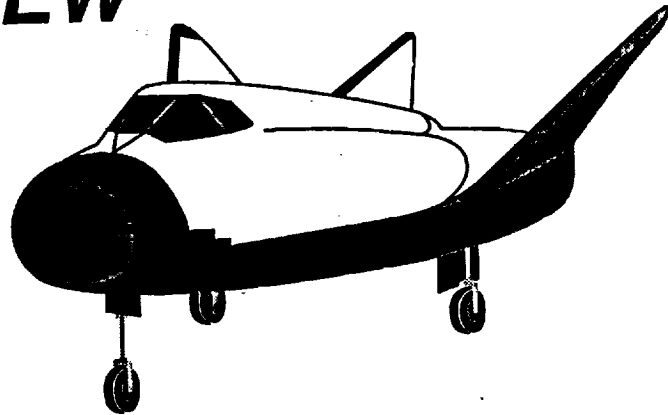


SPACE R&T OVERVIEW



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

OAST

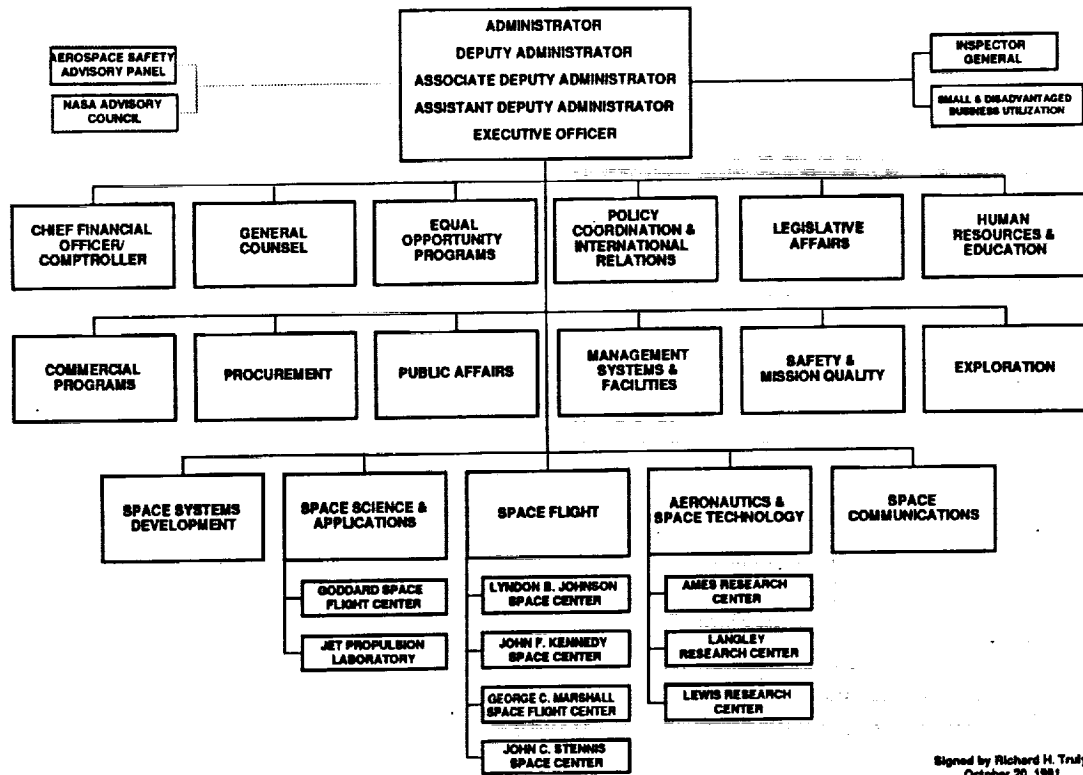
March 1992

SPACE RESEARCH & TECHNOLOGY OVERVIEW

OAST

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

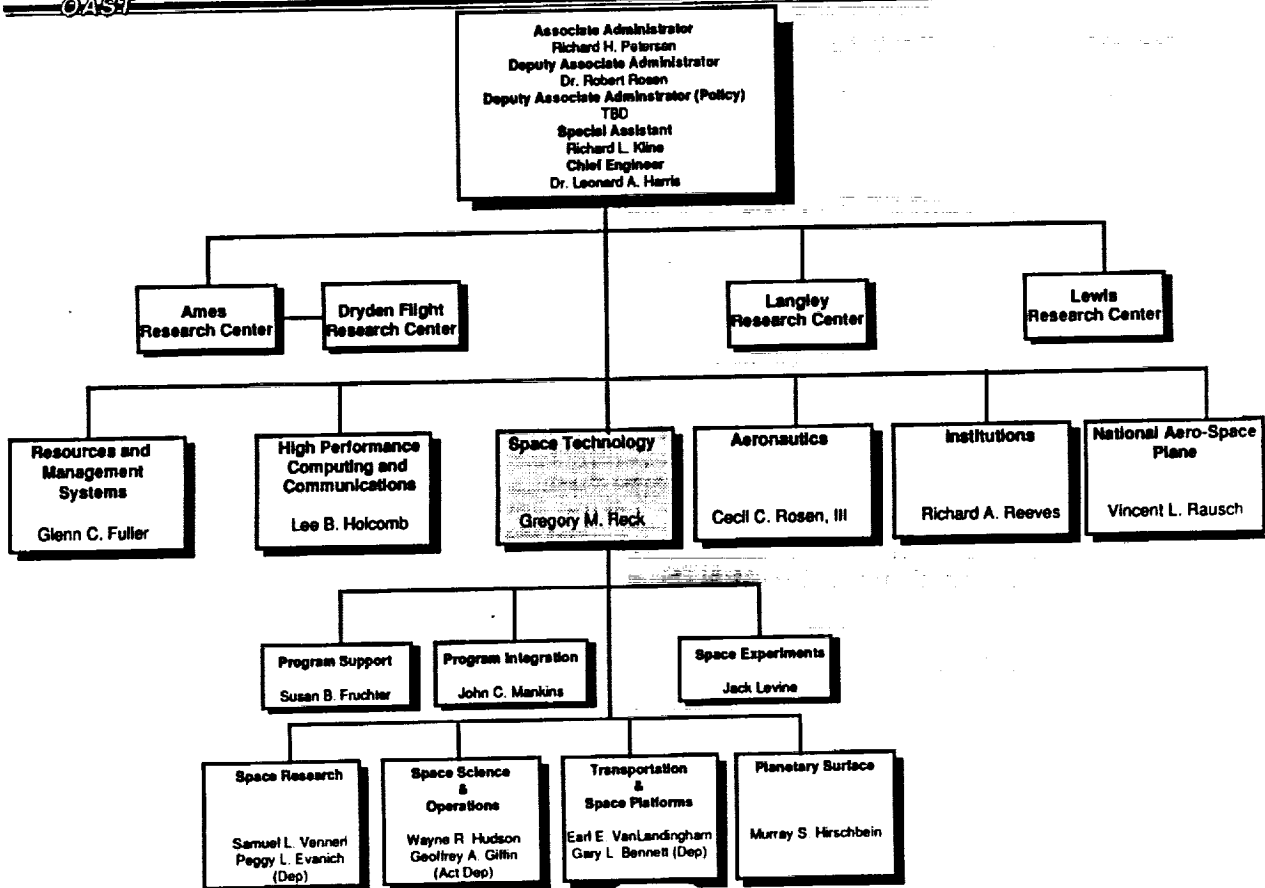
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION



