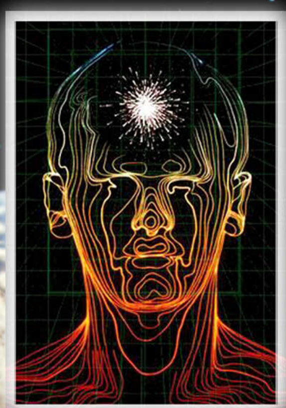
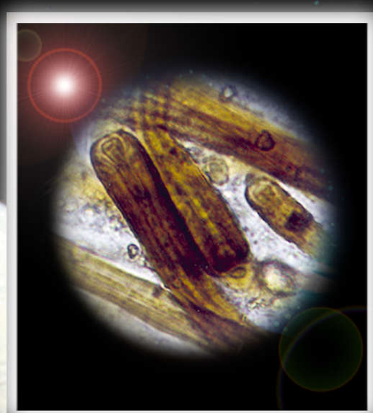
Ames Research Center FY00 Implementation Plan

Leading Technology into the new Millennium





Ames Research Center

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Ames Research Center FY00 Implementation Plan

LEADING TECHNOLOGY INTO THE NEW MILLENNIUM

Implementing NASA's Strategic Plan
with respect to
Center of Excellence,
Center Missions, and
Lead Center Programs and Responsibilities

A Roadmap for Ames' Customers and Employees

January 2000
Ames Research Center
Moffett Field, CA 94035

A Message from the Ames Center Director

As we enter the next millennium, we should pause and consider all that we as a nation have accomplished in the last 100 years. It's startling to think that at the beginning of the 20th Century airplanes were just a dream. In 1999, not only are airplanes a common form of transportation, but rocket launches and space exploration have become facts of everyday life. We at Ames Research Center can look back on all our accomplishments during the last 60 years and state proudly that we have developed many of the technologies that have made these advances possible.

As we look into the future, new revolutions in science and technology will grow out of the hard work we're performing now. It is imperative that the work we do today fits with the nation's goals and the roadmap established for the entire Agency. The Agency states its broad goals and objectives within the NASA Strategic Plan. The Ames Research Center FY00 Implementation Plan articulates how the Agency's strategic vision translates into the functions and duties of the employees at Ames.

I ask all Ames' employees to read this Plan and to know what is expected of them and of Ames. This Plan will help ensure that Ames is at the forefront of aerospace technology development, scientific research, and space exploration as we enter the new millennium

Henry McDonald
Center Director
Ames Research Center

Ames Management Team Concurrence

We, the senior management team at Ames, are committed to working with the men and women of the Center and with all our stakeholders, partners, and customers to implement this plan.

Henry McDonald
Director

William E. Berry
Deputy Director

Robert J. Hansen
Deputy Director for Research

Robert Rosen
Associate Director for Aerospace Programs

G. Scott Hubbard
Associate Director of Astrobiology and Space Program

Nancy F. Bingham
Associate Director for System Management and Planning

Cliff Impresgia
Director of Research and Development Services

Steve F. Zornetzer
Director of Information Sciences and Technology

Jana M. Coleman
Director of Center Operations

L.S. "Skip" Fletcher
Director of Aerospace

David Morrison
Director of Astrobiology and Space Research

Lewis S. G. Braxton, III
Chief Financial Officer

G. Warren Hall
Director of the Safety, Environmental, and Mission Assurance Office

Lawrence Caroff
SOFIA Program Manager

J. Victor Lebacqz
Director, Aviation Operations Systems Program Manager, Aviation System Capacity

Maurice M. Averner
Program Manager, Gravitational Biology and Ecology

Eugene L. Tu
Program Manager, High Performance Computing and Communications
Program Manager, Information Technology R&T Base

John J. Coy
Program Manager, Rotorcraft R&T Base

David R. Picasso
Director, Consolidated Supercomputing Management Office

Robert J. Shiner
Director, Simulation Facility Group

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I. Introduction

This document presents the implementation plan for Ames Research Center (ARC) within the overall framework of the NASA Strategic Plan. It describes how ARC intends to implement its Center of Excellence responsibilities, Agency assigned missions, Agency and Enterprise lead programs, and other roles in support of NASA's vision and mission.

All Federal agencies are required by the 1993 Government Performance and Results Act to implement a long-term strategic planning process that includes measurable outcomes and strict accountability. At NASA, this planning process is shaped by the Space Act of 1958, annual appropriations, and other external mandates, as well as by customer requirements. The resulting Strategic Plan sets the overall architecture for what we do, identifies who our customers are, and directs where we are going and why. The Strategic Plan is the basis upon which decisions regarding program implementation and resource deployment are made.

Whereas the *strategic planning process* examines the long-term direction of the organization and identifies a specific set of goals, the *implementation planning process* examines the detailed performance of the organization and allocates resources toward meeting these goals. It is the purpose of this implementation document to provide the connection between the NASA Strategic Plan and the specific programs and support functions that ARC employees perform. This connection flows from the NASA Strategic Plan, through the various Strategic Enterprise plans to the ARC Center of Excellence, primary missions, Lead Center programs, program support responsibilities, and ultimately, to the role of the individual ARC employee.

II. Vision, Mission, Goals, and Values

NASA Vision and Mission

VISION

NASA is an investment in America's future. As explorers, pioneers, and innovators, we boldly expand frontiers in air and space to inspire and serve America and to benefit the quality of life on Earth.

MISSION

- *To advance and communicate scientific knowledge and understanding of the Earth, the solar system, and the universe, and use the environment of space for research.*
- *To advance human exploration, use, and development of space.*
- *To research, develop, verify, and transfer advanced aeronautics, space, and related technologies.*

Meeting the NASA Mission

NASA uses a variety of means to organize and focus the efforts of the Centers to achieve Agency missions. The primary organizations and initiatives are Strategic Enterprises, Centers of Excellence, Center Missions, and Lead Centers for technical programs.

STRATEGIC ENTERPRISES

NASA has established the four Strategic Enterprises to function as primary business areas for implementing NASA's mission and serving customers. Each Enterprise has a unique set of strategic goals, objectives, and implementing strategies that address the requirements of the Agency's primary customers. NASA's Centers define how Enterprise programs and central services will be developed and delivered to external and internal customers.

The four NASA Strategic Enterprises are:

- ***Aero-Space Technology***
- ***Space Science***
- ***Human Exploration and Development of Space***
- ***Earth Science***

CENTERS OF EXCELLENCE

Centers of Excellence are focused, Agency-wide leadership responsibilities in a specific area of technology or knowledge. They must strategically maintain or increase the Agency's preeminent position in the assigned area of excellence in line with the program requirements of the Strategic Enterprises and the long-term strategic interests of the Agency. A designation of Center of Excellence brings to the Center the charge to be preeminent within the Agency, if not worldwide, with respect to the human resources, facilities, and other critical capabilities associated with the particular area of excellence.

The Ames Center of Excellence is:

- *Information Technology*

CENTER MISSIONS

Center missions identify the primary concentration of capabilities to support the accomplishment of Strategic Enterprise goals. Each Center has designated areas of mission responsibility, which provide a basis for building human resources capabilities and physical infrastructure in direct support of Enterprise requirements.

The Ames missions are:

- *Astrobiology*
- *Aviation Operations Systems*

LEAD CENTER PROGRAMS

Each NASA program is assigned to a Lead Center for implementation. Lead Center Directors have full program management responsibility and authority, and thus, full accountability for assigned missions or programs, ensuring that they are being managed to agreed-on schedule milestones, budget guidelines, technical requirements, and all safety and reliability standards.

The ARC Lead Center Responsibilities in support of Agency Programs are:

- *Intelligent Systems (IS)*
- *High-Performance Computing and Communications (HPCC).*

The ARC Lead Center Responsibilities in support of other Agency Assignments:

- *Consolidated Supercomputing Management Office (CoSMO)*
- *Information Technology Security (ITS).*

The ARC Lead Center Responsibilities in support of the Enterprises are:

- *Information Technology R&T Base Program*
- *Rotorcraft R&T Base Program*
- *Aviation Operations Systems R&T Base Program*
- *Aviation System Capacity Program*
- *Simulation Facility Group Director*
- *Stratospheric Observatory for Infrared Astronomy (SOFIA) Program*
- *Gravitational Biology and Ecology Program (GB&E).*

CENTER CORE COMPETENCIES

Ames Research Center's assigned roles and responsibilities are based on its core competencies. Founded in the Center's workforce capabilities and physical assets, these competencies are enhanced by a broad range of collaborations with other government agencies, industry, and academia.

- *Intelligent Systems*
- *High-Performance Computing and Networking*
- *Astrobiology*
- *Aerospace Operations Systems*
- *Human Factors*
- *Vertical Flight*
- *Applied Aerospace Information Technologies*
- *Space Transportation Technology/Thermal Protection Systems*
- *Life Sciences*
- *National Asset Management*

INSTITUTIONAL SUPPORT

In addition to these organizations, ARC has many institutional systems that support the Center of Excellence, missions, lead center programs, and other research and technology development activities. These systems are essential for ARC to meet its programmatic commitments and for operation of the Center.

ARC's Mission, Approach, and Values

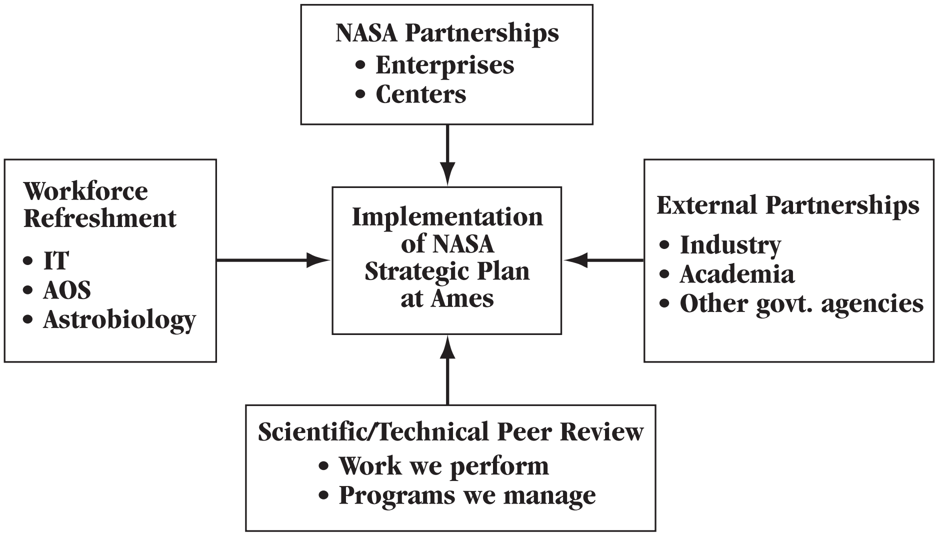
MISSION

- *As NASA's Center of Excellence for Information Technology, to lead and coordinate research encompassing the fields of high-performance computing and networking, human-centered computing, and automated reasoning.*

- *As NASA's lead center for Astrobiology, to develop science and technology requirements for current and future flight missions that are relevant to astrobiology, including advanced concepts and technology development; to identify and develop astrobiology mission opportunities, life sciences experiments for spaceflight, and space science research components of astrobiology; to carry out fundamental and applied research in astrobiology and astrobiology-related technologies; and to lead in information technology applications and astrobiology education and outreach programs that inform and inspire the American public.*

- *As NASA's lead center for Aviation Operations Systems, to champion research efforts in air traffic control and human factors; to lead the Agency's research efforts in rotorcraft technology; and to create design and development process tools, and wind tunnel and simulation facilities.*

APPROACH



VALUES

ARC's management and supervisors recognize that people are the organization's most important asset. To ensure a safe work environment that accurately reflects that belief, ARC encourages and promotes adherence to the following core values:

SAFETY

We will ensure a safe and secure working environment for our staff.

RESPECT

We have respect for the individual and for diversity in culture, background, and experience. We maintain the highest principles of fairness and equitable treatment of all employees.

COMMUNICATION

We recognize that only through open and honest communication will our goals be achieved.

TEAMWORK

We believe in cooperative interaction among others and ourselves. By working together with respect, trust, and mutual support, we achieve common goals.

CREATIVITY

We foster creativity, ingenuity, and innovation in our endeavors.

INTEGRITY

We maintain the highest principles of integrity, honesty, and accountability.

EXCELLENCE

We continually strive to improve. We demand professionalism in our conduct and excellence in our products.

CUSTOMER FOCUS
We are responsive to our customers and satisfy their requirements.

RESPONSIBILITY
We are responsible stewards of the public interest, public resources, and the public trust.

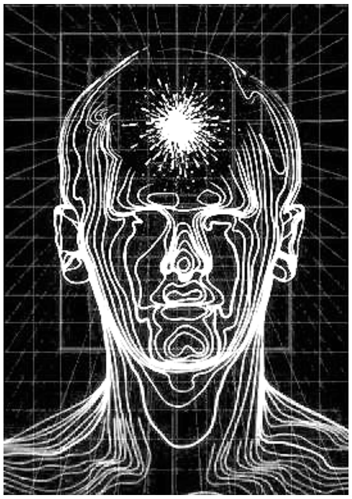
RELEVANCE
We ensure that all our endeavors are aligned with national needs and the Agency vision and purpose.

DISCOVERY
We are bold, but prudent, as we expand the boundaries of scientific understanding and technical knowledge in air and space.

III. Implementing Agency-Level Responsibilities

NASA'S Center of Excellence for Information Technology (COE-IT)

COE-IT DESCRIPTION



NASA's missions in space exploration and aeronautics will require advances in many areas of science and technology, but most critical among these enabling technologies will be that collection of technologies known as Information Technology (IT). To ensure that NASA fully exploits this most critical enabling technology, Ames Research Center has been designated the NASA Center of Excellence for Information Technology. Because of both its long history of computer science research excellence and its location in the heart of Silicon Valley, ARC was the logical place for NASA to focus its IT research program. The ARC has embraced its responsibilities as the NASA Center of Excellence for Information Technology and accepted the challenge of excellence.

