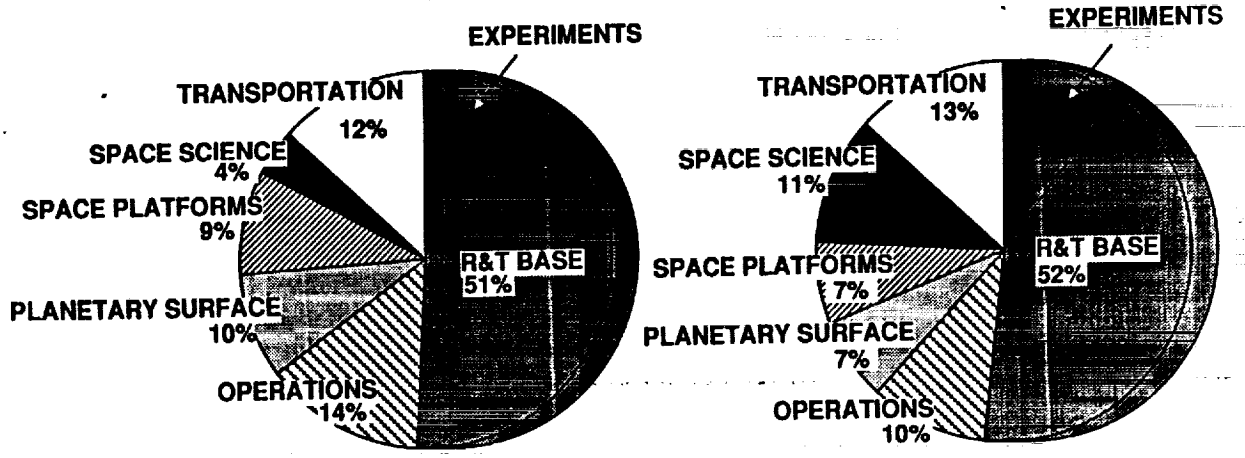
OAST

	HIGHEST PRIORITY ◊◊◊			2nd-HIGHEST PRIORITY ◊◊			3rd-HIGHEST PRIORITY ◊		
Space Science Technology	Submillimeter Sensing	Direct Detectors	Laser Sensing	---	---	---	---	---	---
	Cooler and Cryogenics	Microprecision CSI	---	---	---	---	---	---	---
Planetary Surface Technology	Radiation Protection	Regenerative Life Support (Phys-Chem.)	Space Nuclear Power (SP-100)	High Capacity Power	---	---	---	---	---
	---	---	Extravehicular Activity Systems	---	---	Laser Electric Power Beaming	---	---	---
Transportation Technology	ETO Propulsion	---	---	---	---	---	---	---	---
	---	Advanced Cryogenic Engines	Nuclear Thermal Propulsion	Nuclear Electric Propulsion	---	---	---	---	---
Space Platforms Technology	Platform Structures & Dynamics	Platform Power & Thermal Mgt.	---	---	---	---	---	---	---
	---	---	---	---	---	---	---	---	---
Operations Technology	Space Data Systems	---	Artificial Intelligence	---	---	---	---	---	---
	---	---	TeleRobotics	---	---	---	---	---	---