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

● **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

FLIGHT PROGRAMS FORECAST

● **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

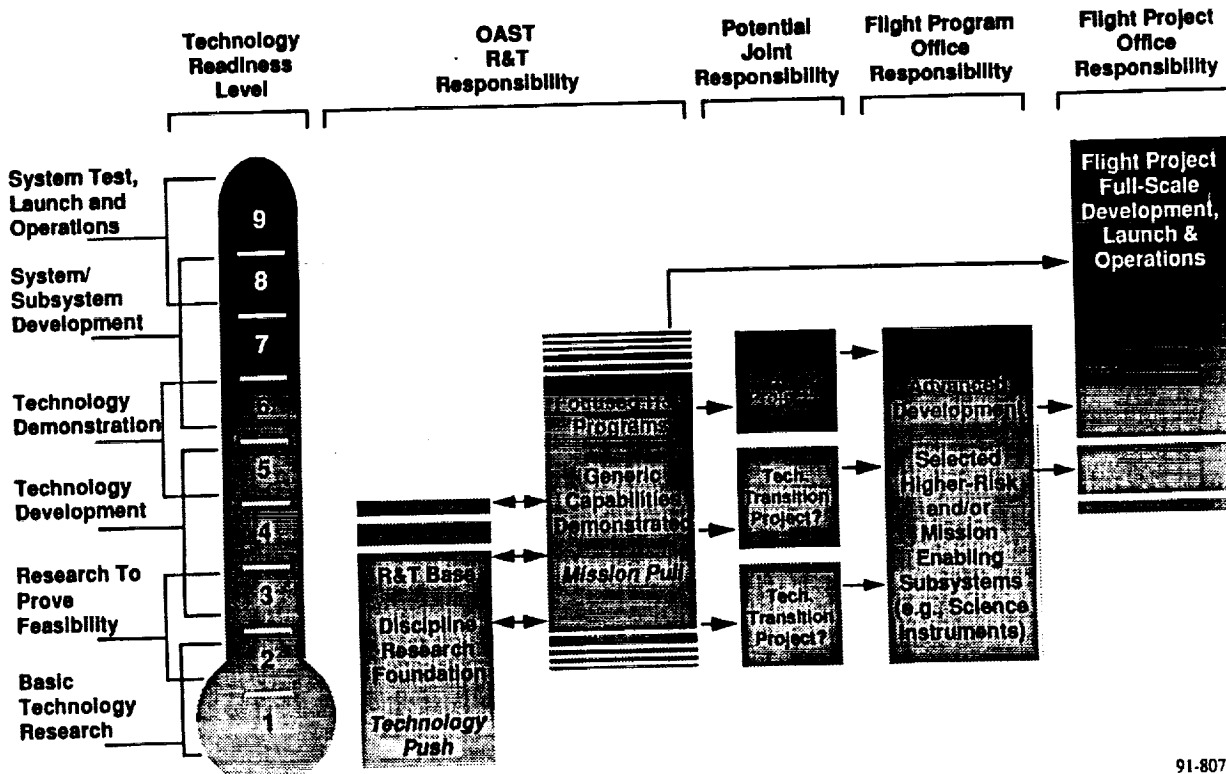
● **20-YEAR FORECAST INCLUDES**

'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

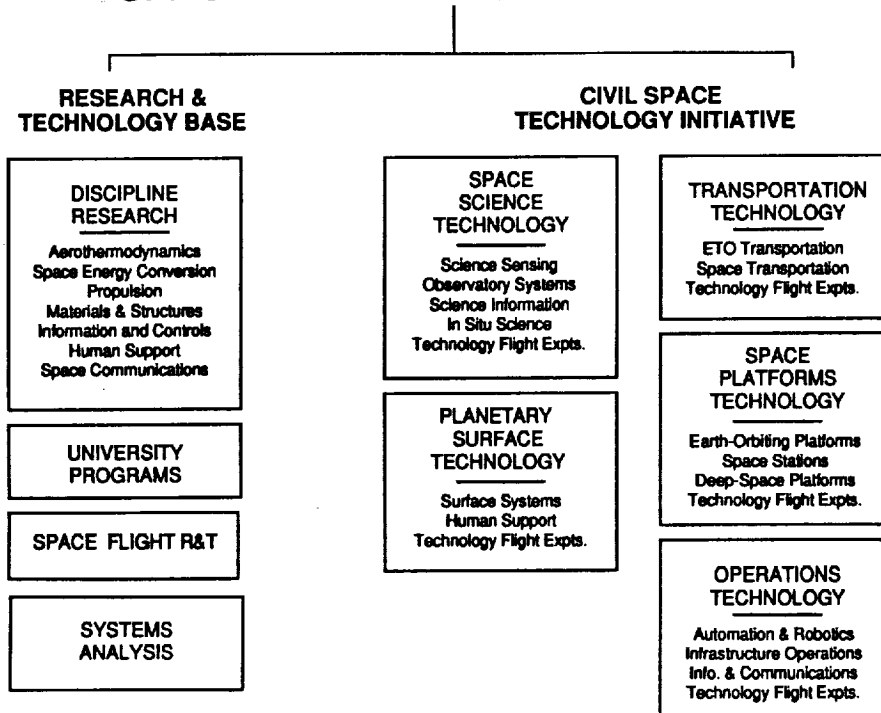
OAST



91-8079c

INTEGRATED TECHNOLOGY PLAN FOR THE CIVIL SPACE PROGRAM

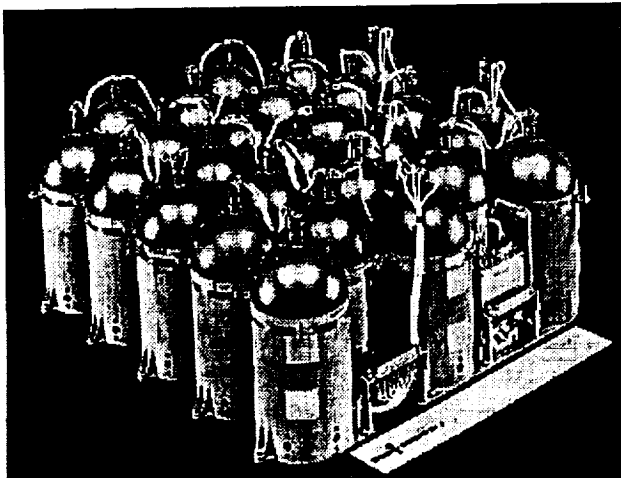
SPACE RESEARCH & TECHNOLOGY



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

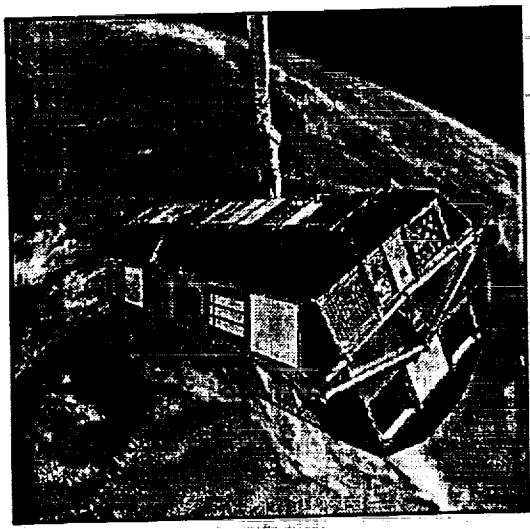
**INTEGRATED TECHNOLOGY PLAN FOR THE CIVIL SPACE PROGRAM
R&T Base Discipline Programs Content**

	BASE CAPABILITIES			ADVANCED TECHNOLOGIES			"BREAKTHROUGH" TECHNOLOGIES		
Aerothermodynamics	Hypersonic Flowfield Sim. Fundamental Data Bases	Hypersonic Vehicle Synth.	—	Fit. Environ. Instrument'n Aerothermo. Design Tools	Configuration Design/Optimiz.	—	—	—	—
Space Communications	Travelling Wave Tubes (TWTs) MMICs	—	—	KaBand TWT Solid State MMIC Systems	Digital Switching Processors Direct Broadcast (Audio)	Ground Terminals	—	Laser Comm. Components Mobile Comm. Systems (Personal)	—
Space Energy Conversion	Photovoltaic Perf. Validation Electrochemical Diagn./Models	Solar Dynamics Design/Analysis	—	Adv. Solar Cells (GaAs, In-P) Concentrators and Arrays	Adv. Batteries (Rechg/Life) Solar Dynamics Conv. Systems	Thermoelectric Conv. Systems Power Mgt. & Distribution	—	Laser Power Components Adv. Fuel Cells (LiCO2) Liquid Sheet Radiators	Alkal Metal T-E Conversion Diamond Film Pwr Electronics