COE-IT FOCUS AREAS

During the past two years, the COE-IT has led an effort to understand NASA's future IT requirements and the concomitant research investments necessary to meet them. In addition, COE-IT and its various review committees (including academic and industrial advisors) have assessed both NASA's research processes and its relative strengths and weaknesses. As described in the new multicenter document titled "Information Technology at NASA: Accepting the Challenge of Excellence," this study has identified three IT research cornerstones upon which NASA can build its future:

(1) Automated Reasoning for Autonomous Systems

NASA's mission of space exploration coupled with the Administrator's challenge to do it "faster, better, and cheaper" has provided the requirement for one of the most stressing applications facing the computer science research community—that of designing, building, and operating progressively more capable autonomous spacecraft and rovers. Research on automated reasoning for autonomous systems will enable a new generation of spacecraft to do more exploration at a much lower cost than traditional approaches. An impressive early example of this technology (Remote Agent Autonomy Architecture) has demonstrated its usefulness on the Deep Space One (DS-1) mission.

(2) High-Performance Computing and Networking

NASA has a long history of leadership in high-performance computing for both scientific and engineering applications. Today the field of high-performance computing is changing rapidly: on the high end, new architectures are under development that combine the performance gains of massively parallel computing with the flexibility of shared-memory multiprocessor approaches; on the low end, powerful microprocessor-based systems are now performing computations that would have required a supercomputer until very recently; and finally, the advent of high-speed connectivity is making the slogan "the network is the computer" true for more and more applications. Toward this end, NASA is playing an important role in the NGI (Next-Generation Internet) project, which will develop networks that are 100 to 1000 times faster than today's Internet.

(3) Human-Centered Computing

The emerging concept of "human-centered computing" represents a significant shift in thinking about information technology in general, and about intelligent machines in particular. It embodies a "systems view," in which the interplay between human thought and action and technological systems is understood as inextricably linked and an equally important aspect of analysis, design, and evaluation. Within this framework, NASA researchers are inventing and deploying sophisticated computational aids designed to amplify human cognitive and perceptual abilities. Essentially these are cognitive prostheses, computational systems that leverage and extend human intellectual capacities, just as the steam shovel was a sort of muscular prosthesis.

By building on these three research cornerstones, IT will enable a wide range of applications and missions, some of which we can only dimly glimpse today. Over the last year, ARC has identified five mission-critical application areas, with the objective of transforming them through application of advanced IT:

(1) Robotic Exploration of Space

The next generation of robotic explorers must exhibit an unprecedented level of autonomy. They will need to be smart, adaptable, curious, and self-reliant in harsh and unpredictable environments. Research on automated reasoning for autonomous systems will enable a new generation of spacecraft to do more exploration at a much lower cost than traditional approaches.

(2) Aviation Operations

The projected growth in air traffic over the coming decade will strain our already congested air traffic and ground management systems, producing an unacceptable increase in the number of accidents or system delays if uncontrolled. NASA, in collaboration with the FAA, is developing advanced IT systems that will play a major role in realizing the twin goals of safer aircraft operation and higher throughput of the airport and ground control infrastructure. For example, a new generation of cognitive and perceptual prostheses are being considered to assist pilots and air traffic controllers.

(3) Science Data Understanding

NASA is responsible for launching and gathering data from progressively more sophisticated orbital and deep space instruments. For example, the Earth Observing System (EOS) is being deployed to monitor global climate change. When fully operational, the sensor-rich satellites will generate about one terabyte of data per day. Equally important as the need for progress in high-capacity data storage and dissemination schemes is the development of tools aimed at facilitating human understanding of these immense data sets. On the opposite end of the data generation spectrum, distance greatly limits the ability of the space science community to fully exploit the presence of our machines on remote planets. Emerging research results from the three NASA IT cornerstones will better enable scientists to understand our world as well as distant worlds.

(4) Design and Manufacturing in the Virtual Environment

The future missions of NASA, such as Mars exploration, involve uniquely difficult design and engineering challenges. Early in the design cycle, complex trade-offs between spacecraft characteristics and mission concepts must be performed in the virtual environment by geographically distributed teams of experts. As mission and platform design proceeds, detailed evaluations of cost and performance impacts associated with utilizing advanced technologies are required. To address these challenges, NASA researchers are exploiting all three of our IT cornerstones.

(5) Human Exploration of Space

A critical requirement for NASA is to reduce the cost of operating in space. Advanced information technology research permits dramatic reductions in launch and operational costs of spaceflight systems. For example, as humans contemplate journeys to Mars and beyond, research requirements clearly exist for developing a wide range of performance support systems, diagnostic systems, condition-based maintenance systems, and a wide range of other systems that operate autonomously or semi-autonomously in support of mission requirements.

COE-IT IMPLEMENTATION STRATEGY

ARC has committed itself to taking the actions necessary to meet its responsibilities as the NASA Center of Excellence for Information Technology. The ARC Independent Verification and Validation (IV&V) Facility, which works to ensure the quality, safety, reliability, cost, and performance of software, is a key contributor to this effort. The ARC IV&V Facility is committed to providing the highest quality mission-critical software throughout NASA and to managing projects in its six strategic business areas: Systems and Software IV&V; Applied Software and Systems Engineering Research; Software Measurement; Software Independent Assessments; Educational Outreach; and Technology Transfer. In these strategic business areas, the ARC IV&V Facility uses its expertise to help each mission-critical application area meet the challenge of "better, faster, and cheaper," and to partner with industry and academia to increase ARC's understanding of software engineering processes.

ARC has also embarked on a multifaceted strategy aimed at improving the quality and relevance of its IT research program. Developed in consultation with its various COE-IT review and advisory committees, this strategy includes the following thrusts:

- **Recruit a reputable IT senior management team.**

  Over the last few years ARC has totally rebuilt its senior and midlevel IT management team. This restructuring included transfer of the COE leadership to the Director of Information Sciences and Technology, a new director for CoSMO, and two Associate Directors for the Information Sciences and Technology Directorate. Midlevel manager positions recently filled include Division Chiefs for the Computational Sciences Division, Software Technology Division, Human Factors Research Division, and the Numerical Aerospace Systems Division. The Aviation Systems Research, Technology, and Simulation Division Chief will be selected in the near future.

- **Recruit a critical mass of first-rank IT researchers.**

  ARC has aggressively recruited the best computer scientists (over 100 in the last two years) available nationwide—researchers who comprise the intellectual engine that will drive NASA's IT research now and in the future.

- **Create an "excellence-driven" research environment.**

  To preclude losing fine scientists because of an unproductive or unsupportive work environment, ARC has made strong strides in building a research climate that values scientific and technical excellence and that allocates resources on that basis. First, a rigorous peer review system has begun for all IT programs performed or managed at ARC. Given NASA's limited resources, it is important that it perform only technically competent and strategically relevant IT research. Perhaps equally important, good researchers prefer their work to be assessed by technically competent reviewers rather than the alternative, which often promotes partisanship.

  Additionally, COE-IT has formed an IT steering committee comprising senior national leaders in IT who performed a thorough assessment of NASA-wide IT needs and capabilities.

- **Encourage and solicit collaboration with the best.**

  NASA cannot afford to "go it alone" in IT research and must learn to eradicate the "not invented here" mentality. Toward this end, COE-IT will continually assess relevant research in industry, government, and academia to identify potential areas of collaboration. To facilitate these collaborations, ARC has recruited a focused team of professionals (representative of industry, government, and academia) that includes a Silicon Valley CEO, a recently retired Vice Admiral, several university personnel, and a full-time collaboration manager. Thus far, ARC has over 130 IT-related research partners in industry and government. Additionally, ARC is increasing its university-based research and is building particularly strong relationships with key university partners.

In summary, ARC constantly works to earn and re-earn the COE designation. To remain worthy of the designation, the ARC IT community must continue to critically assess its progress and strive toward consistently delivering strategic IT research programs that not only are of the highest technical quality, but also are strongly enabling with respect to NASA's future missions. Significant progress in this direction has been made.

ARC's Mission Assignments

ASTROBIOLOGY

Mission Description

Astrobiology is defined in the NASA Strategic Plan as the study of the living universe. Astrobiology studies are multidisciplinary and are directed toward understanding:

- *Origin of life—how life began in the context of the formation and diversity of planetary systems.*

- *Evolution of life—the co-evolution of life and the planetary environment, and the limits of life.*

- *Distribution of life—the search for other biospheres (past or present) in our solar system and beyond.*

- *Destiny of life—how life may adapt to our changing environment and to other environments beyond the Earth.*

The designation of ARC as the Agency lead in Astrobiology recognizes ARC's historical strength in multidisciplinary research in the Life, Space, and Earth sciences, and ARC's unique involvement in all of NASA's Strategic Enterprises. Subsequently, ARC was also designated as the lead for Astrobiology by the Space Science, Earth Science, and Human Exploration and Development of Space Enterprise Offices. In 1997, ARC was assigned the closely related Life Science Program Office for Gravitational Biology and Ecology. In 1998, ARC was designated by the Office of Space Science as its lead center for Astrobiology. This designation requires that the Center exercise scientific and technological leadership in this field for the benefit of the entire scientific community. ARC also provides the principal support to the Office of Space Science in managing its astrobiology program, including the host function and operations management for the NASA Astrobiology Institute (NAI) (described later).

Mission Focus

Astrobiology is a new term for a broad, multidisciplinary field linking the NASA space program with the biological sciences. Recent discoveries about life, the environment, and the potential for life elsewhere, when coupled with the dramatic advances in technological tools and mission capabilities over the past decade, allow us to hope to answer long-held questions about the living universe, and to explore significant new ones. The over-arching questions include: How does life begin and evolve? Does life exist elsewhere in the universe? and What is life's future on Earth and beyond? The detailed content of astrobiology is further defined in the 10 goals and 17 objectives of the NASA Astrobiology Roadmap, which was approved in December 1998.

In order to answer the fundamental questions of astrobiology, the NASA Astrobiology program pursues the following science goals:

- *Understand how life arose on the Earth.*
- *Determine the general principles governing the organization of matter into living systems.*
- *Explore how life evolves on the molecular, organism, and ecosystem levels.*
- *Determine how the terrestrial biosphere has co-evolved with the Earth.*
- *Establish limits for life in environments that provide analogues for conditions on other worlds.*
- *Determine what makes a planet habitable and how common these worlds are in the universe.*
- *Determine how to recognize the signature of life on other worlds.*
- *Determine where there is (or once was) life elsewhere in our solar system, particularly on Mars and Europa.*
- *Determine how ecosystems respond to environmental change on time scales relevant to human life on Earth.*
- *Understand the response of terrestrial life to conditions in space or on other planets.*

IMPLEMENTATION APPROACH

- Research
  ARC scientists carry out basic research, participate in flight missions, and facilitate participation of the national science community in astrobiology. To implement the Agency's Center Mission effectively, ARC will continue to develop its research staff and facilities to maintain technical excellence across the range of disciplines encompassed by astrobiology.

- Strategic Planning
  ARC led in the development of a NASA Astrobiology Roadmap, and we will continue to bring together the science and technology communities to identify additional research priorities and translate them into appropriate NASA programs, technology challenges, and flight missions. Through its Center for Mars Exploration, ARC will also continue to support planning for the NASA Integrated Mars Exploration Program.

- Operation of Facilities
  ARC will define, develop, and operate major research facilities for the benefit of the scientific community. These include flight operations for Life Science payloads on the Space Shuttle, operation of a suite of centrifuge facilities at the Center for Gravitational Biology, development of the SOFIA airborne observatory and the Space Station Biological Research Facility

for use by the science community in the next century, and development and operation of a new NASA Astrobiology Research Laboratory.

- Mission Planning and Technology
  ARC will continue to lead the effort to identify astrobiology opportunities on NASA's current missions, ascertain the key technology needs for future ground and flight research in astrobiology, and develop advanced mission concepts to meet astrobiology's far-ranging science goals. Recognizing the broad range of mission and technology expertise throughout and beyond NASA, ARC will continue to involve all relevant field centers as well as external expertise in academia and industry in obtaining the greatest scientific and mission results in the shortest time possible and for the lowest cost.

- NASA Astrobiology Institute
  The NASA Astrobiology Institute (NAI), managed by ARC, has been formed to carry out world-class, multidisciplinary research on a wide range of fundamental science questions in the nascent field of astrobiology. The NAI was created as a virtual institute, whose members use state-of-the-art communications technologies and tools (eventually to include the NASA Research Network/Next-Generation Internet) to collaborate across geographical and institutional boundaries, employing the best minds across the country to answer fundamental astrobiology questions. NASA has charged the NAI with coordinating and catalyzing astrobiology across a range of disciplines and organizations; developing and demonstrating modern communications technologies in support of multidisciplinary research; providing advice to and technologies for NASA missions; training students; and providing outreach to the general public. In May 1999, a distinguished Nobel Laureate was appointed Director of the NAI. The Director and management staff of the NAI reside at ARC. NAI operation is guided by an Executive Council, formed from representatives of each lead institution. A close relationship is maintained between the NAI and IT organizations at ARC in order to promote the development, implementation, and demonstration of communications technologies.

  It is planned to enlarge the membership and scope of the NAI via a new Cooperative Agreement Notice (CAN). The existing 11 lead member institutions will be augmented by several more, with emphasis on the areas of extrasolar biospheres, genomics, and others.

- Outreach and Education
  The NAI's Outreach Office serves both internal and external functions. Its priorities include forming partnerships with each member institute, coordinating our members' projects to enhance their impact, and assisting in the creation of institute-wide efforts. The NAI Outreach Office takes a comprehensive interest in educating the American public and the global community on the activities of the Institute and the field of Astrobiology. This

interest includes the generation and use of both traditional communications (print, electronic, "live" exhibits, etc.) and experimental learning innovations (webcasts, remote instrument manipulation, interactive forums). The NAI Outreach Office undertakes uniquely focused activities to reach specific audience communities, such as K–14 educators/students, college-level and postgraduate faculty/students, Internet users, science/technology centers, media outlets, professional colleagues, and traditionally underserved communities. Wherever possible, implementations involve leveraging NAI and Astrobiology Program expertise, direction, and funds with those contributed by external organizations. In collaboration with the Associate Center Director for Astrobiology and Space Programs and the ARC Astrobiology Integration Office (AIO), the NAI Outreach Office presents the field of Astrobiology in the context of Astrobiology research, focused NAI activities, space missions, and technology development.