LBF403

SPACE RESEARCH & TECHNOLOGY PROGRAM

OAST



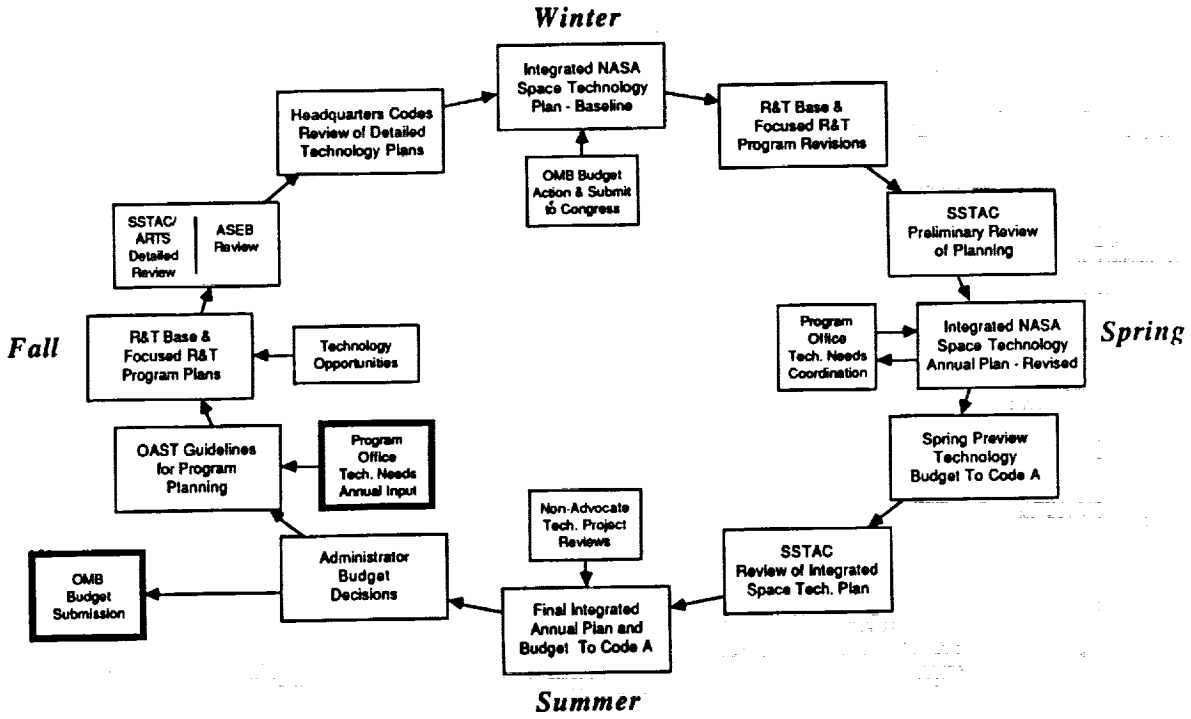
FY 1992
$309.3M

FY 1993
$332.0M

LBF 404

SPACE TECHNOLOGY PLANNING CYCLE

OAST



March 25, 1991
JCM:7207b

FY1991 SPACE TECHNOLOGY ACCOMPLISHMENTS

OAST

SCIENCE

HgZnTe 1x270 ARRAY
SILICON-COMPATIBLE INFRARED SENSORS
GeBIB DETECTOR ARRAYS
SIS MIXER ELEMENTS
2-MICRON LASER FOR LIDAR
MICRODYNAMIC COMPONENT TESTER
AOTF-BASED IMAGING SPECTROMETER

OPERATIONS

AUTOMATED ASSEMBLY OF SPACE STRUCTURES
ADVANCED TELEOPERATION
AUTONOMOUS MOBILE EXPLORATION ROBOT
MINI-ROVER TECHNOLOGY
ASTRONAUT SCIENCE ADVISOR
AUTOCLASS IV
REAL-TIME DATA SYSTEM
SPACECRAFT HEALTH AUTOMATED REASONING PROTOTYPE
SCIENTIFIC ANALYSIS ASSISTANT
LOSSLESS DATA COMPRESSOR
IMAGING SPECTROMETER FLIGHT PROCESSOR
HIGH SPEED FIBER OPTIC TRANSCEIVER
DIGITAL AUTOCORRELATOR SPECTROMETER
SPACEFLIGHT OPTICAL DISK RECORDER
INTELLIGENT DATA MANAGEMENT

PLANETARY SURFACE

STIRLING COLD END MOTORING TEST
REGENERATIVE LIFE SUPPORT

TRANSPORTATION

NEW CFD TOOLS FOR TURBINE BLADE DESIGN
NEW TECHNOLOGY MAIN COMPUSTION CHAMBER
HIGH-ASPECT-RATIO COOLING CHANNEL DESIGNS
LOW COST THRUST CHAMBER CRITICAL TEST
CERAMIC COMPOSITE ENGINE PARTS
CERAMIC BALLS FOR LONG-LIFE BALL BEARINGS

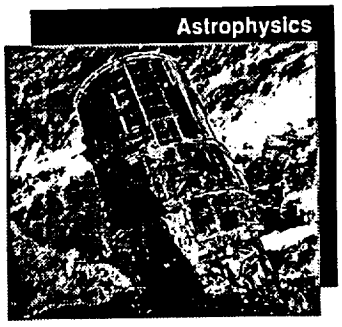
SPACE PLATFORMS

CONTROLS-STRUCTURES INTERACTION
HYBRID-SCALE MODEL OF SSF CONFIGURATION
SIMULATED EVA ASSEMBLY OF TRUSS STRUCTURE AND PANELS