Human Support	Extravehicular Activity Suit Human Modeling (Cogn./Physical)	—	—	EVA Gloves PLSS Components	EMU Components Interactive EVA Displays	Life Support Models Life Support Sensors/Cntrls	—	Visualization Research Virtual Reality Environments	AI Computer Associates
Information and Controls	Electro-optic Mat'ls/Sensors	—	—	Advanced AI Research	Computational Controls Software Develop. Tools	—	—	Micromachines Neural Networks High-Temp Superconductors	Multiple Interactive Robots
Materials and Structures	Materials Synthesis High Temp. TPS	Space Durable Materials Advanced Space Struct. Concepts	Sp. Environ. Effects (Mat'ls) Tribology	Optics Mechanisms Extreme TPS	High Precision Struct. Lg./Deployed Struct. Debris Shielding	Durable Polymers High Temp. Veh. Struct.	—	Intermetallics & Metal Matrix Computational Chemistry	Computational Materials "Smart" Materials
Propulsion	Combustion Models/Diagn. Engine Analysis Expert Systems	Internal Pump Flow CFD Cryo. Fluid Modeling	—	Ion Thrusters Hydrogen Arcjets MPD Thrusters	Water Resistojets Iridium-Rhenium Engine Liners	H-O Engines Propulsion Health Mgt.	—	High Energy Density Propell. Electrodeless Thrusters (ECR)	Laser Rocket Propulsion Fission/Fusion Propulsion Superconduct Bearings

NOVEMBER 13, 1987
JCM 680

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)**

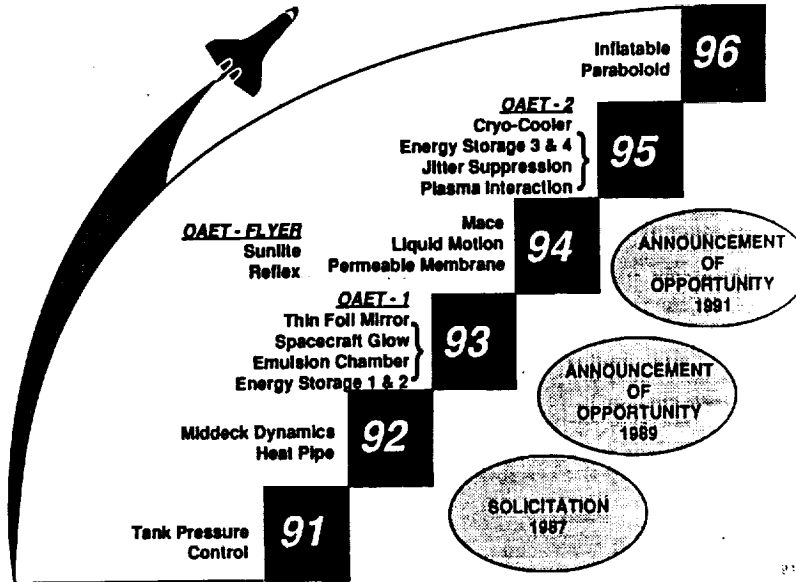
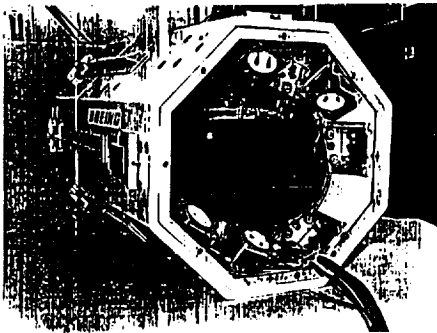
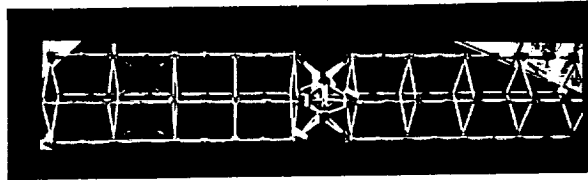
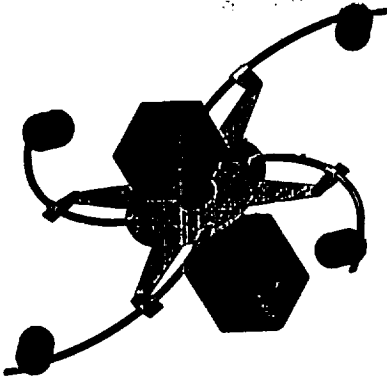
- DESIGN, DEVELOP AND FLIGHT TEST INDUSTRY, UNIVERSITY AND NASA TECHNOLOGY FLIGHT EXPERIMENTS