- Astrobiology Integration Office
  The AIO at NASA Ames Research Center integrates the broad scientific disciplines within the scope of Astrobiology with novel technologies and mission opportunities to determine life's place in the universe, and shares the results of this endeavor with humanity. The success of Astrobiology as a new endeavor is dependant not only on integration of traditional scientific disciplines from astronomy to zoology and geology to genomics, but also on further integration of these sciences with the technological revolutions in biotechnology, micro- and nanotechnology and information technology, and with novel payload opportunities in NASA's broad-ranging space science, human exploration, and Earth science mission program.

The AIO will accomplish this broad-ranging integration through leadership in strategic planning for Astrobiology, working with the science, technology, and mission communities to define major areas of research and the mission and technological resources needed to achieve key results in these areas. The AIO will sponsor technology, payload, and advanced mission concept development efforts within and outside of NASA to further develop innovative approaches toward meeting the goals of Astrobiology. With the recognition that Astrobiology belongs to the public, the AIO will maximize the societal and economic benefits of Astrobiology to humanity through outreach to historically underrepresented communities, development of broad-ranging curricula to excite students, and other novel approaches.

AVIATION OPERATIONS SYSTEMS (AOS)

Mission Description

Aviation Operations Systems (AOS) is the mission assigned to ARC by the Agency in recognition of ARC's history of contributions in flight management, air traffic management automation, and aviation human factors, as well as in the airborne technologies of guidance and control. AOS are defined as those ground, satellite, and aircraft systems and human operators that control the operational safety, efficiency, and capacity of aircraft operating in the airspace and airports. AOS studies specifically encompass:

- *Communication, navigation, and surveillance (CNS) systems;*
- *Air traffic management systems, interfaces, and procedures;*
- *Relevant cockpit systems, interfaces, and procedures;*
- *Operational human factors, their impact on aviation operations, and error mitigation;*
- *Weather and hazardous environment characterization, detection, and avoidance systems.*

Mission Focus

The program investment strategies that contribute to the Aero-Space Technology Enterprise outcome goals of Safety and Capacity are based on the report "Toward a Safer 21st Century, Aviation Safety Research Baseline and Future Challenges" (Huettner, C.H., NASA NP 1997-12-231-HQ, December 1996). This report suggests three general areas for safety research focus: Aircraft/Aviation System, People, and Environment. These areas can be further generalized to address both safety and capacity as:

- *System Design, Assessment, and Reliability*
- *Human Performance and Deficit Countermeasures*
- *Hazardous Environment Prediction and Mitigation*

Implementation Approach

- Research
  ARC conducts basic and applied research in aviation operations systems through the Aviation Operation Systems Base R&T Program, which it leads for the Agency, and through specific systems technologies research programs, such as the Aviation System Capacity Program for which it is the Enterprise Lead Center, and the Aviation Safety Research Program, for

which it plays a support role. To implement its Center mission effectively, Ames will develop its research staff and facilities to maintain technical excellence across the range of disciplines encompassed by aviation operations systems, specifically automation science, human factors, and information technology.

- Strategic Planning
  ARC leads in the development of a NASA Throughput Roadmap, bringing together the appropriate customer communities to identify research priorities and translate these into appropriate NASA programs and technology challenges.

- Operation of Facilities
  ARC defines, develops, and operates major research facilities, as appropriate, to support research in AOS. These include simulators and laboratories devoted to Air Traffic Management (ATM) automation and human factors.

- Customer Outreach
  The Aviation Operation Systems Subcommittee is the prime, formal interface with the customer community regarding customer feedback and requirements for AOS programs. Additionally, informal interaction takes place through cooperative programs with the AOS customer community. The FAA, as the prime government customer, provides its input through numerous joint programs and the FAA/NASA Coordinating Committee. Appropriate collaborative research is also assured by an Interagency Integrated Product Team formed under a formal Memorandum of Understanding.

ARC's Lead Center Roles for Agency-Wide Programs

INTELLIGENT SYSTEMS (IS)

An essential element in the success of NASA's COE-IT is the strategic investment area, "Intelligent Systems." The Intelligent Systems (IS) Initiative is designed to begin a national strategic research program that will fulfill or exceed the NASA Administrator's vision for next-generation information technology capabilities. The Initiative will achieve this vision by developing state-of-the-art and revolutionary IS technologies, by leveraging government and university research, and by feeding maturing technologies to ongoing NASA missions and activities, to industry activities, and to other government agencies.

Current NASA investment in information technologies can be characterized as (a) dominated by relatively short-term, five-year horizon projects and applications, and (b) predominately oriented toward aeronautics applications (HPCC, AOS, Aviation Safety, Rotorcraft, and the National Research and Education Network (NREN)). A modest amount of IS-related works is also found under Space Science (especially in the crosscutting technologies program) and in Earth Sciences (focused on Earth Observing System Data and Information System (EOSDIS) and data analysis). Under ARC management, the IS program will be targeted at fulfilling Agency-wide, mission-driven mid- and far-term IS technology requirements, with minimal overlap with other current IT programs.

The IS program will emphasize the research, development, and technology transfer of revolutionary methods, technologies, and processes that apply across NASA's and the nation's engineering and science infrastructure. IS contains four Technology Elements that, in combination, provide a comprehensive strategy that integrates high-risk research, concept and prototype development, and the transfer of mature technologies to all IS mission customers throughout NASA. Briefly, automated reasoning means taking the programmer out of the loop. Scientists can solve problems on their own terms rather than having to program solutions, and spacecraft can operate autonomously rather than responding to ground commands. Intelligent data use means that all the data collected by a mission is managed as a coherent asset, is integrated to provide the best understanding possible, and is disseminated to interested parties. Human-centered computing means that mission operations are designed from a systems perspective that looks at how humans and machines interact, taking into account basic human perceptual, cognitive, and social abilities. Revolutionary computing involves breakthrough technologies that can change the way we think of computation.

Approach

Achieving the capabilities described above will require coordinated investment in both in-house and extramural research with partners in universities, industry, and other NASA Centers. Ames Research Center is well-positioned to assume technical leadership and take management responsibility for this strategic investment area. In particular, ARC has internationally recognized leadership in the areas of Artificial Intelligence, Advanced Software Engineering, and Robotic Systems. ARC is building upon these essential core capabilities. Accordingly, ARC is integrating with these core capabilities new and rapidly evolving programs in biomimetics (e.g., neural networks and neurotechnology) and other nontraditional computational schemes to establish revolutionary new approaches to computing for the next century.

Overall IS program objectives, and hence the planned products of the Intelligent Systems Strategic Investment area, will be determined by NASA's long-term research IS requirements. These requirements will be driven by the needs of future Agency missions in the 5- to 15-year year time frame. Depending on the results of assessing the mission needs for IS technologies, future IS products may include some or many of the following:

- *Demonstration of biochips and biomimetic architectures for sensing applications*
- *Experimental demonstration of scalable quantum logic operations*
- *Optical interconnection systems for computing*
- *Open agent architectures with reusable autonomy components*
- *Next-generation hardware and software computing methodologies*
- *Cooperative adaptive intelligent agents for scientific discovery and design*
- *Multimodal virtual environment simulation with realistic dynamics*
- *Techniques for remote collaboration with distributed environments*
- *Coordinated planning and execution for fleets*
- *Dynamic models of human sensory and cognitive capacities*
- *Next-generation principles for image and video coding*
- *Intelligent acoustic and vision processors*
- *Mature model-based programming processes and tools*
- *Biologically motivated hardware and software for learning from data sets*
- *Mobile devices with effective pen input and wireless communications*
- *Limited utility knowledge discovery and data mining tools*
- *Causal relations inference from large data sets*
- *High-bandwidth sharing of distributed human/machine resources*
- *Multiperson performance modeling combined with engineering simulations*
- *Cognitive task analysis for human-computer systems with variable autonomy.*

Rather than proceed in the long term in an incremental fashion (similar to a Base program), the IS program will reinvent itself periodically, providing a chance for self-assessment, reorientation of its priorities, and reconsideration of its fundamental goals and objectives. NASA Procedures and Guidelines (NPG) 7120.5A provides a means for program review and reassessment through Non-Advocate and Independent Reviews. The IS program plan proposes an initial year-long pilot or transition program, to be followed by a series of renewable, five-year program phases. A Non-Advocate Review (NAR), leading to approval by the Program Management Council (PMC) and Administrator, will precede each IS program phase except for the initial one-year pilot. Periodic Independent Reviews are proposed during the five-year interval between NARs, allowing a longer-term technology development view than in most NASA focused programs, while at the same time preserving the accountability and "sunset" advantages of time-limited focused programs. The IS program plan tries to find a middle way between focused and Base programs, capturing many of the advantages of each.

HIGH-PERFORMANCE COMPUTING AND COMMUNICATIONS (HPPC) PROGRAM

The purpose of the Federal Computing Information and Communications (CIC) Program is to extend U.S. technological leadership in high-performance computing and computer communications. As this is accomplished, these technologies will be widely disseminated to accelerate the pace of innovation and improve national economic competitiveness, national security, education, health care, and the global environment. The NASA HPCC Program is a critical element of the Federal CIC effort.

The specific goals of the NASA HPCC Program are to (1) accelerate the development, application, and transfer of high-performance computing capabilities and computer communications technologies to meet the engineering and science needs of the U.S. aerospace, Earth and space sciences, spaceborne research, and education communities; and (2) accelerate the distribution of these technologies to the American public.

FY00 OBJECTIVES

The primary objectives of the HPCC Program in fiscal year 2000 are:

- *Continue to advance application, system software, and testbed technologies leading to the demonstration of a 1000-fold improvement over FY92 baseline in time to provide a solution for space and Earth sciences and Aero-Space Transportation Grand Challenge applications on teraFLOPS testbeds in FY01.*
- *Demonstrate end-to-end performance improvement of Grand Challenge and/or NASA mission applications across a 500-times-more-capable internetwork than the FY96 baseline.*
- *Disseminate breakthrough learning technologies and applications into K–12 schools.*
- *Install a first-generation, scalable, embedded computing testbed operating at 30–200 MOPS/watt, and demonstrate scalable spaceborne applications and software-implemented fault tolerance on this testbed.*

ARC provides overall management of all work toward these objectives and, specifically, performs work in support of the first three of these objectives.

APPROACH

In order to meet these program goals, HPCC is organized into three Grand Challenge Computing projects, a high-performance communications project, and an education project. The three Grand Challenge Computing projects are Computational Aerosciences (CAS), Earth and Space Sciences (ESS), and Remote Exploration and Experimentation (REE). The NREN Project pursues the development of high-performance communication technologies for NASA missions. The Learning Technologies (LT) Project represents the primary educational component of HPCC.

Two of the Grand Challenge projects (CAS and ESS) jointly plan and execute work in the areas of ground-based computing testbeds and system software. The third Grand Challenge project (REE) extends ground-based technologies to NASA's spaceborne embedded systems. All projects benefit directly from computer network research carried out by the NREN project. NREN plans and executes work in the area of communications testbeds and network systems.

Beginning in FY00, the NASA HPCC Program will be further organized into three technology areas (applications, system software, and testbeds) that integrate across all the projects. These technology areas enable the coordination and integration of research and prototyping activities within the entire program. In response to national goals as well as Agency mission requirements, a renewed emphasis will be placed on the underlying system software and testbed technologies needed to enable stressing NASA applications on high-performance systems.

In the next three to five years, the overall goals of the HPCC will be to:

- Develop algorithm and architectural testbeds utilizing high-performance computing and networking concepts for increased end-to-end performance, interoperability of applications, portability across testbeds, and reliability.
- Provide impact to NASA missions through the demonstration of HPCC technologies on U.S. aerospace transportation, Earth and space sciences, and spaceborne community research problems.
- Develop services, tools, and interfaces essential to distributing technologies to the educational community and the American public.

ARC's Lead Center Roles for Other Agency Assignments

CONSOLIDATED SUPERCOMPUTING MANAGEMENT OFFICE (CoSMO)

The Consolidated Supercomputing Management Office (CoSMO) is a NASA Chief Information Officer (CIO)-sponsored functional initiative. The primary goal of CoSMO is to meet the High-Performance Computing requirements for all Enterprises, while realizing an optimal return on investment through effective and efficient management of NASA's high-performance computing assets. It is responsible for the acquisition, maintenance, operation, management, upgrade, and cost-center budgeting for NASA's supercomputer resources, regardless of location. Operations and maintenance support are provided to NASA research and development and secure-computing programs.

FY00 Objectives

CoSMO objectives for consolidated Agency-wide management of supercomputing are to:

- *Complete consolidation of Langley Research Center's secure supercomputing at the Naval Oceanographic Office (NAVOCEANO), Stennis Space Center, Mississippi.*
- *Establish an Agency-wide, consolidated operations contract for supercomputing.*
- *Transition the 256-processor Steger 02K supercomputer into a production machine.*
- *Work with the IT Investment Council to develop a NASA Strategic Plan for Supercomputing.*

Approach

CoSMO's approach is to evolve NASA's high-performance computing assets toward an environment that embraces the concepts of a "metacenter." This metacenter, in theory, will permit any user of CoSMO to have uniform access to all computing and storage assets associated with CoSMO. The scope of supercomputing resources within NASA includes high-speed processors, mass-storage systems, and network interfaces. Supercomputers include production, research and development, and secure-computing engines.