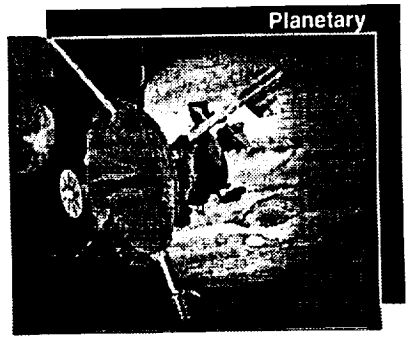
RESEARCH & TECHNOLOGY BASE

PERSONNEL LAUNCH SYSTEM BENCHMARK STUDY
OPTIMIZED PLS HL-20 DATABASE
PLS APPROACH & LANDING SIMULATION STUDY
CERAMIC MATRIX COMPOSITES
WIND TUNNEL AIR FLOW DENSITY MEASUREMENTS
MAGELLAN AEROBRAKE MANEUVER GAS FLOW PREDICTIONS
ADVANCED CONCENTRATOR PHOTOVOLTAIC SYSTEM
ADVANCED PHOTOVOLTAIC SOLAR ARRAY
HOT ROCKET TECHNOLOGY
HIGH POWER ELECTRIC PROPULSION
FOIL BEARING TECHNOLOGY
BRUSH SEAL TECHNOLOGY
MOLECULAR COMPUTATIONAL FLUID DYNAMICS
MULTILAYER INSULATION TECHNOLOGY
TOUGHENED UNI-PIECE FIBROUS INSULATION MATERIAL
ADAPTIVE UNSTRUCTURED MESHES
RADIATION RESISTANCE OF NOVEL TINJ-CONTAINING POLYIMIDE
LDEF SUMMARY
LDEF IONIZING RADIATION
LDEF METEROID AND DEBRIS
FIRST TERAHERTZ FOCAL PLANE ARRAY
MICRO-SENSOR FOR FLOW MEASUREMENTS
ORBITAL ACCELERATION RESEARCH EXPERIMENT
SHUTTLE INFRARED LEESIDE TEMPERATURE SENSING
MULTI-FLEXIBLE BODY DYNAMIC MODELING TOOLS
PHOTONIC DEVICES FOR PLANETARY LANDER
EVA EMU ELECTRONIC CUFF CHECKLIST
VIRTUAL ENVIRONMENT FACILITY

TECHNOLOGY CONTRIBUTIONS TO SCIENCE SPACECRAFT

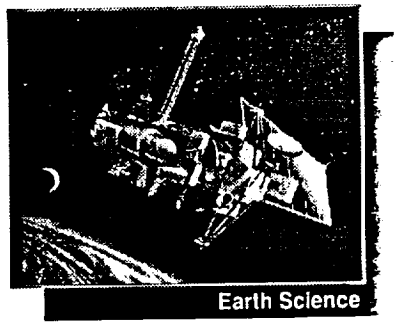


- Hubble - VLSI Data Processing
- Astro - Startracker
- Hubble - Battery Technology
- Hubble - Image Restoration



- Galileo (& Hubble) - CCD Array
- Voyager - Spacecraft Health Monitoring
- Magellan - Radar Ground Processor

- UARS - 205 GHz Limb Sounder Technology
- Shuttle Imaging Radar - SAR Technologies
- TOPEX - Millimeter Accuracy Laser Ranging



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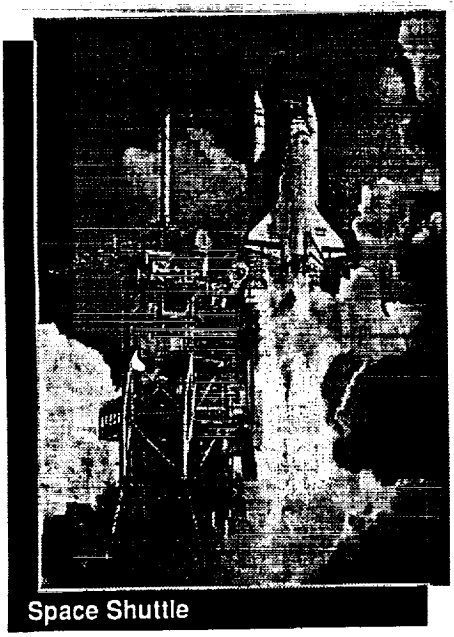
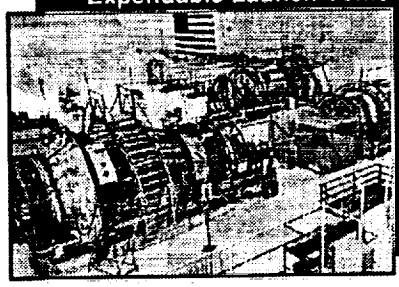
TECHNOLOGY CONTRIBUTIONS TO TRANSPORTATION