● **FLIGHT OPPORTUNITIES VIA**

- SPACE SHUTTLE
- EXPENDABLE LAUNCH VEHICLES
- SPACE STATION FREEDOM

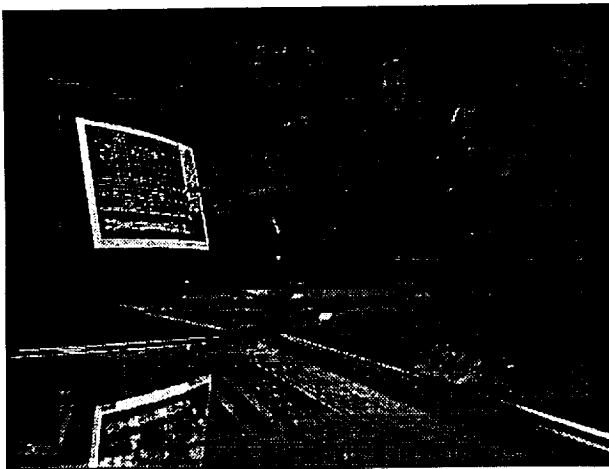
Office of Aeronautics and Space Technology

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

UNIVERSITY SPACE ENGINEERING RESEARCH PROGRAM



UNIVERSITY-BASED CENTERS

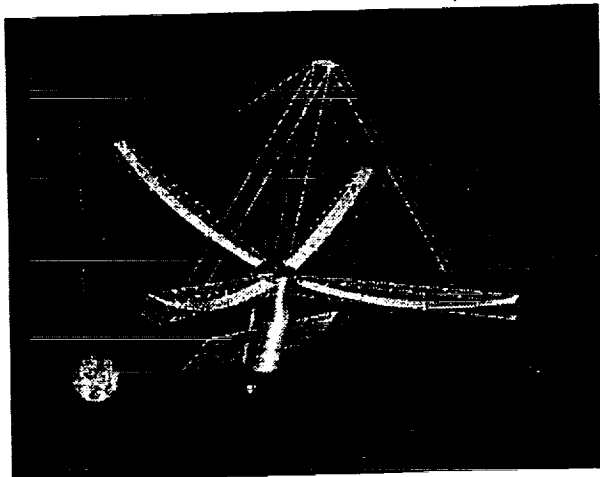
- ATTRACT AND RETAIN STUDENT AND INDUSTRY SUPPORT
- SUPPORT AND EXPAND THE NATION'S ENGINEERING TALENT BASE
- FOSTER INNOVATIVE, MULTI-DISCIPLINARY RESEARCH

91-2118

- 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

SYSTEMS ANALYSIS

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



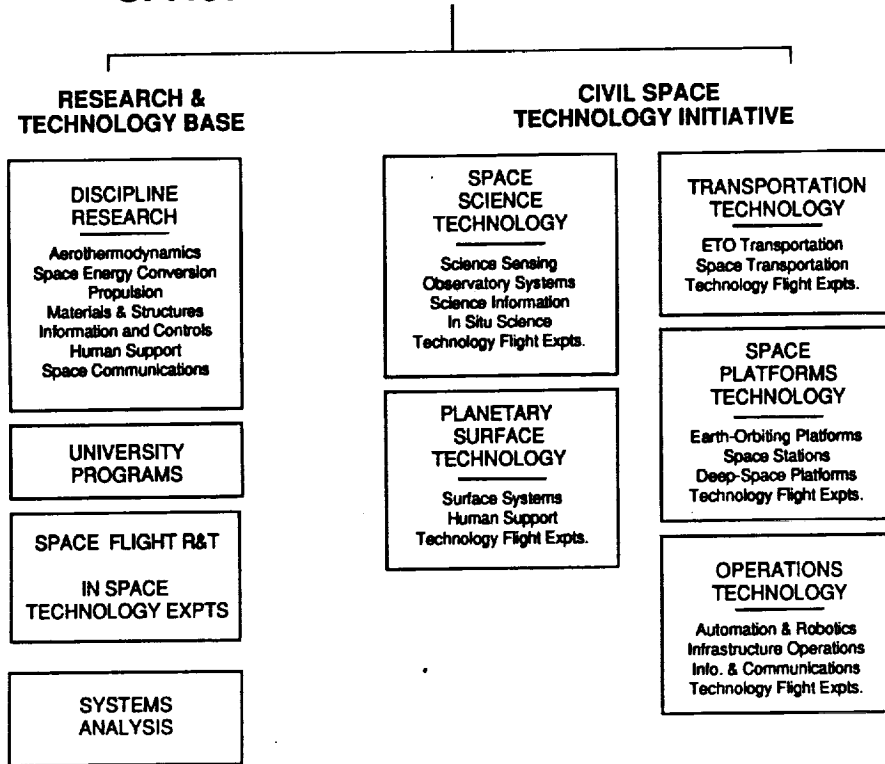
- FOCUSED PROGRAMS
 - IDENTIFY CRITICAL TECHNOLOGY ISSUES OF FUTURE MISSION CONCEPTS
 - TRANSPORTATION
 - SPACE SCIENCE
 - SPACE PLATFORMS
 - SPACE EXPLORATION
 - OPERATIONS
- BREAKTHROUGH
 - IDENTIFY BENEFITS OF HIGHLY INNOVATIVE SPACE TECHNOLOGY IDEAS AND SPACE APPLICATIONS OF NEW TECHNOLOGY FRONTIERS
- 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



LBF40316

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

SCIENCE TECHNOLOGY

INSTRUMENT

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

OBSERVATION

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

IN SITU MEASUREMENT

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

DATA & INFORMATION

- Data Archives
- Information Visualization

Office of Aeronautics and Space Technology

91-8047

SPACE SCIENCE MILESTONES

Activities	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
INSTRUMENT	Develop HgZnTe Linear Array Detector	HgZnTe 1x16 Array Demo	CO2 LAWS Breadboard Demo		2 Micron Laser Local Oscillator			(10-20 Micron) IR Array for EOS	2 Micron Solid State Breadboard		
	Develop Ti:Sa Laser for Lidar		600GHz SLS Receiver Demo				LWIR Array for SIFTF (20 Microns)	800 GHz Sensor Optimized, 1000GHZ Initial		High Resolution CCD Array	
DATA & INFORMATION						Prototype Recognition Tech. for Image & Spatial Data Features	Prototype System for Data Screening & Classification		Integrated Testbed Demo		
					Document Scope of High Rate Instruments, Data Structures and Science Algorithms		First Generation Visualization Tools Incorporated into Workstation		Interactively Visualizing with Animated Science Data Models		
IN SITU MEASUREMENT						Remote Sampling Image			5KM Science Instrument Emplacement & Deployment		
							Automated Rock Coring, Multipurpose Sample Acquisition End Effector		Integrated SAAP Testbed Validated in Natural Environment		
OBSERVATION	Characterize 100K Temp. Materials Test Panel Capability to 130K			30K Stirling Cooler Demo			X-Ray Gratings, Variable Line Spacing		Submicron, 100K, 2M Parabolic Panel		
			Demo 100K Telescope Panel Coating	30K Stirling Cooler	Breadboard Model			Complete MOI Testbed Validation		Fabrication & Performance CHAR 2-5K	