Longer-term goals for the CoSMO program are to:

- *Consolidate operations across NASA and design an optimal supercomputing architecture.*
- *Colocate supercomputing platforms within large data centers, where applicable.*
- *Modernize data centers to improve service and reduce life-cycle costs.*
- *Form partnerships with other Federal agencies and industry to support NASA's supercomputing requirements.*

INFORMATION TECHNOLOGY SECURITY (ITS)

The Principal Center for ITS (PC-ITS) was established to bring a unified approach and an Agency focus to the problem of information security. The PC-ITS is committed to developing and maintaining a secure, state-of-the-art computing infrastructure that can support the NASA programs and projects as well as NASA researchers throughout the world. This commitment requires a strategy that: prevents information from being disclosed to anyone who is not authorized to use it; prevents information from being maliciously corrupted, modified, or forged; and prevents access from being denied because of burdensome procedures or malicious attacks.

FY00 Objectives

The program objectives are to:

- *Complete and expand the NASA Public Key Infrastructure (PKI).*
- *Deploy an Agency-wide secure messaging system that utilizes the PKI.*
- *Maintain an aggressive Agency-wide ITS awareness and training program.*
- *Continue the mandatory IT Awareness and Training program.*
- *Establish a process for refreshment and new employee training.*
- *Incorporate improved ITS training contract language in existing contracts and in new contracts, include requirements for prerequisite training for authorization to perform network or system administration functions.*
- *Implement strategies to reduce system vulnerabilities against hacker attacks.*
- *Enhance and maintain all Centers with current monitoring capabilities by acquisition and deployment of audit and monitoring tools. Develop performance metrics for reporting vulnerability reduction progress.*
- *Incorporate operational trust standards for firewall implementations at all Centers.*
- *Conduct self-tests at all NASA Centers for reporting all incidents to the NASA Automated Security and Response Capability (NASIRC).*
- *Update the policies and procedures addressing ITS.*

Approach

The approach of the ITS program is to:

- *Update the policies and procedures addressing ITS.*
- *Establish standard metrics and reporting processes for all Centers to follow.*
- *Utilize technologies to help manage the security of the IT environment.*
- *Increase the ITS program resources through the Agency budget process.*

Achieving these goals and objectives will require coordinated investment and cooperation at the Agency level and by the other NASA Centers.

IV. Implementing Enterprise-Level Responsibilities

Aero-Space Technology (AT) Enterprise

The Office of Aero-Space Technology (OAT) has developed a set of goals for the future that reflect national priorities for aeronautics and space. These ten goals, outlined in the AT brochure "Three Pillars for Success," are grouped into three areas or "pillars" in order to stress their significance and contribution to America's future. The pillars are Global Civil Aviation, Revolutionary Technology Leaps, and Access to Space. The following sections describe the goals and ARC's involvement in them.

PILLAR ONE: GLOBAL CIVIL AVIATION

As the largest positive industrial contributor, aviation products are vitally important to the U.S. balance of trade. Moreover, it is projected that air travel demand will triple over the next 20 years. To preserve our Nation's economic health and the welfare of the traveling public, NASA must pursue high-risk research to provide needed technology advances for safer, cleaner, quieter, and more affordable air travel. Accordingly, the Global Civil Aviation pillar encompasses the following five goals:

- *Reduce the aircraft accident rate by a factor of 5 within 10 years, and by a factor of 10 within 20 years.*
- *Reduce emissions of future aircraft by a factor of 3 within 10 years, and by a factor of 5 within 20 years.*
- *Reduce the perceived noise levels of future aircraft by a factor of 2 (from today's subsonic aircraft) within 10 years, and by a factor of 4 within 20 years.*
- *While maintaining safety, triple the aviation system throughput, in all weather conditions, within 10 years.*
- *Reduce the cost of air travel by 25 percent within 10 years, and by 50 percent within 20 years.*

PILLAR TWO: REVOLUTIONARY TECHNOLOGY LEAPS

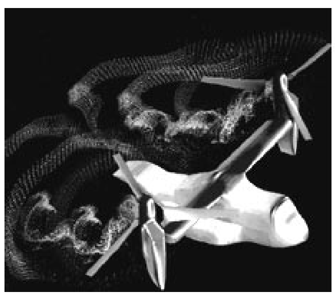
NASA's charter is to explore high-risk technology areas that can revolutionize air travel and create new markets for U.S. industry. The technology challenges for NASA include: eliminating the barriers to affordable supersonic travel, expanding general aviation, and accelerating the application of technology advances. To meet these challenges, the Revolutionary Technology Leaps pillar strives to meet three goals:

- *Reduce the travel time to the Far East and Europe by 50 percent within 20 years, and do so at today's subsonic ticket prices.*
- *Invigorate the general aviation industry, delivering 10,000 aircraft annually within 10 years, and 20,000 aircraft annually within 20 years.*
- *Provide next-generation design tools and experimental aircraft to increase design confidence, and cut the development cycle time for aircraft in half.*

PILLAR THREE: ACCESS TO SPACE

NASA envisions the space frontier as a future, busy crossroads of U.S.-led international science, research, commerce, and exploration. NASA's experience with this vast resource has already yielded new treasures of scientific knowledge, life-enhancing applications for use on Earth, and fantastic celestial discoveries. To realize the potential for research and commerce in space, the United States must achieve one imperative, overarching goal—affordable access to space. Specifically, the third pillar, Access to Space, encompasses two goals:

- *Reduce the payload cost to low-Earth orbit by an order of magnitude, from $10,000 to $1000 per pound, within 10 years, and by an additional order of magnitude within 20 years.*
- *Reduce the cost of interorbital transfer by an order of magnitude within 15 years, and reduce travel time for planetary missions by a factor of 2 within 15 years, and by an order of magnitude within 25 years.*



ARC's Lead Roles in Aero-Space Technology

The goals and objectives of the AT Enterprise are expressed in terms of the three pillars and ten goals described previously. ARC is committed to working with industry and other government entities to develop the technology that will make these goals a reality. Research and development conducted by the AT Enterprise is led by individual NASA research centers according to the primary roles and missions that have been assigned to each Center. ARC is the lead center for the focused programs in Aviation System Capacity (ASC) and High-Performance Computing and Communications (HPCC) and for the Research and Technology (R&T) base programs in AOS, Information Technology (IT), and Rotorcraft. In addition, ARC leads the Enterprise core competencies in the areas of human factors, air traffic management, information system technologies, integrated aeronautics design tools, rotorcraft R&T, nonmetallic thermal protection systems (TPS), and integrated vehicle health management (IVHM). Other strategic investment areas include critical national research facilities, high-performance computing, environmental research and modeling, and high-performance aircraft survivability.

INFORMATION TECHNOLOGY R&T BASE PROGRAM

The Information Technology R&T Base Program is sponsored by the OAT to develop and transfer information technology solutions that support NASA's missions. It is organized into three program investment areas: Integrated Design Technology, Software Technology, and Advanced Computing Technology.

Program FY00 Objectives

The objectives of the IT R&T Base Program in FY00 are to:

- *Develop a real-time aerospace design exploration capability in support of space transportation vehicles.*
- *Develop verifiably correct program synthesis technology for reduced time in software coding and testing.*
- *Demonstrate a prototype heterogeneous distributed computing environment to enable collaborative science and engineering.*

Program Approach

The IT R&T Base Program aims to provide fundamental advances in simulation and test techniques, software technology, and advanced, high-end computational capabilities. The IT Program comprises three investment areas: Integrated Design Technology, Software Technology, and Advanced Computing Technology. Integrated Design Technology focuses on the development of tools and integrated systems for the design and manufacture of flight vehicles. The Software Technology investment area focuses on the development and management of complex flight and aviation operation systems, automated generation and verification of flight-critical software, and software and data integrity. Because these activities, and many others within OAT, rely on ever-increasing computational capabilities, it follows that the third investment area, Advanced Computing Technology, addresses advanced capabilities of computing systems. The unique role of this area is its emphasis on integrated dynamic supercomputing systems capabilities.

Enterprise Goals/ Objectives Served

The primary AT Enterprise goals served by these areas of the IT Program include:

Pillar One: Global Civil Aviation

- *Reduce the aircraft accident rate by a factor of 5 within 10 years, and by a factor of 10 within 20 years.*
- *Reduce the cost of air travel by 25 percent within 10 years, and by 50 percent within 20 years.*

Pillar Two: Revolutionary Technology Leaps

- *Provide next-generation design tools and experimental aircraft to increase design confidence, so that the cycle time for aircraft is cut in half.*

Pillar Three: Access to Space

- *Reduce the payload cost to low-Earth orbit by an order of magnitude, from $10,000 to $1000 per pound, within 10 years, and by an additional order of magnitude within 20 years.*
- *Reduce the cost of interorbital transfer by an order of magnitude within 15 years, and reduce travel time for planetary missions by a factor of 2 within 15 years, and by an order of magnitude within 25 years.*

Enterprise Goals/ Objectives Served

The primary AT Enterprise goals served by these areas of the Rotorcraft R&T Base Program are:

Pillar One: Global Civil Aviation

- *Reduce the aircraft accident rate by a factor of 5 within 10 years, and by a factor of 10 within 20 years.*
- *Reduce the cost of air travel by 25 percent within 10 years, and by 50 percent within 20 years.*
- *Reduce the perceived noise levels of future aircraft by a factor of 2 (from today's subsonic aircraft) within 10 years, and by a factor of 4 within 20 years.*
- *While maintaining safety, triple the aviation system throughput, in all weather conditions, within 10 years.*

Pillar Two: Revolutionary Technology Leaps

- *Provide next-generation design tools and experimental aircraft to increase design confidence, so that the cycle time for aircraft is cut in half.*

ROTORCRAFT R&T BASE PROGRAM

The Rotorcraft R&T Base Program is sponsored by the OAT to provide technology leadership in both the short and long term. The program consists of four major projects: (1) Design for Efficient and Affordable Rotorcraft (DEAR); (2) Select Integrated Low-Noise Technologies (SILNT); (3) Safe All-Weather Flight Operations for Rotorcraft (SAFOR); and (4) Fast-Response Industry Assistance Requests (FRIAR).

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Program FY00 Objectives

The objectives of the Rotorcraft R&T Base Program are to:

- *Complete the proof-of-concept demonstration of an innovative design for the world's first ultrasafe gear.*
- *Flight demonstrate active control technology for rotorcraft interior noise reduction; provide interior noise prediction methods for range or rotorcraft types.*

Program Approach

The long-term goals in the rotorcraft program are strongly coupled with both industry and academia through the aeronautics strategic planning process and direct customer interaction. The DEAR, SILNT, and SAFOR projects are structured to address the identified longer-term, higher-risk technology needs. The shorter-term technology development is implemented through a unique government/industry partnership, the National Rotorcraft Technology Center (NRTC). NASA and the Department of Defense (DoD) fund this effort, with matching funds from the rotorcraft industry, to develop technology that ensures the economic competitiveness and continued military supremacy of U.S. rotorcraft. Technology projects, of which an example is the FRIAR project, are selected from an annual research portfolio proposed and cofunded by the industry members, with participation of subtier manufacturers and academia.

AVIATION OPERATIONS SYSTEMS R&T BASE PROGRAM

The AOS Program works to enable major increases in safety of aircraft operations in the National Airspace System (NAS) and worldwide through the development and validation of advanced technology concepts, methodologies, and procedures, and their transfer to the user and regulatory communities. The key components that comprise aviation safety are the aircraft/ aviation system, people, and the environment. The AOS Base Program comprises three investment areas to address these components: Systems Design, Assessment, and Reliability (SDAR); Human Performance and Countermeasures (HPC); and Hazardous Environment Prediction and Mitigation (HEPM).

Program FY00 Objectives

Following the completion of a significant amount of research in system monitoring and modeling, training, and weather information, all of which is being transferred to the new Aviation Safety Research Program, the AOS program will be extensively redesigned in FY00.

Program Approach

The Systems Design, Assessment, and Reliability (SDAR) research projects address aviation system performance and reliability, including the human operators explicitly, from both assessment and design points of view. The specific emphasis is on design methodologies and validated technologies and procedures for both airborne and ground system automation that properly address integration with the human operators.

The HPC research projects will develop knowledge bases and models of fundamental human information processing capabilities. These tools can then be used to develop technologies to enhance human information processing capabilities or to devise countermeasures to remediate them.

The Hazardous Environment Prediction and Mitigation (HEPM) research projects will develop databases, knowledge bases, models, and predictive technologies to assess critical weather influences on both safety and efficiency. Advanced concepts and procedures to identify environmental hazards and to avoid or mitigate their effects will be identified.

Extensive cooperation will be undertaken with the operations community and the FAA.

Enterprise Goals/ Objectives Served

The primary AT Enterprise goal served by these areas of the AOS Program is:

Pillar One: Global Civil Aviation

- *Reduce the aircraft accident rate by a factor of 5 within 10 years, and by a factor of 10 within 20 years.*

Enterprise Goals/ Objectives Served

The primary AT Enterprise goal served by these areas of the AOS Program is:

Pillar One: Global Civil Aviation

- *Reduce the aircraft accident rate by a factor of 5 within 10 years, and by a factor of 10 within 20 years.*

AVIATION SYSTEM CAPACITY PROGRAM

The Aviation System Capacity (ASC) Program strives to enable safe increases in the capacity of major U.S. and international airports through both modernization and improvements in the Air Traffic Management System and the introduction of new vehicle classes that can reduce congestion. Specifically, the goals of the ASC Program are to create advanced concepts and technologies that will enable new aircraft development; and to implement operational concepts and their associated decision support tools, procedures, and hardware systems to maximize safety, efficiency, and flexibility of operations in the National Airspace System. The ASC Program comprises three major projects that, as an integrated effort, provide a focused technology foundation. These projects are: Advanced Air Transportation Technologies (AATT); Terminal Area Productivity (TAP); and Civil Tiltrotor (CTR).