Space Shuttle

- Structural Analysis for Solid Rocket Motor (SRM) Redesign
- Vacuum Plasma Spray Coatings & Chambers
- Health Monitoring (Test Facilities)
- Thermal Protection System
- Bearing Cooling Analysis
- Real Time Data System
- Orbiter Experiments
- Damping Seals
- Modified Tires

Expendable Launch Vehicles



- Advanced Primary Battery

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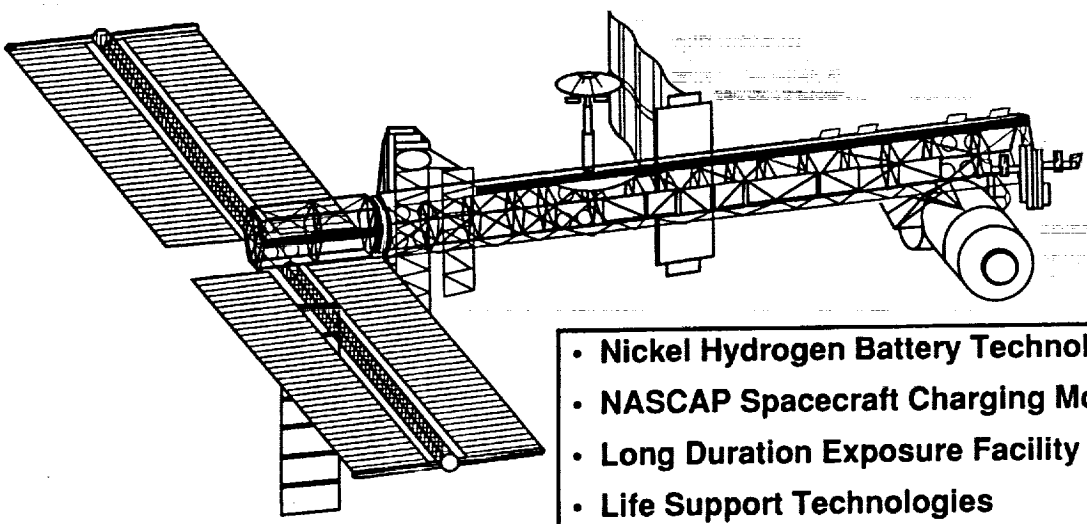
92-8023a

TECHNOLOGY CONTRIBUTIONS TO SPACE PLATFORMS



- Nickel Hydrogen Battery Technology
- NASCAP Spacecraft Charging Model
- Long Duration Exposure Facility
- Life Support Technologies
- Multipropellant Resistojet
- Large Area Solar Cells
- Arcjet Thruster

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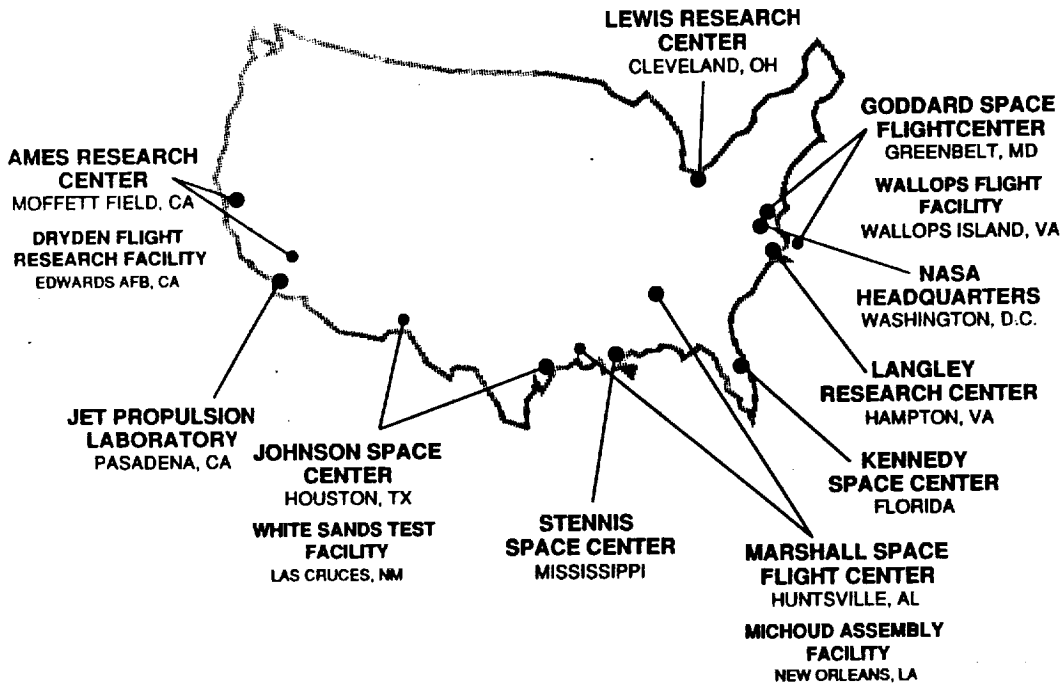
92-8024