▲ 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

91-8050A
rev 8/23/91

Office of Aeronautics and Space Technology

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

91-8051
rev 8/23/91

Office of Aeronautics and Space Technology

PLANETARY SURFACE MILESTONES

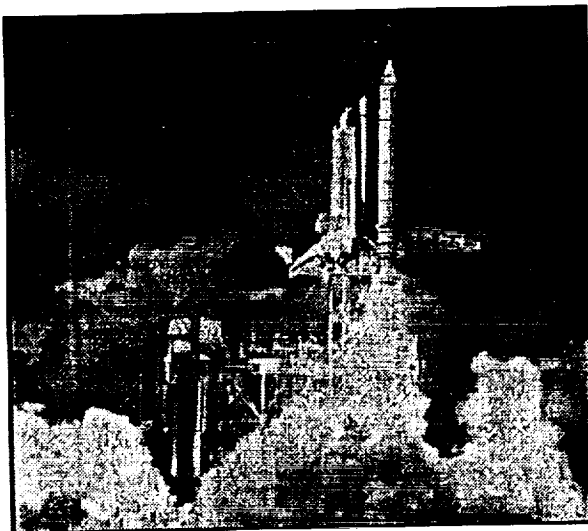
Activities	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
SURFACE OPERATIONS	Demonstrated ColdEnd (525K) Operation of Stirling System		Select RFC Component Technologies		Decision on Laser Power Beaming R&T		Complete Testbed Evaluation for Early Unpress. Lunar Piloted/Teleoperated Rover; Early RFC Demo			Complete Tech. for Surface Nuclear Reactor Power	
	Complete Fabrication of 1050K Stirling Power Conversion System			Complete Dynamic Conversion (Stirling) Test		Restart Nuclear Assy. Test Site		Complete Laser Power Beaming Demo.			
HUMAN SUPPORT	Deliver Models of Human Locomotion in 1/6-Gravity				Initiate Adv. RLSS Tech. Testbed			Complete Lunar EVA R&T; Guidelines for Lunar Habitats			
	Developed Mars EVA/EMU Suit Thermal Model		Fabricate Lightweight EVA Suit Elements Deliver Initial Lunar Shielding Concepts			Complete EVA Suit Tech. for Early Lunar Mission Option; Radiation Code with $\leq 25\%$ Uncertainty			Comp. Integrated Lunar Outpost Testbed Man-Rated Demos w/Adv. RLSS		

- ▲ Indicates Funded
- △ Indicates NonFunded

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 Technology

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
- Aerassist Technologies

91-8066

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TRANSPORTATION MILESTONES

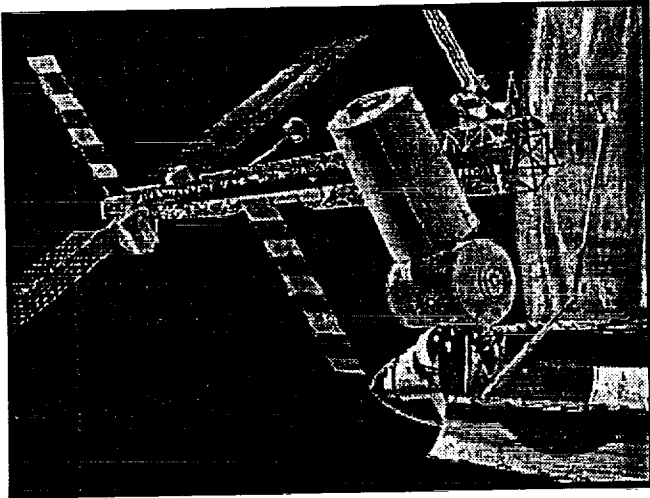
Activities	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
SHUTTLE ENHANCEMENT			Hydrostatic Damping Bearing Test in TTB		Vacuum Plasma Spray Thrust Chamber Demo in TTB			Forward Looking Wind Profiler On STS for Ascent			
		Flight Certify TUF1 Tiles		Ground-Based Lidar Wind Profiler (STS Landing)			Integrated Health Monitoring Capability				
NEXT GENERATION MANNED TRANSPORTS	Develop Optimized HL-20 Data Base		Identify Preferred Propulsion Concepts		Complete Aero-Aeroheating Config. Analysis		Engine/Vehicle Health Management Arch. Defined		Engine Component Tech. Defined		
			SSTO Assessment Complete		Identify Preferred Vehicle Concepts		Integral Structural Concept Demo		Select Candidate Concept		
HEAVY LIFT CAPABILITY	Complete CFD Tools for Turbine Design				Verify System Monitoring for PreFlight Checkout & Inflight Shutdown			Adv. Thrust Chamber Large Scale Test in TTB			
			Ceramic Rolling Element Bearings Test in TTB				Cryogenic Fluid Film Bearing Tech.				
LOW-COST TRANSPORT			Cooperative Industry/Gov't Prog. Defined		Flt-Demo Redundant Flt Control Syst. with GPS Receiver		Lg-Scale Booster Eng. Concept Verification		Adv. VHM Demo. Improved for Ground Processing		
		Sub-Scale Test Low-Cost Thrust Chamber		Test EMA Prototype for Centaur		Continuous Forged AL-LI Cryo Tank Test Article		Fault Tolerant Avionics Suite Flt. Demo			
SPACE TRANSFER VEHICLE/ LANDERS		TPCE flown on Shuttle		Select Nuclear Thermal & Electric Concepts		NTP Nuclear Fuel Element Test		Breadboard Cryo Engine		Ultra-Reliable Avionics Architecture Defined	
		Adv. Expander Testbed Defined			500kw Electric Propulsion Test Facility			Unfueled Test of Flt. NTP			Verify NTP Tech Readiness