Program FY00 Objectives

The following milestones reflect the specific objectives of the Ames Research Center elements of the ASC Program for FY00:

- *Develop, demonstrate, and transfer extended terminal-area decision support tools for arrival and surface operations in support of the FAA Free Flight Phase One Program. (AATT)*
- *Deploy and demonstrate an Aircraft Vortex Spacing Separation (AVOSS), and the ability to transmit air traffic control (ATC) information between an aircraft's autoflight system and ATC, via advanced tools developed under the center terminal radar approach control facilities (TRACON) Automation System (CTAS). (TAP)*
- *Create a full-span database for low-noise rotor concepts and code validation. (CTR)*
- *Demonstrate electronic transfer of flight plan updates from the ATC CTAS systems directly into the aircraft Flight Management System (FMS) to decrease approach and taxi times.*
- *Demonstrate the Airborne Information for Lateral Spacing (AILS) tool for conducting independent parallel approaches to runways spaced less than 3400 ft apart via a full-mission simulation.*

Program Approach

The goal of the AATT Project is to enable substantial increases in the efficiency and capacity of aircraft operations within both the national and the global air transportation system. The approach is to maximize "free flight" to allow the users to lower direct operating costs by trading off time and routing, and to improve the effectiveness of high-density operations in regions where free flight will not be possible. The program also works to enable operation in a smooth and efficient manner across boundaries of free-flight and capacity-constrained-flight regions; provide system improvements that are easily deployable anywhere in the world; and improve the ability to model and simulate advanced capabilities in the airspace system and its subcomponents. The AATT Project manages programmatic and technical integration with a systems engineering effort that includes IV&V support in the areas of software development tracking and evaluation.

The goal of the Terminal Area Productivity (TAP) Project is to increase airport terminal area capacity in nonvisual, or instrument-weather, conditions. The technical approach is to provide technologies and operating procedures that will increase productivity of the airport terminal area in instrument-weather conditions to safely match that of clear-weather, or visual conditions. It is anticipated that integrated ground and airborne technology will safely reduce spacing inefficiencies associated with single runway operations and the required spacing for independent, multiple-runway operations conducted under instrument flight rules.

The goal of the NASA Civil Tiltrotor Project is to develop the most critical technologies needed to overcome the inhibitors of operating civil tiltrotor aircraft within the air transportation system. These technologies include an efficient, low-noise proprotor; an integrated cockpit for minimum pilot workload during low-noise approaches and departures near congested terminal areas; and safe and cost-effective one-engine-inoperative emergency contingency power capability.

Enterprise Goals/ Objectives Served

These simulation facilities provide critical support to the following AT Enterprise Pillars and goals:

Pillar One: Global Civil Aviation

- *Reduce the aircraft accident rate by a factor of 5 within 10 years, and by a factor of 10 within 20 years.*
- *While maintaining safety, triple the aviation system throughput, in all weather conditions, within 10 years.*
- *Reduce the perceived noise levels of future aircraft by a factor of 2 (from today's subsonic aircraft) within 10 years, and by a factor of 4 within 20 years.*
- *Reduce the cost of air travel by 25 percent within 10 years, and by 50 percent within 20 years.*

Pillar Two: Revolutionary Technology Leaps

- *Reduce the travel time to the Far East and Europe by 50 percent within 20 years, and do so at today's subsonic ticket prices.*
- *Provide next-generation design tools and experimental aircraft to increase design confidence, and cut the development cycle time for aircraft in half.*

Pillar Three: Access to Space

- *Reduce the payload cost to low-Earth orbit by an order of magnitude, from $10,000 to $1000 per pound, within 10 years, and by an additional order of magnitude within 20 years.*
- *Reduce the cost of interorbital transfer by an order of magnitude within 15 years, and reduce travel time for planetary missions by a factor of 2 within 15 years, and by an order of magnitude within 25 years.*

SIMULATION FACILITY GROUP DIRECTOR

AT Enterprise leaders determined that central management of major aeronautical facilities was in the Nation's best interest and established several facility groups. ARC is responsible for management of one of those groups: the Simulation Facility Group (SFG). This group is the single mechanism utilized by the Enterprise for strategic management and integrated activity planning in the areas of facility investment, operations policy, business management, and test technology for designated simulation facilities. The SFG considers a U.S. national perspective that includes not only the military and commercial aerospace interests of the government, but those of industry as well.

Facilities within the purview of SFG are: the Crew Vehicle Systems Research, Vertical Motion Simulator, and Future Flight Central Facilities at Ames Research Center; and the Visual Motion Simulator, Differential Maneuvering Simulator, and Cockpit Motion Facilities at Langley Research Center.

Program FY00 Objectives

The group's FY00 objectives are as follows:

- *Compile near-term and long-term customer requirements.*
- *Develop facility investment strategy and plans, including innovative financing methods for new capability, upgrade of existing capability, and consolidation/closure.*
- *Establish national requirements. Explore new technology to increase the efficiency of aerospace research conducted in the simulation facilities.*
- *Develop methods of increasing the use of simulation in order to reduce the cost of the design cycle of aerospace vehicles.*

- *Facilitate the development and maintenance of a consistent charging policy and cost reporting formats.*
- *Develop common customer interfaces, such as test request information, model design criteria, customer contract/agreement, and customer critique procedures.*

Program Approach

The Simulation Facility Group (SFG) Director leads the strategic management activities of the simulation facilities, with assistance provided by the Simulation Integration Task Team (ITT). The ITT consists of functional managers responsible for operating the simulation facilities at ARC and Langley. The SFG recommends and encourages implementation of common processes, products, and procedures across the AT Enterprise.

ENTERPRISE GOALS/ OBJECTIVES SERVED

The enterprise goals supported by this work are:

Pillar Three: Access to Space

- *Reduce the payload cost to low-Earth orbit by an order of magnitude, from $10,000 to $1000 per pound, within 10 years, and by an additional order of magnitude within 20 years.*
- *Reduce the cost of interorbital transfer by an order of magnitude within 15 years, and reduce travel time for planetary missions by a factor of 2 within 15 years, and by an order of magnitude within 25 years.*

ARC's Supporting Roles in Aero-Space Technology

SPACE TRANSPORTATION TECHNOLOGY

ARC leads the Enterprise core competencies in the areas of nonmetallic thermal protection systems (TPS), integrated vehicle health management (IVHM), advanced information technology systems, and physics-based tool development and test applications.

PROGRAM FY00 OBJECTIVES

ARC's FY00 objectives for the Space Transportation Technology Program are to:

- *Complete supporting work on the TPS designs, technologies, test data, and hardware for the next generation of Reusable Launch Vehicles (RLV) including the X-33. Complete Independent Verification and Validation (IV&V) tasks for the X-33 flight software. Support initial flight testing of the X-34 and X-33, as appropriate.*
- *Participate in the new Pathfinder Future X Program by implementing the Slender Hypersonic Aerothermodynamic Research Probe (SHARP-B2) flight experiment and the IVHM experiments on the X-34 and X-37 per approved plans. Continue to plan and advocate the SHARP-L1 flight experiment.*
- *Participate in technology developments in the aforementioned technology areas, as appropriate, for second-generation RLV New Derived/Shuttle Derived (ND/SD) RLVs. This participation will be in accordance with the planning process being completed in the latter part of FY99 and will support a 2005 national decision between the two competing approaches to meet the safety and cost targets for Goal 9 of the Enterprise.*
- *Implement technology development for the third-generation RLV, as defined in the Spaceliner 100 "blueprint" that was developed in FY99. ARC's lead roles here include revolutionary advances in SHARP technologies, adaptive intelligent TPS (aiTPS), and a testbed for the development of aiTPS and IVHM that will fully realize the goal of having "intelligent" vehicles.*
- *Provide advanced TPSs required for the Mars Sample Return Earth Entry Vehicle and develop a TPS flight validation test known as Prometheus.*
- *Continue to support space transportation planning needs of the Integrated Mars Exploration Program jointly led by the Lyndon B. Johnson Space Center (JSC) and the Jet Propulsion Laboratory (JPL).*

PROGRAM APPROACH

Important elements of the work performed in support of the Space Transportation Technology programs are: (1) new TPS materials/systems; rapid design tools for TPS sizing, including operation and development of improved flow diagnostics of unique, large-scale, high-temperature, arc-jet ground-test facilities; and general support of industry-led teams developing next-generation vehicles; and (2) IVHM systems that can diagnose in-flight/postflight vehicle health. The utility of IVHM will be to take corrective action to mitigate in-flight anomalies and dramatically reduce the time for recycling vehicles for reflight by prescribing only the ground maintenance that is required. ARC will also develop advanced tools for vehicle design, embodying them into Intelligent Synthesis Environments, and will carry out IV&V for software for new space transportation systems, as is being done for the X-33 software. ARC will lead the way in developing the first "smart systems" for "intelligent" vehicles under the aegis of the Spaceliner 100 activity built upon its strengths in Information Systems Technology.

AIRFRAME AND PROPULSION SYSTEMS BASE TECHNOLOGY PROGRAMS

ARC performs a variety of tasks to support both the Airframe Systems Base Technology Program led by Langley Research Center and the Propulsion Systems Base Technology Program led by Glenn Research Center. These programs draw upon many of the ARC core competencies, including Information Technology and critical facilities, to achieve their goals.

Program FY00 Objectives

To support programs in Airframe and Propulsion Systems, ARC is undertaking the following tasks in FY00:

- *Define noise reduction concepts for Futuristic Aircraft.*
- *Conduct a large-scale semispan wind tunnel investigation of airframe noise reducing concepts.*

Approach

ARC will use existing core competencies collaboratively with other NASA Centers to support their program goals and responsibilities.

Space Science Enterprise

The mission of the Space Science Enterprise, as described in The Space Science Enterprise Strategic Plan (Nov. 1997), is to solve mysteries of the universe, explore the solar system, discover planets around other stars, and search for life beyond Earth.

Detailed space science planning begins with a set of fundamental questions or pillars. These questions form the basis for our scientific program over the next several decades. They are:

- *How did the universe begin and what is its ultimate fate?*
- *How do galaxies, stars, and planetary systems form and evolve?*
- *What physical processes occur in extreme environments (black holes)?*
- *How and where did life begin?*
- *How is the evolution of life linked to cosmic phenomena?*
- *Why does the sun vary and how do the Earth and other planets respond?*
- *How might humans inhabit other worlds?*

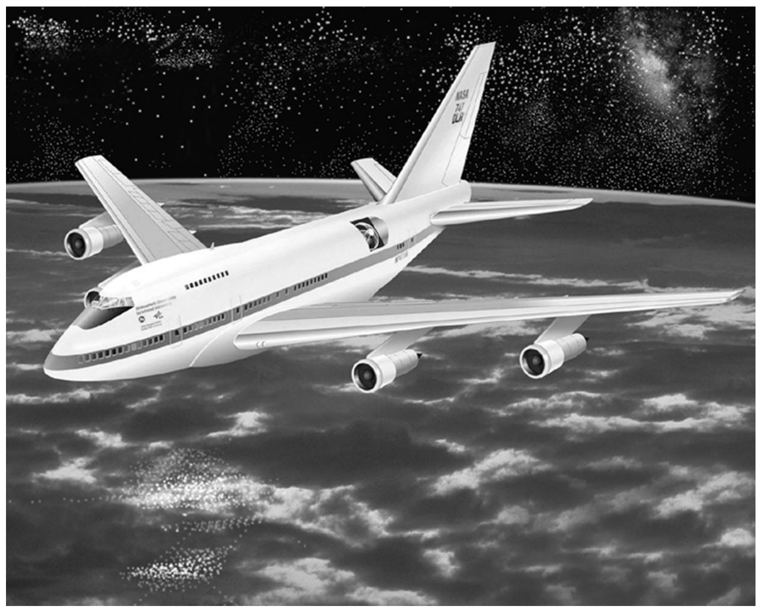
To address these fundamental questions, the Space Science Enterprise, in conjunction with the space science community, has laid out a series of Enterprise Goals to guide our activities. These include:

- *Establish a virtual presence throughout the solar system, and probe deeper into the mysteries of the universe and life on Earth and beyond.*
- *Pursue space science programs that enable and are enabled by future human exploration beyond low Earth orbit.*
- *Develop revolutionary technologies for missions.*
- *Contribute to achieving science, mathematics, and technology education goals and share the excitement and inspiration of our discoveries.*

These goals have been further refined into 11 Science Goals:

- Goal 1: *Understand how structure in our universe (e.g., clusters of galaxies) emerged from the Big Bang.*
- Goal 2: *Test physical theories and reveal new phenomena throughout the universe, especially through the investigation of extreme environments.*
- Goal 3: *Understand how both dark and luminous matter determine the geometry and fate of the universe.*
- Goal 4: *Understand the dynamical and chemical evolution of galaxies and stars and the exchange of matter and energy among stars and the interstellar medium.*
- Goal 5: *Understand how stars and planetary systems form together.*
- Goal 6: *Understand the nature and history of our solar system, and what makes Earth similar to and different from its planetary neighbors.*

- Goal 7: *Understand mechanisms of long- and short-term solar variability, and the specific processes by which Earth and other planets respond.*
- Goal 8: *Understand the origin and evolution of life on Earth.*
- Goal 9: *Understand the external forces, including comet and asteroid impact that affect life and the habitability of Earth.*
- Goal 10: *Identify locales and resources for future human habitation within the solar system.*
- Goal 11: *Understand how life may originate and persist beyond Earth.*



ARC's Role in Support of the Space Science Enterprise

ARC supports the Space Science objectives through fundamental research in astrobiology, exobiology, origins, astrophysics, and planetary science, as well as through technology and flight project development and operations. The chief elements supporting Space Science are: Space Science Research; the Stratospheric Observatory for Infrared Astronomy Program; and other elements, including the Center for Mars Exploration and the Lunar Prospector Project.