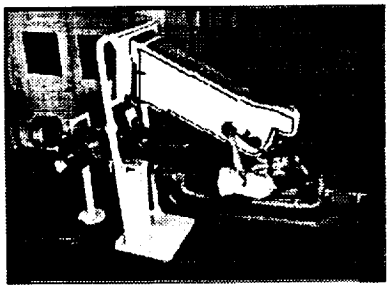
NASA INSTALLATIONS

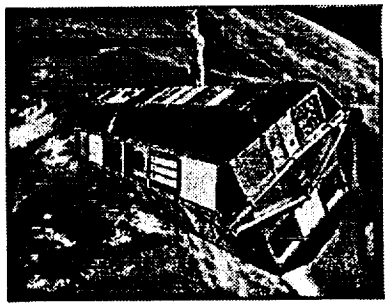


RESEARCH CENTERS

AMES

- Human Support
- Artificial Intelligence
- Aerothermodynamics
- Thermal Protection Systems
- Computer Science



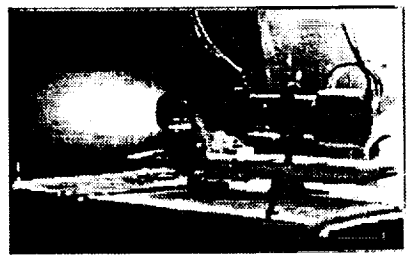


LANGLEY

- Large Space Systems
- Aerothermodynamics, Materials, Structures & Dynamics
- Remote Sensing
- Advanced Vehicle System Concept Studies
- Robotic Systems
- Space Data Systems
- Guidance, Navigation & Control

LEWIS

- Electric Propulsion
- Thermal Management
- Chemical Propulsion
- CryoFluid Systems
- Communications Systems
- Nuclear Propulsion
- Space Power Systems



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SPACE SCIENCE CENTERS

JET PROPULSION LABORATORY

- Autonomous Systems & Robotics
- Guidance, Navigation & Control
- Sensors
- Space Data & Information Systems
- Optical Systems
- Advanced Propulsion

GODDARD

- Sensors
- Space Data Systems
- Laser Communications
- Telerobotics

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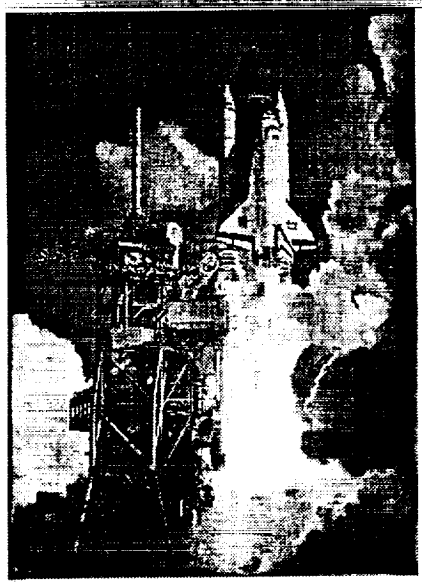
SPACE FLIGHT CENTERS

KENNEDY

- Telerobotics
- Artificial Intelligence

MARSHALL

- Chemical Propulsion
- Structures, Materials & Dynamics
- CryoFluid Systems
- Space Power Systems
- Controls & Avionics



STENNIS

- Chemical Propulsion
- Vehicle Health Monitoring

JOHNSON

- Human Support
- Thermal Management
- Controls & Avionics
- Mission Operations
- InSitu Resource Utilization/Surface Systems

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