▲ 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

91-8052

Office of Aeronautics and Space Technology

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

91-8053

Office of Aeronautics and Space Technology

SPACE PLATFORMS MILESTONES

Activities	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
EARTH ORBITING PLATFORMS	Complete Testing & e-0 Evolutionary Model		CSI Ground Test/Bed Operational	Launch Mid-deck Active Control (MACE) Experiment			Demo Advanced Control Technologies		Large Scale Flight Experiment		
	Conduct CSI Benefits Studies for Multi-P/L Platforms & Attached P/L		Laboratory Test & Selection of On-Orbit NDI Technologies	Complete Advanced LEO Meteoroid & Debris Model							
SPACE STATION	Award Contract for SD Ground Test System			Complete SD Ground Test Program			Complete Testing of Prototype Cell/Lens	Complete Ground Test of Conc. Solar Array		Demo 100 W/kg Conc. Solar Array	
	Acquire Hybrid-Scale Model of SS Freedom MB-15 (AC) Configuration			Complete Assessment of SOA Contaminant Sensors		Advanced Portable Life Support Methods Selected	Complete Testing of Lightweight NH2 Battery		Complete Adv. EMU Prototype	On-Orbit Demo of Multi-Propellant Reelstojet	
DEEP SPACE PLATFORMS	Complete Assessment of Spacecraft Adv. Power Systems						Demo Fault Tolerant PMAD Breadboard				
	Determine Advanced Guidance Methodology						Demo Advanced Isotope Power Conversion Unit		Demo Hybrid Smart Synch. Rectifier		

▲ Indicates Funded
△ Indicates NonFunded

Office of Aeronautics and Space Technology

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

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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91-8054

OPERATIONS MILESTONES

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
AUTOMATION & ROBOTICS	Automated Assembly Planar Structure		Complete Non-Planar Truss Assembly Complete Automatic STS scheduling System			Demonstrate One-Operator SMM Repair		Complete Development of AI Analysis Tools for Planetary Science			
	Improved RMS Performance Demo			Demonstrate Pt-in-a-Box In Flight Test Insert AI Tools in all MCC Stations			Serpentine STS Inspection Tool				
INFRASTRUCTURE OPERATIONS				Demonstrate 2-D Crane Positioning Initiate Operation of Flight Control TestBed			Evaluation of Flight Control & Operations TestBed Using CRAFT/Cassini Mission				
				Demonstrate Automated Space Welding Demonstrate Realtime Data Analysis for Command Sequence Validation				Demonstrate Automated Construction of Large EOS-like Platform Structure			
INFORMATION & COMMUNICATIONS	Demonstrate Testbed with SODR Controller		Non-Volatile RAM Tests 60 GHZ TWT Power Conditioner		Flight Demo of SODR Drive Unit Demonstrate 3-D RAM Technology		Demonstrate Phased Array Antenna				
	CHFPS Architecture Definition Report		Demonstrate AutoCorrelation Spectrometer		CHFPS Operating System Complete		Demonstrate Integrated Data Systems Testbed				
TECHNOLOGY FLIGHT EXPERIMENTS							Test & Validate Aero/maritime Mobile Technology		Validate Active Phased Array Antenna		
							GEO to Ground Optical Comm Expt		GEO to LEO Optical Comm Expt		

- ▲ Indicates Funded
- △ Indicates NonFunded

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INTEGRATED TECHNOLOGY PLAN FOR THE CIVIL SPACE PROGRAM
Strategic Plan ITP: CSTI Element Categorization

OAST

Space Science Technology	Submillimeter Sensing	Direct Detectors	Active μ wave Sensing Laser Sensing	Sample Acq., Analysis & Preservation	Passive Microwave Sensing	---	Optoelectrics Sensing & Processing	Probes and Penetrators	---
	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	---	Artificial 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. Aerospace	Aerobreaking	Transfer Vehicle Avionics	ETO Vehicle Avionics	ETO Vehicle Structures & Materials	Autonomous Rendezvous & Docking	COHE	Auxiliary Propulsion
	Cryogenic Fluid Systems	Flight Expt 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 Flt. Telerobotic Services/DTF-1	Flight Control and Operations	Space Assembly & Construction	Space Processing & Servicing	Photonics Data Systems
	---	CommSat Communications	TeleRobotics	Operator Syst./Training	Navigation & Guidance	CommSat Communications Flight Expts	---	Ground Test and Processing	---
HIGHEST PRIORITY 000			2nd-HIGHEST PRIORITY 00			3rd-HIGHEST PRIORITY 0			

LBF40343 (PI)

INTEGRATED TECHNOLOGY PLAN FOR THE CIVIL SPACE PROGRAM
FY 1992 Program ITP: CSTI Element Categorization

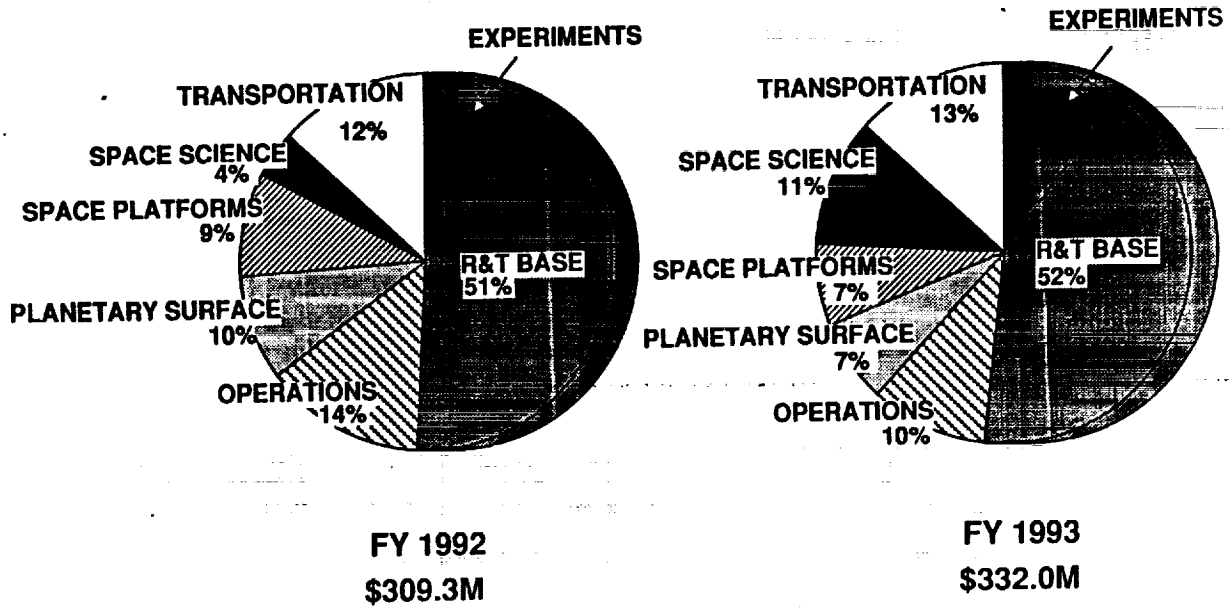
OAST

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	---	---	---	---	---	---
HIGHEST PRIORITY 000			2nd-HIGHEST PRIORITY 00			3rd-HIGHEST PRIORITY 0			

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SPACE RESEARCH & TECHNOLOGY PROGRAM