SPACE SCIENCE RESEARCH

Space Science Research at ARC implements the Space Science Enterprise Goals through three elements, dealing with Astrophysics, Planetary Systems, and Exobiology. Since the unifying theme for these three elements is origin and evolution of stars, planets, and life, the total research effort represents a major thrust in the Enterprise's Astrobiology program. Astrophysics research addresses Enterprise goals and objectives that deal with understanding how the structure in our universe emerged, the dynamical evolution of galaxies and stars, and the exchange of matter and energy among stars and the interstellar medium. Planetary Systems research addresses Enterprise goals and objectives that deal with understanding star formation, the evolution and distribution of volatile and organic material, the origin and distribution of planetary systems, rings, and primitive bodies, and planetary atmosphere evolution. Exobiology research addresses Enterprise goals and objectives that deal with understanding the origin, evolution, and distribution of life by conducting research on the cosmic history of biogenic compounds, prebiotic evolution, the early evolution of life, computational astrobiology, and life extreme environments.

FY00 Objectives

TThe following FY00 objectives are representative of a more comprehensive approach represented by some 130 separate research tasks. Most of these tasks relate directly to the goals above that are relevant to Astrobiology (e.g., Goals 6-11).

- *Identify organic matter on the surfaces of outer solar system planets and trans-Neptunian objects. (Goal 6)*
- *Synthesize the formation of amino acids under conditions representative of the formation of the solar system. (Goal 8)*
- *Determine how the jets emanating from young stars are related to and driven by their circumstellar disks. (Goal 5)*
- *Search for extrasolar planets using the Keck Telescope in Hawaii and the Lick Observatory in California. (Goal 5)*
- *Compute the effects of carbon dioxide ice clouds on early Martian climate to determine if there was sufficient greenhouse effect to allow liquid surface water on early Mars. (Goal 11)*
- *Identify Martian conditions under which substantial water exchange can be achieved between the atmosphere and regolith. (Goal 10)*
- *Compute accretion models for extrasolar giant planets on nearly circular orbits soon after their discoveries are announced. (Goal 5)*
- *Publish model impact rates on all the moons in the outer solar system. (Goal 9)*
- *Examine structural changes as a function of time and temperature in simulated cometary and interstellar ices. (Goal 4)*
- *Simulate early Mars when surface pressures were much higher. (Goal 11)*
- *Identify comet and asteroid analog volatile mixtures using ion mobility spectrometry. (Goal 6)*
- *Extend calculations with the gas-grain protostellar disk code to include more detailed chemistry to compare with observations. (Goal 5)*

- *Develop a returned Mars sample quarantine protocol. (Goal 11)*
- *Initiate isotopic measurements of polyols/sugars in the Murchison meteorite. (Goal 10)*
- *Determine the mechanism of transport across protobiological transmembrane channels. (Goal 8)*
- *Identify microbial lipid biomarkers in various types of microbial mats. (Goal 8)*
- *Complete an isotopic study of very ancient kerogens and carbonates. (Goal 8)*
- *Release a CD-ROM of Earth-based ring occultation data prepared by the Planetary Ring Node. (Goal 6)*
- *Develop new written instructions and standards for NASA's microbial examination of spaceflight hardware. (Goal 11)*
- *Develop the theory of the shape and motion of the heliospheric termination shock. (Goal 2)*
- *Participate in instrument-level tests of the SIRTF Infrared Array Camera (IRAC), with emphasis on validating performance of the Channel III & IV Si:As detector arrays. (Goal 1)*

STRATOSPHERIC OBSERVATORY FOR INFRARED ASTRONOMY PROGRAM

The Stratospheric Observatory for Infrared Astronomy (SOFIA), a key element of NASA's new Origins program, is a large-aperture infrared/submillimeter observatory being developed cooperatively by NASA and the Deutsche Forschungsanstalt für Luft- und Raumfahrt (DLR) in Germany. SOFIA will operate in the stratosphere, above 99 percent of the water vapor that obscures infrared wavelengths from all ground-based observatories. The SOFIA System includes the observatory—a 2.5-meter-aperture telescope mounted in an open-port cavity in a 747 aircraft—plus a science and mission operations center located at Ames Research Center. Across most of the infrared spectral region, SOFIA will have the highest broadband imaging and spectroscopic resolution of any observatory currently approved for development, and will also be deployable worldwide to observe transient events such as occultations and supernovae.

PROGRAM FY00 OBJECTIVES

- *For the German-provided telescope, to successfully complete a critical design review so that full-scale production of the telescope may begin.*
- *For the U.S. Systems, to complete the critical design review of the SOFIA System so that full-scale production of the aircraft modification, onboard mission control system, and science and mission operations center may be initiated. Also to complete test activity in the Section 46 mockup in support of the Observatory System's critical design review.*

PROGRAM APPROACH

The observatory is optimized for studying far-infrared wavelengths between 30 and 300 micrometers; however, science data will be obtained across the broad wavelength range of 0.3 to 1600 micrometers through the use of numerous focal plane instruments brought to the observatory by the international science community. The ability to upgrade instruments regularly will enable the observatory to employ the very latest focal plane and other instrument technologies, including large-format infrared (IR) and submillimeter detector arrays, which will be transferable to other missions over SOFIA's 20-year operating lifetime.

The SOFIA System is under development by contractor teams in the U.S. and Germany. The U.S. team, led by the Universities Space Research Association (USRA), is developing the 747 modification, including the large cavity cutout, rerouting of the airframe structure around the cutout, rerouting of the aircraft systems through the telescope cavity, and developing the new systems installations such as the cavity door and environmental control system. USRA's team is also providing the onboard mission control system and the science and mission operations center. Several of these items are being developed in conjunction with NASA ARC, which is providing some of the designs, hardware, and facilities. In Germany, a consortium of companies led by MAN Technology is developing the airborne telescope assembly, including its 2.7-meter-diameter primary mirror, and its optics, structure, vibration isolation,

ENTERPRISE GOALS/ OBJECTIVES SERVED

Goal 4: *Understand the dynamical and chemical evolution of galaxies and stars and the exchange of matter and energy among stars and the interstellar medium.*

Goal 5: *Understand how stars and planetary systems form together.*

Goal 6: *Understand the nature and history of our solar system, and what makes Earth similar to and different from its planetary neighbors.*

Goal 8: *Understand the origin and evolution of life on Earth.*

Enterprise Goals/ Objectives Served

Goal 4: *Understand the dynamical and chemical evolution of galaxies and stars and the exchange of matter and energy among stars and the interstellar medium.*

Goal 5: *Understand how stars and planetary systems form together.*

Goal 6: *Understand the nature and history of our solar system, and what makes Earth similar to and different from its planetary neighbors.*

Goal 8: *Understand the origin and evolution of life on Earth.*

and pointing control systems. The telescope will be ready in late 2001 for installation into the modified 747, scheduled to take place in Germany, followed by its return to the U.S. for a planned series of tests and certification flights. Science operations will start about a year after the telescope is installed in the 747.

OTHER SPACE SCIENCE ELEMENTS

Additional research areas at ARC play major roles in the implementation of the Space Science Goals. One area is the Center for Mars Exploration (CMEX), a joint activity of the Space and Information Systems Directorates, which deals with goals and objectives for integrated human and robotic Mars exploration. A second area, Space Projects, addresses Enterprise goals and objectives that deal with advanced technology and advanced mission concepts for solar system exploration missions and projects. The third unit is Space Technology, which addresses Enterprise goals and objectives that deal with development of advanced technologies to enable future robotic and human solar system exploration missions. The final unit is the Lunar Prospector Project. Data gathered by the Lunar Prospector spacecraft will complete the most comprehensive data set available for any extraterrestrial planetary body. It will also allow better usage of the Moon, as a model to study other worlds and as a potential platform for studying further human exploration of space.

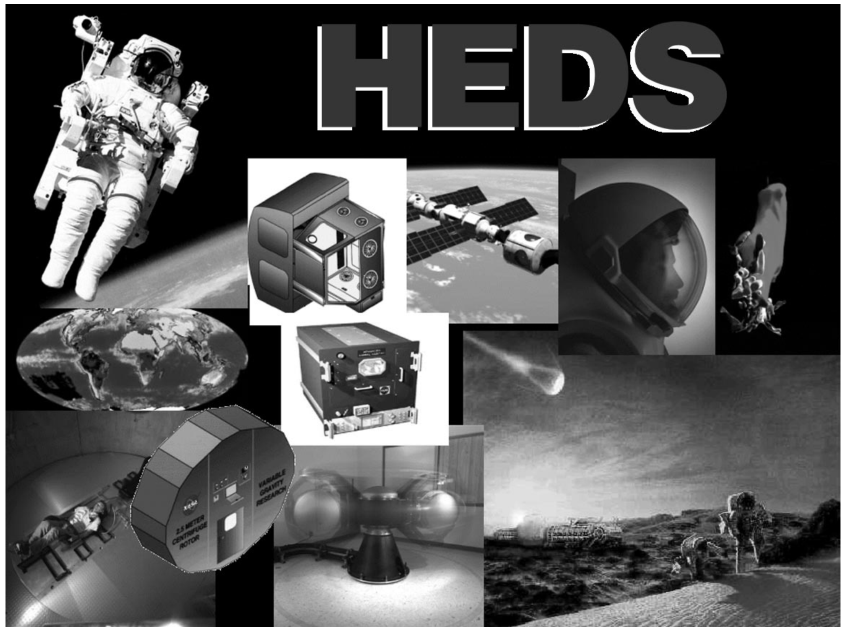
FY00 Objectives

- *Complete the delivery of all data products for Lunar Prospector and deliver to the Planetary Data System (PDS). Complete a final report on the Lunar Prospector Mission.*
- *Fabricate IR detectors and test under the conditions expected at the Next-Generation Space Telescope (NGST) and SOFIA focal planes.*
- *Continue development of the Airborne Infrared Echelle Spectrometer (AIRES) facility science instrument for SOFIA.*
- *Complete the technical demonstration of the Kepler Mission, including data reduction and analysis, and publish the findings in a final report.*
- *Analyze the Vulcan Camera data from six star fields for evidence of giant extrasolar planet transits.*
- *Publish a NASA SP on Human Exploration: The Mars Surface Mission.*

Human Exploration and Development of Space (HEDS) Enterprise

The mission of the Human Exploration and Development of Space (HEDS) Enterprise is to open the space frontier by exploring, using, and enabling the development of space, and to expand the human experience into the far reaches of space. The goals and objectives of the HEDS Enterprise are:

- Goal 1: Expand the frontier
  - *Objective 1: Enable human exploration through collaborative robotic missions.*
  - *Objective 2: Define innovative, safe, and affordable human exploration mission architectures.*
  - *Objective 3: Invest in enabling high-leverage exploration technologies.*
- Goal 2: Expand scientific knowledge
  - *Objective 1: In partnership with the scientific community, use the space environment to explore chemical, biological, and physical systems.*
- Goal 3: Enable and establish a permanent and productive human presence in Earth orbit
  - *Objective 1: Provide safe and affordable access to space.*
  - *Objective 2: Deploy and operate the ISS to advance scientific, exploration, engineering, and commercial objectives.*
  - *Objective 3: Ensure and enhance health, safety, and performance of humans in space.*
  - *Objective 4: Meet strategic space mission operations needs while reducing costs and increasing standardization and interoperability.*
- Goal 4: Expand the commercial development of space
  - *Objective 1: Facilitate access to space for commercial researchers.*
  - *Objective 2: Foster commercial participation on the International Space Station.*
- Goal 5: Share the experience and discovery of human spaceflight
  - *Objective 1: Increase the scientific, technological, and academic achievement of the Nation by sharing our knowledge, capabilities, and assets.*



ARC's Role in Support of the HEDS Enterprise

ARC supports the HEDS guidelines through fundamental research in astrobiology, gravitational biology and ecology, evolutionary biology, advanced technology development, and advanced concepts for lunar and Mars exploration. The chief elements supporting HEDS are:

- *The Gravitational Biology and Ecology (GB&E) Program*
- *Life Science Research*
- *The Space Station Biological Research Project (SSBRP)*
- *Information Technology (IT).*

GRAVITATIONAL BIOLOGY & ECOLOGY (GB&E) PROGRAM

Management of the HEDS Program in Gravitational Biology & Ecology (a possible name change to Fundamental Biology Research Program (FBRP) is being considered) has been assigned to Ames Research Center by the NASA Office of Life Sciences. Also associated with this program is an Agency-wide responsibility for life science education and public outreach.

FY00 Objectives

- *Publish at least 90 percent of the research data sponsored by the GB&E Program and make it accessible on the Internet.*
- *Increase research principal investigators (PIs) in the GB&E Program to contribute to the 9-percent projected increase for the Office of Life and Microgravity Sciences and Applications (OLMSA).*
- *Select and award proposals emphasizing biology-inspired technologies.*
- *Establish an integrated NASA-wide program in evolutionary biology led by a National Center for Evolutionary Biology with participation of at least 5 research institutions and engaging 20 investigators.*
- *Analyze data from Mir to achieve a one-crew-year "jump start" for International Space Station (ISS) fundamental biology.*
- *Issue Life Sciences NASA research announcement (NRA), including Gravitational Biology & Ecology.*
- *Utilize the Internet and advanced communication tools to assure that archived flight and ground data reach the scientific, educational, and public arenas.*
- *Create and support educational programs and resources using HEDS Enterprise content.*
- *Create virtual tours, virtual experimental environments, and public displays to provide participatory experiences in space focused on human exploration and the advance of human potential.*

Program Approach

The approach of the GB&E Program is to:

- *Effectively use microgravity and the other characteristics of the space environment to enhance our understanding of fundamental biological processes.*
- *Develop the scientific and technical foundations for a safe, productive human presence in space for extended periods and in preparation for exploration.*
- *Apply this knowledge and technology to improve the Nation's competitiveness, education, and the quality of life on Earth.*
- *Inform, educate, and provide opportunities for students and the public to participate in life science research, which uses the unique laboratory of space to understand fundamental biology, physiology, evolution, and development of living systems.*

Enterprise Goals/Objectives Served

The primary HEDS Enterprise goals and objectives served by the GB&E program are:

Goal 1: *Expand the frontier.*

– ***Objective 3:*** *Invest in enabling high-leverage exploration technologies.*

Goal 2: *Expand scientific knowledge.*

Goal 3: *Enable and establish a permanent and productive human presence in Earth orbit.*

– ***Objective 2:*** *Deploy and operate the ISS to advance scientific, exploration, engineering, and commercial objectives.*

– ***Objective 4:*** *Meet strategic space mission operations needs while reducing costs and increasing standardization and interoperability.*

Enterprise Goals/ Objectives Served

The primary HEDS Enterprise goals and objectives served by Life Science Research are:

***Goal 1:** Expand the frontier.*

- ***Objective 3:** Invest in enabling high-leverage exploration technologies.*

***Goal 2:** Expand scientific knowledge.*

***Goal 3:** Enable and establish a permanent and productive human presence in Earth orbit.*

- ***Objective 2:** Deploy and operate the ISS to advance scientific, exploration, engineering, and commercial objectives.*
- ***Objective 3:** Ensure and enhance health, safety, and performance of humans in space.*
- ***Objective 4:** Meet strategic space mission operations needs while reducing costs and increasing standardization and interoperability.*

***Goal 5:** Share the experience and discovery of human spaceflight.*

- ***Objective 1:** Increase the scientific, technological, and academic achievement of the Nation by sharing our knowledge, capabilities, and assets.*

LIFE SCIENCE RESEARCH

The goal of Life Sciences Research at ARC is to understand the role and influence of gravity on living systems, from cells in culture to physiological studies in animals and humans. Through a better understanding of fundamental biology will come knowledge useful for both the development of countermeasures to the deleterious effects of weightlessness and the maintenance of human health on Earth.

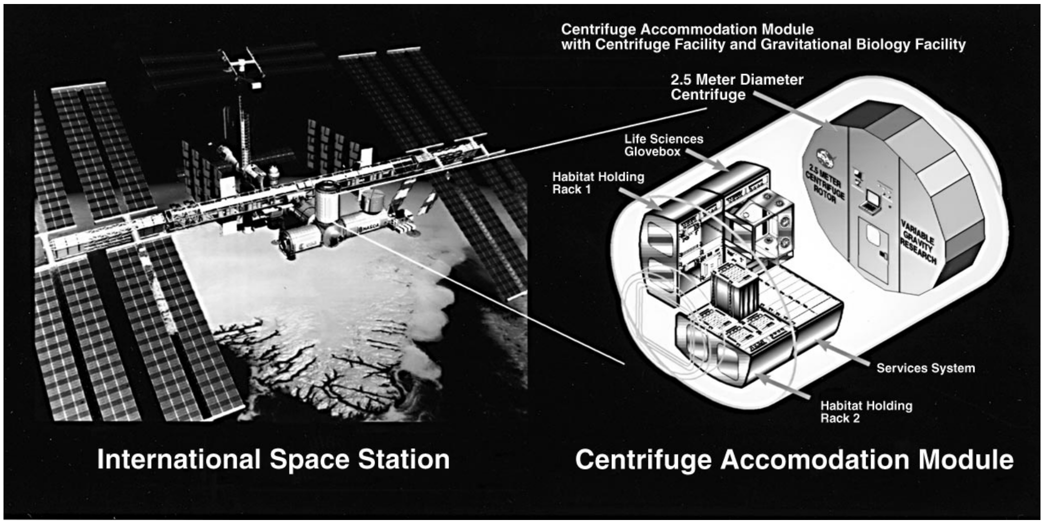
FY00 Objectives

- *Complete data analysis and publish results from the Space Shuttle Neurolab mission (STS-90).*
- *Fly gravitational biology experiments on STS-95 and STS-93.*
- *Initiate the Hyper-g Project to provide baseline data on the effects of altered gravity on biological systems.*
- *Initiate new research in astrobiology and evolutionary biology.*
- *Advocate to principal investigators the use of the unique suite of ground-based research acceleration facilities at ARC.*
- *Complete Mars Surveyor 2001 technology tests.*
- *Support the Johnson Space Center (JSC) in the design and evaluation of a short-arm centrifuge for potential use as a countermeasure to biomedical problems associated with long-term spaceflight.*
- *Complete human bedrest study to determine the efficacy of lower-body negative pressure and exercise as a potential countermeasure for flight biomedical problems.*
- *Apply ARC three-dimensional (3-D) imaging and communication technologies to facilitate the transfer and analysis of medical information, jointly with Stanford University and the Salinas Valley Medical Center.*
- *Support NASA Headquarters in the organization and conduct of international workshops and working groups to facilitate the collaborative development and use of flight equipment and flight opportunities, as well as the exchange of scientific information.*
- *Support NASA's Education Outreach Program by outfitting the "ground-based" Spacelab for the ARC element of the NASA International Education Program for students and teachers.*

Approach

The approach of Life Science Research at Ames is to:

- *Conduct extensive ground-based studies utilizing a suite of unique gravitational research facilities and advanced 3-D imagery technologies.*
- *Facilitate the use of the Space Shuttle, the International Space Station, and a variety of automated orbiting vehicles by NASA's Life Sciences community.*
- *Develop the technology and flight equipment required to support NASA's Life Sciences research on the ground and in space.*
- *Transfer technology and promote education for the improvement of the quality of life on Earth.*



Enterprise Goals/ Objectives Served

The primary HEDS Enterprise goal and objectives served by the SSBRP are:

***Goal 1:** Expand the frontier.*

***Goal 3:** Enable and establish a permanent and productive human presence in Earth orbit.*

- ***Objective 2:** Deploy and operate the ISS to advance scientific, exploration, engineering, and commercial objectives.*

***Goal 5:** Share the experience and discovery of human spaceflight.*

- ***Objective 1:** Increase the scientific, technological, and academic achievement of the Nation by sharing our knowledge, capabilities, and assets.*

SPACE STATION BIOLOGICAL RESEARCH PROJECT (SSBRP)

The Space Station Biological Research Project (SSBRP) supports Life Sciences Research goals by enabling long-term space science research in all the life sciences disciplines. The research program will initially emphasize microbiology and cell culture research using Incubator (INC) and Cell Culture Unit (CCU) habitats supported in a Habitat Holding Rack (HHR). Later, research capability will be augmented by a second HHR, a Life Sciences Glovebox (LSG), variable-g centrifuge, and habitats for plants, insects, rodents, aquatic organisms, and avian and reptilian eggs.

Project FY00 Objectives

- *Complete contracts with hardware developers and International Partners for Habitats and Host systems, including the Habitat Holding Rack, Centrifuge, and Life Sciences Glovebox.*
- *Complete designs and begin fabrication of UF-3 flight hardware, including Cell Culture Unit, Incubator, Insect Habitat, Glovebox, and Habitat Holding Rack 7.*
- *Develop and implement the equipment and experiments to support the flight of plants and avian eggs on the UF-1 Space Station mission.*

Project Approach

The Project is responsible for design, development, test, verification, and on-orbit validation of the flight hardware and software. SSBRP is also responsible for the development of interactive ground communication facilities with Space Station, other NASA Centers, and PIs in their laboratories. SSBRP will also develop common-use Space Station laboratory support equipment such as a Small Mass Measurement Device (SMMD), a Micro Mass Measurement Device (MMMD), compound and dissecting microscopes, and radiation dosimeters. Partners in the hardware development include the National Aerospace Development Agency of Japan (NASDA), Canadian Space Agency (CSA), Hungarian Space Office (HSO), and six small and large business enterprises.

OTHER HEDS RESEARCH

Additional research elements at ARC play major roles in the implementation of the HEDS Enterprise Goals. The Center for Mars Exploration (CMEX) supports integrated human and robotic Mars exploration research. Advanced Life Support (ALS) research develops systems that provide the foundation for long-duration missions by significantly reducing life-cycle costs, improving operational performance, promoting self-sufficiency, and increasing safety, as well as providing commercial opportunities for public benefit. The Advanced Technology Development Biosensors (ATD-B) Project facilitates the flow of advanced sensor and measurement technologies within and between NASA and other organizations.

FY00 Objectives

- *Guide the integrated human and robotic Mars Exploration Program in its science-based exploration strategy in the search for past and present life on Mars, particularly in characterizing landing sites and evaluating landing site data.*
- *Develop the policies and procedures for forward and backward planetary protection to ensure that samples may be brought back to Earth from Mars without damaging the terrestrial biosphere.*
- *Assess the technology needed to gain access to, and aseptically collect samples from, the kilometers-deep martian hydrosphere.*
- *Evaluate the application of controlled airborne platforms for the acquisition of high-resolution and high-sensitivity remote sensing data for the selection of potential landing sites.*
- *Build a neural-net simulator facility for testing Mars aerovehicle designs (airplanes, rotorcraft, balloon concepts).*
- *Develop liquefier technology to support In Situ Resource Utilization (ISRU) demonstration on Mars 2003 mission.*
- *Develop and demonstrate information technologies (both software and hardware) to reduce the cost of and increase the performance of human and robotic spaceflight, including autonomous ground and flight systems, enhanced crew operations, intelligent synthesis environment, and data management/analysis.*
- *Develop new thermal protection materials, new aeroassist techniques for the braking of spacecraft in the atmosphere of Mars and on high-speed return in the atmosphere of Earth, and new technologies for the production and cryostorage of propellants and life-support gases and liquids on the surface of Mars.*
- *Work with industry, Glenn Research Center (GRC), and Marshall Space Flight Center (MSFC) to develop integrated onboard vehicle health management systems to improve vehicle reliability and reduce the ground turnaround of reusable launch vehicles.*

Enterprise Goals/ Objectives Served

The primary HEDS Enterprise goals and objectives served are:

***Goal 1:** Expand the frontier.*

- ***Objective 3:** Invest in enabling high-leverage exploration technologies.*

***Goal 2:** Expand scientific knowledge.*

***Goal 3:** Enable and establish a permanent and productive human presence in Earth orbit.*

- ***Objective 2:** Deploy and operate the ISS to advance scientific, exploration, engineering, and commercial objectives.*
- ***Objective 3:** Ensure and enhance health, safety, and performance of humans in space.*
- ***Objective 4:** Meet strategic space mission operations needs while reducing costs and increasing standardization and interoperability.*

***Goal 5:** Share the experience and discovery of human spaceflight.*

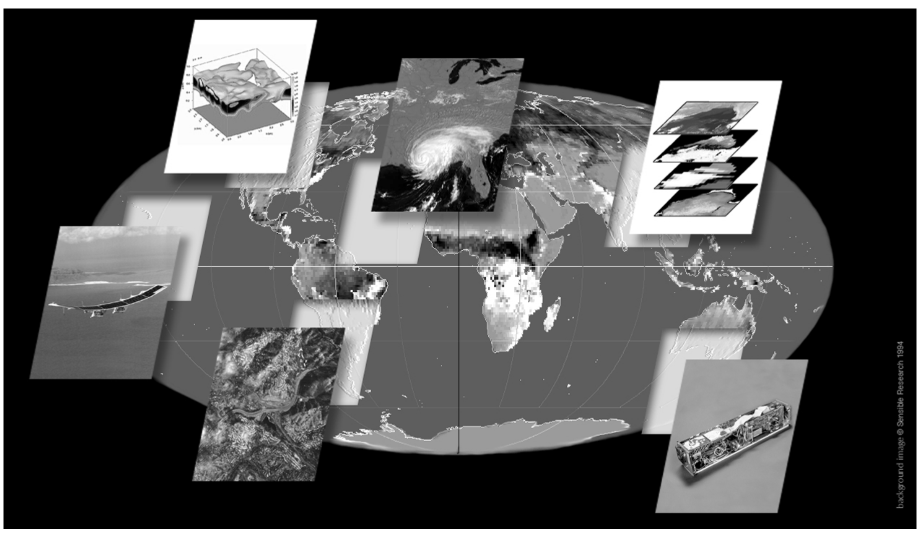
- ***Objective 1:** Increase the scientific, technological, and academic achievement of the Nation by sharing our knowledge, capabilities, and assets.*

- *Develop automation for life-support system operations, power-generation operations, and in situ propellant-production operations.*
- *Through use of the Internet, increase the participation of the public, educators, and students in the process of planning and implementing the integrated Mars exploration program.*
- *Advance the application of remote sensing and geographic information systems (GISs) to landscape epidemiology and facilitate the transfer of these technologies to the domestic public health community, and internationally through the Center for Health Applications of Aerospace-Related Technologies (CHAART).*

Earth Science Enterprise

The Earth Science Enterprise endeavors to understand the total Earth system and the effects of natural and human-induced changes on the global environment. The Earth Science Enterprise is responsible for creating and maintaining an integrated scientific observation system for the multidisciplinary study of Earth's critical, life-enabling, interrelated processes involving the atmosphere, oceans, land surfaces, and polar regions. The Enterprise is directed toward acquiring scientific knowledge relevant to formulating and implementing environmental policy, both nationally and internationally. The Enterprise goals are:

- Goal 1: *Expand scientific knowledge of the Earth system using NASA's unique capabilities from the vantage points of space, aircraft, and in situ platforms.*
- Goal 2: *Disseminate information about the Earth system.*
- Goal 3: *Enable the productive use of Office of Earth Science (OES) science and technology.*



ARC's Role in Support of the Earth Science Enterprise

ARC supports the Earth Science goals through fundamental research in astrobiology, ecology, and atmospheric science, as well as through instrument development and science management for NASA airborne platforms.

Enterprise Goals/ Objectives Served

All three Earth Science Enterprise goals are served by Earth Science Research at Ames:

Goal 1: *Expand scientific knowledge of the Earth system using NASA's unique capabilities from the vantage points of space, aircraft, and in situ platforms.*

Goal 2: *Disseminate information about the Earth system.*

Goal 3: *Enable the productive use of OES science and technology.*

EARTH SCIENCE RESEARCH

Earth Science Research at ARC supports the goals and objectives of the Enterprise described in the Earth Science Enterprise Strategic Plan of 1998 and the OES Science Research Plan of 1996. ARC performs basic research in atmospheric chemistry and dynamics, atmospheric physics, and ecosystem science and technology, and leads major airborne science to provide new knowledge on both atmospheric and ecosystem processes.