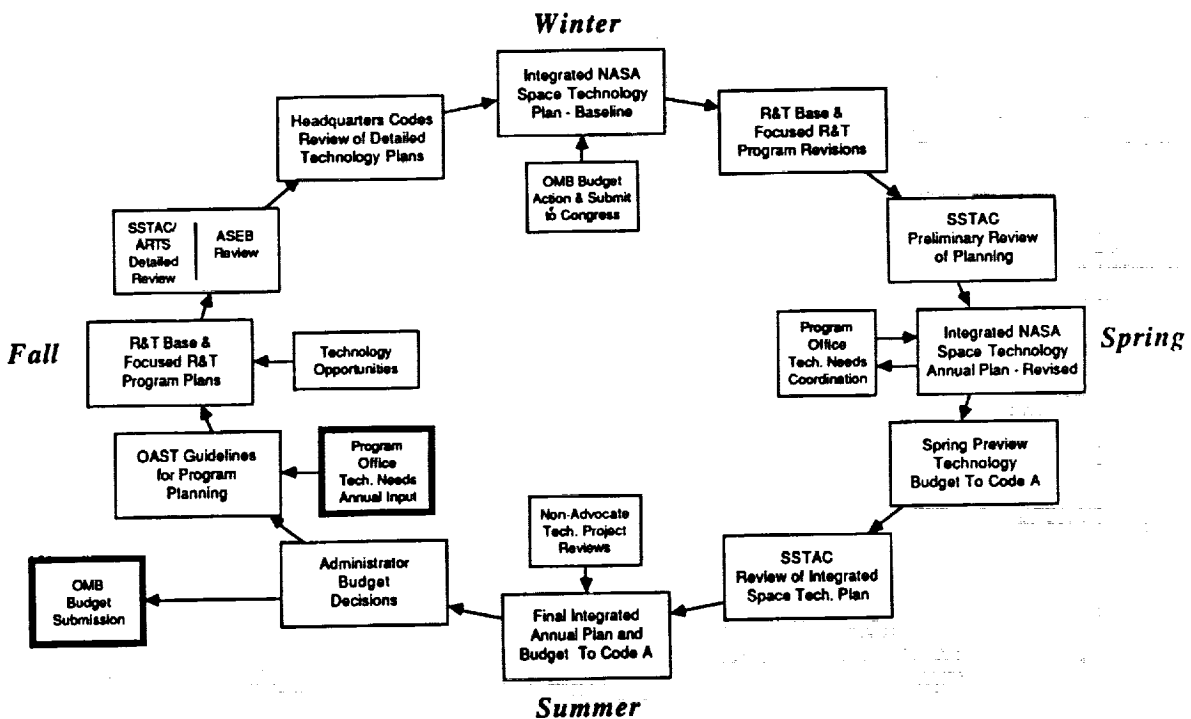
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LBF 404

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
 AUTOCCLASS IV
 REAL-TIME DATA SYSTEM
 SPACECRAFT HEALTH AUTOMATED REASONING PROTOTYPE
 SCIENTIFIC ANALYSIS ASSISTANT
 LOSSLESS DATA COMPRESSOR
 IMAGING SPECTROMETER FLIGHT PROCESSOR
 HIGH SPEED FIBER OPTIC TRANSCIEVER
 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

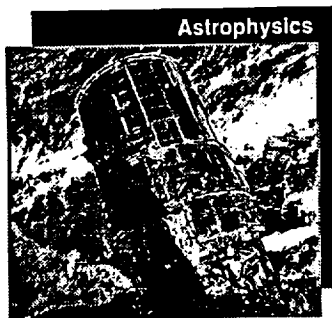
SPACE PLATFORMS

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

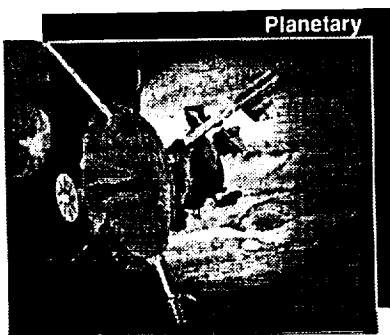
RESEARCH & TECHNOLOGY BASE

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

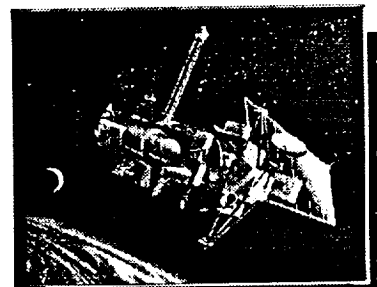


- Hubble - VLSI Data Processing
- Astro - Startracker
- Hubble - Battery Technology
- Hubble - Image Restoration



- 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

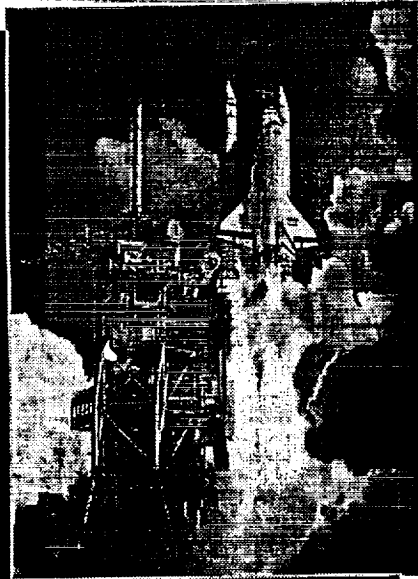


Earth Science

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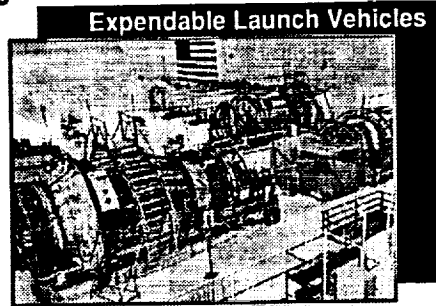
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TECHNOLOGY CONTRIBUTIONS TO TRANSPORTATION



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



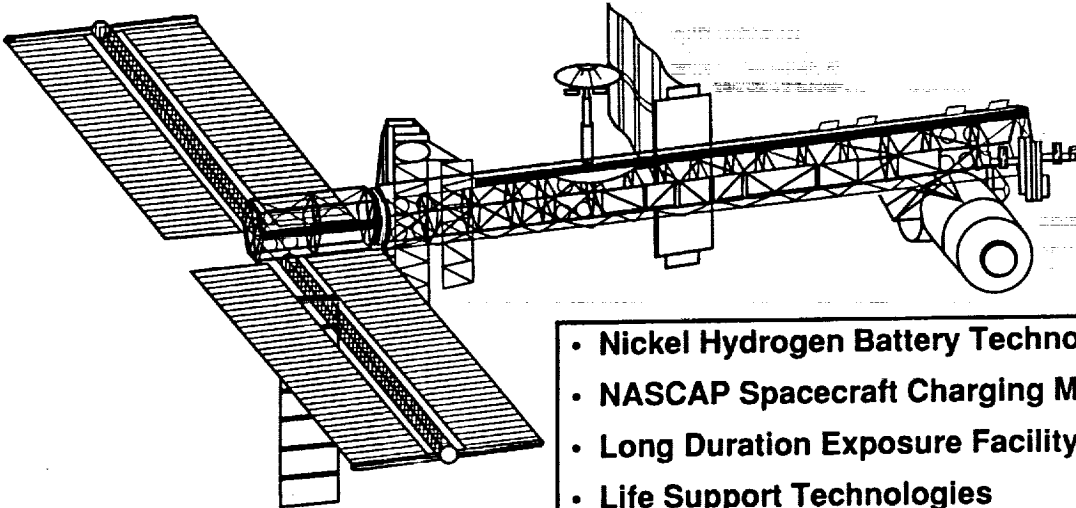
Expendable Launch Vehicles

- Advanced Primary Battery

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92-8023a

TECHNOLOGY CONTRIBUTIONS TO SPACE PLATFORMS

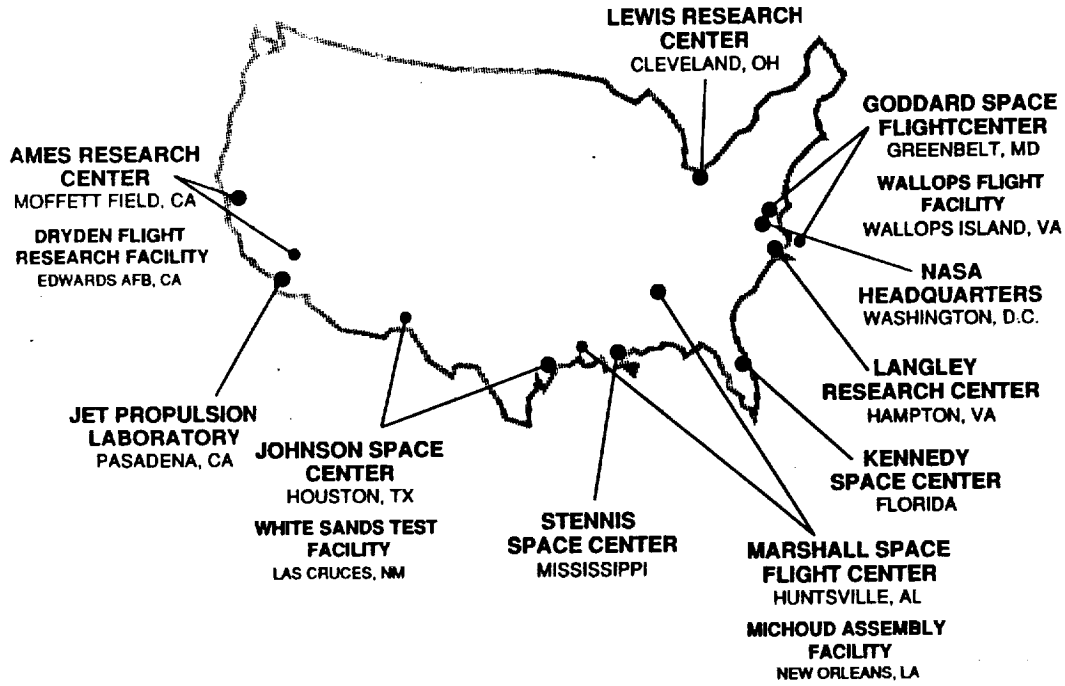


- Nickel Hydrogen Battery Technology
- NASCAP Spacecraft Charging Model
- Long Duration Exposure Facility
- Life Support Technologies
- Multipropellant Resistojet
- Large Area Solar Cells
- Arcjet Thruster

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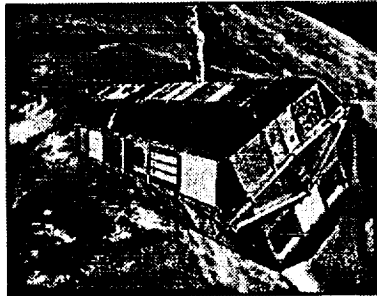
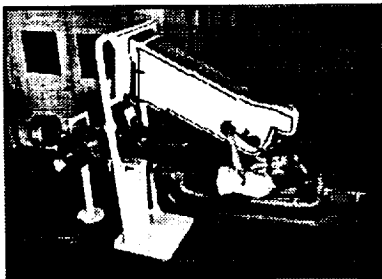
NASA INSTALLATIONS



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

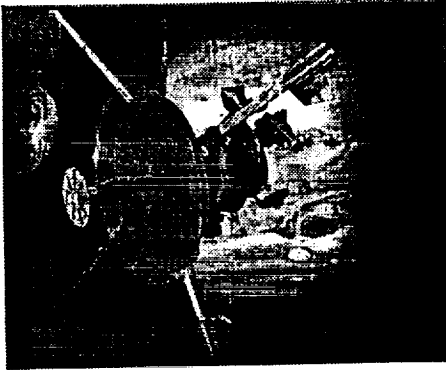
- Electric Propulsion
- Thermal Management
- Chemical Propulsion
- CryoFluid Systems
- Communications Systems
- Nuclear Propulsion
- Space Power Systems



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SPACE SCIENCE CENTERS

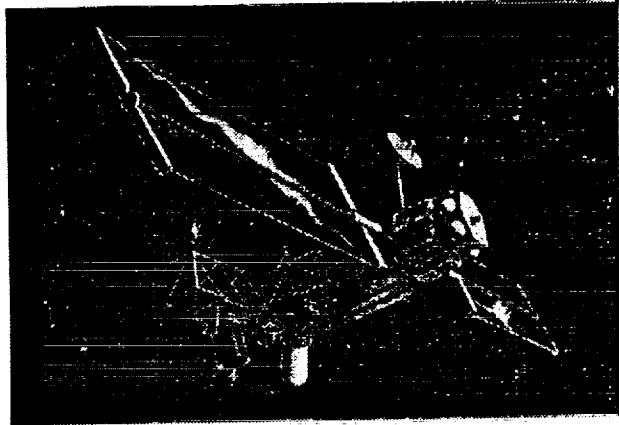
JET PROPULSION LABORATORY



- 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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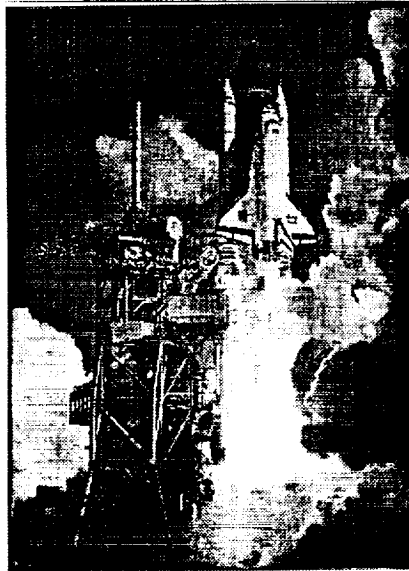
SPACE FLIGHT CENTERS

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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