FY00 Objectives

- *Manage the SAGE III Ozone Loss and Validation Experiment (SOLVE) airborne science mission and deliver data sets required to fulfill the mission objectives.*
- *Provide modeling products in support of the SOLVE campaign, using primarily a trajectory model with detailed microphysics, heterogeneous chemistry, and gas-phase chemistry. The main objectives will be to compare the ability of competing polar stratospheric cloud theories to match SOLVE measurements, and examine the sensitivity of ozone depletion to these parameters.*
- *Improve cloud parameterizations used in global climate models by using a large eddy simulation model with detailed microphysics to investigate cloud structural statistics in shallow boundary layer cumulus clouds and stratiform cirrus clouds.*
- *Examine the spectral radiative properties of dust and smoke aerosol in southern Africa and the effects they have on the radiative properties of clouds during the Southern African Fire/Atmosphere Regional Science Initiative (SAFARI 2000).*
- *Develop and validate an Aerosol Physical Chemistry Model (APCM) for the upper troposphere using measurements from the Subsonic Aircraft: Contrail and Cloud Effects Special Study (SUCCESS).*
- *Evaluate and optimize hyperspectral data and the application of these data to climate change studies through the use of Principal Component Analysis (PCA).*
- *Conduct ecosystem process, disturbance, long-term historical climate effects, pollen, remote sensing, and modeling studies in South America as part of the Large-Scale Biosphere Atmosphere (LBA) Project, the cooperative fire research project with Brazil and the USFS and the Astrobiology Program, and in other sites.*
- *Conduct ecosystem process, ecophysiological and radiative transport modeling, uncertainty analysis, and remote sensing research for global to regional ecosystem processes, including the role of ecology in carbon and other nutrient cycling, hydrologic processes, and biogenic trace gas production into the atmosphere.*
- *Advance the optical science, radiative transport modeling, and sensor instrumentation for land sciences (MODIS/ASTER Airborne Simulator (MASTER), Digital Array Scanned Interferometer (DASI), multispectral cameras, thermal infrared (TIR), and polarization imagers) in support of Earth Observing System (EOS) and airborne science.*

- *Advance the spectroscopic instrumentation for laboratory and field uses to conduct optical sensing and science at microscopic resolutions in extreme and other environments.*
- *Conduct research in conjunction with Life and Space Sciences on the questions in Astrobiology that relate to the future of life on Earth and beyond Earth, using environmental simulation, modeling, microbial and plant sciences, and sensing of biosignatures.*
- *Coordinate with several research groups to publish findings from the First International Cloud Climatology Regional Experiment (FIRE) Arctic Cloud Experiment and the Surface Head Budget of the Arctic Ocean (SHEBA), with the goal of providing the most detailed study to date on the Arctic atmosphere/ice surface radiative energy budget.*
- *Acquire and rapidly distribute airborne remote sensing data from a suite of sensors in conjunction with Dryden Flight Research Center (DFRC) and others to science and practical end users in support of the first EOS system and for advanced sensor systems.*
- *Coordinate the publication of the continuing series of interagency studies of fire effects in Brazil and other sites worldwide.*
- *Publish the book Evolution and the Physical Environment as a result of the Linnean Society workshop of the same name as part of Astrobiology.*
- *Transfer knowledge and technology to the public and private sectors through education and direct applications research projects under the auspices of an Earth Science Application Center for the Western U.S.*
- *Develop the science and transfer the knowledge of landscape epidemiology to the worldwide public health community through the activities of CHAART.*
- *Using remote sensing, conduct research in conjunction with the U.S. Geological Service (USGS) to understand the spread of urbanization and its ecological consequences.*
- *Develop means to address large-scale computing challenges associated with climate modeling, including parallel computing, utilization of computational grids, and the efficient porting of legacy codes onto advanced architectures.*
- *Work with Earth Science Mission Centers to improve mission software development and validation.*
- *Apply the computer science expertise and large-scale system experience of ARC and its partners to help identify the most suitable architectures for the generations of Earth Observing System information systems beyond EOSDIS.*
- *Conduct advanced strategic research in intelligent systems to provide new capabilities to the Earth Science Enterprise to enable advanced mission goals and objectives.*

Approach

Global and regional atmospheric and ecosystem studies are primary areas of investigation at ARC. To carry out these astrobiology-related investigations, scientists, technologists, and mission personnel at ARC work in collaboration with leading scientists and ministries around the world to:

- *Design, formulate, and perform experimental measurements, remote sensing, in situ data analyses, and computer simulations of atmospheric and ecosystem processes, and exchanges between the biosphere and the atmosphere, using both airborne and satellite sensor data.*
- *Conceive and develop advanced instrumentation to satisfy the measurement requirements of the Earth Science Enterprise and related enterprises, emphasizing both airborne and selected spacecraft sensors.*
- *Provide the scientific understanding and the methodology needed to apply remote sensing and geographic data analyses to the study of infectious diseases, and the associated models for risk analysis of disease transmission in the various human populations.*
- *Transfer scientific knowledge and technology to U.S. commercial and private interests, national and international governmental agencies and ministries, other disciplines, and educational institutions.*
- *Provide science mission management and science leadership for major NASA science programs and other agency science programs.*

V. Implementing Center-Level Responsibilities

Initiatives

Safety

In FY00, the Center will be implementing the Safety Accountability Program to reduce the number of hazards on the job and significantly improve safety. The Safety Accountability Program is based on programs in private industry that have been proven effective. The new initiative includes the following key elements:

- *Clear and specific safety policy*
- *Executive Safety Committee chaired by the Center Deputy Director*
- *Re-emphasis on system safety*
- *Safety Accountability Program Core*
- *Safety training for all employees*
- *Annual Safety Week*
- *Hotline*
- *Union Management Safety Committee*

All elements are integrated into a single management plan that is designed to change behavior and improve accessibility to management. The complete integration includes a new management culture shift to accountability, combined with metrics, pay for performance, and real-time feedback to management via automation.

Systems Management

ARC is committed to improving the quality and consistency of the Center's approach toward systems management, which is the integration of systems engineering, system safety and risk assessment, product development, and cost estimation and analysis. The Center has established a Systems Management Office reporting to the Center Director to ensure that the processes, infrastructure, and oversight mechanisms are in place to implement systems management in a disciplined and thorough manner, and to ensure that its effectiveness can be verified independently. The initiatives to be implemented by the Systems Management Office for FY00 include:

- *Training and Skill Development*
- *Tools Development and Deployment*

ISO 9001

ARC utilizes world-class leadership in the effective management of the programs and research it performs. As part of this effort, ARC is focusing on the area of quality system refinement and improvement. By doing so, ARC will demonstrate that it has a Quality Management System in place that continues to meet or exceed the ISO 9001 worldwide standard. The implementation of an ISO 9001 quality system in FY99 clarified responsibilities and interfaces within ARC, minimized knowledge loss due to turnover, improved first-time conformance to requirements, and increased customer satisfaction. Many of the Center's industrial partners are already ISO certified. ISO certification has put ARC on a par with the rest of the Agency and our customers. Surveillance audits will be performed every six months, and a full quality system audit will be performed every three years.

The Aeronautical Test and Simulation Division became the first organization at ARC to become ISO 9001 certified, assuring that simulator and wind tunnel customers receive world-class quality services at the Center. The Independent Verification and Validation Facility in Westmont, Virginia, became the second ARC organization to become ISO 9001 certified. Its ISO certification will support the facilities' efforts in becoming a Center of Excellence in Systems and Software IV&V. The Center as a whole became certified on April 30, 1999, with a perfect score. This monumental effort on the part of management and staff sends a message to our customers that we have the skills and ability to design and develop aeronautical space and information technologies, software, and hardware products in a quality manner.

Human Resources Initiative

ARC has begun the development and implementation of a Human Resources Initiative to place greater emphasis on the fact that our people are our greatest asset. This initiative requires formal, continuing management education for all supervisors and the creation of Individual Development Plans for all staff members. It also creates a process for management accountability to carry out these requirements.

Program and Project Management Development

The ARC Program and Project Management Development Program has been initiated to accelerate the development of the next generation of Center and Agency program and project leaders. The ARC program is building on the academic structure of the Agency's Academy of Program and Project Leadership (NASA APPL) to train and provide developmental assignments to enable a new cadre of ARC program and project management talent as well as to enhance the skills of our existing leaders. The ARC Training and Development group has built a strong collaborative relationship with NASA Headquarters and now serves the Agency as the Western campus for many of the Academy's training programs.

Full Cost Practices

ARC has begun the implementation of full cost practices and will continue to improve the cost-effectiveness of mission performance through complete implementation of the Agency's Full Cost Initiative. This initiative will drive policy and practice improvements in the accounting, budgeting, and management areas that will support "full disclosure" on activities for more fully informed decision making and better performance measurement. The planned improvements include categorizing costs as direct, service, and general and administrative (G&A).

The Full Cost Initiative also ensures compliance with recent legal and administrative guidance, including the 1990 Chief Financial Officers Act, 1993 Government Performance and Results Act, 1993 National Performance Review, Federal Financial Management Improvement Act of 1996, and NASA's 1995 Zero Base Review.

Integrated Financial Management System

In addition to operating the Center's legacy systems, ARC is deeply involved with the Agency-wide effort to standardize and improve the financial and business management processes and systems in the Agency. The ARC Integrated Financial Management Program (IFMP) team is actively participating in all aspects of the Agency-wide program, including reengineering business processes, configuring and testing the system, and preparing employees to work in the new environment. The IFM System will replace the Agency's existing business management environment, which comprises decentralized, nonintegrated systems, originally developed to satisfy unique Center requirements. The IFM System will provide the NASA Strategic Enterprises, Lead Centers, Lead Program Managers, and Center Directors with accurate and timely financial information to support decision making and to enable strategic management. In addition, the system will also be designed to satisfy the needs of external customers who require financial information from NASA.

Education

As stated in the NASA Strategic Plan, one of NASA's roles is to inspire achievement and innovation. In order to accomplish this, NASA uses its unique resources to support educational excellence for all. Ames delivers the NASA Education Program within the framework of the NASA Implementation Plan for Education, 1999–2003. The key Operating Principles of this plan are Customer Focus, Collaboration, Diversity, and Evaluation. The education function at ARC is strategically dispersed throughout the Directorates; in fact, all major technical endeavors at ARC contain educational outreach components. This scenario has increased the magnitude, diversity, and technical excellence of ARC's education programs. The wide ranges of ARC's education programs are constantly being refined, and new programs are being introduced to better serve the needs of the educational community within the Bay Area, the State of California, and ten other Western states. The following is a brief description of the wide range of educational activities at ARC.

- *The California Air and Space Center (CASC) is a nonprofit educational and entertainment resource for the nation. NASA ARC, in partnership with the Cities of Mountain View and Sunnyvale, is establishing the CASC as a world-class science center featuring a teacher institute that will provide professional development opportunities for K–12 teachers of science, mathematics, and technology.*
- *Numerous teacher workshops and conferences are held throughout the region to educate teachers about NASA's programs so they are better able to teach their students.*

- *ARC participates in the annual JASON Project, a live exploration adventure, and trains hundreds of teachers and thousands of students in various science and technology subjects.*
- *The ARC Aerospace Encounter daily hosts fourth- through sixth-grade classes in an interactive, hands-on learning environment designed to teach the basics of science, mathematics, and technology in the thematic areas of aeronautics, Earth science, space science, and space technology.*
- *Center staff participate in National Engineers' week, science and engineering fairs, and an active speakers' bureau.*
- *The NASA Quest program connects NASA scientists and researchers with students via the internet in live web chats or web casts.*
- *New education technology products are produced in conjunction with the significant aeronautics and space programs at the Center. Generally CD-ROMs and web based, the products fully integrate curriculum based on National Science Standards. In FY00, the Air Traffic Management "Gate-to-Gate" CD-ROM, the Lunar Outpost CD-ROM, an Earth Science CD-ROM, and an Astrobiology/Careers CD-ROM, based on NASA occupations, will be produced.*

Equal Opportunity/Diversity

ARC strongly supports the principles of equal opportunity and endorses achieving diversity in the workplace. Everyone working at ARC is valued and no one is excluded on the basis of race, sex, ethnicity, sexual orientation, color, religion, age, disability, or any other nonmerit-based factor. The Center fosters and maintains a work environment that respects and values individual differences and is reflective of the entire range of communities that the Center serves. The Center's efforts are described in the Affirmative Employment Program Plan, updated each fiscal year, and include the following programs:

- ***Recruiting**—ARC will continue to recruit in order to maintain an applicant pool that includes a high representation of minorities, women, and disabled persons.*
- ***Training**—Training programs will continue to be used to heighten the awareness of Center managers and employees to the importance of diversity and acceptance of people from diverse backgrounds.*
- ***Pipeline development**—A variety of outreach activities aimed at primary, secondary, undergraduate, and graduate school students encourage women, under-represented minorities, and persons with disabilities to pursue careers in science and technology.*
- ***Internships**—ARC will continue to use a variety of paid internship programs to incorporate high school, undergraduate, and graduate school students from diverse backgrounds into the Center workforce.*
- ***Employee Groups**—The Multicultural Leadership Council (MLC), six advisory groups, and four ad hoc groups are grass root volunteer organizations that nurture diversity in all its dimensions.*

- ***Diversity Dialogue Groups (DDGs)****—The Diversity Dialogue Group is an important element of the Multicultural Leadership Council. The DDG is a program designed to increase awareness and understanding of differences in the workplace.*
- ***Partnerships****—The Center is continuing to build partnerships with Historically Black Colleges and Universities, the National Hispanic University, and other minority universities, such as Hispanic Serving Institutions and Tribal Colleges and Universities.*

ARC DEVELOPMENT

ARC is embarking on a bold new vision to create a collaborative research park, which brings together premiere talent in the areas of astrobiology, information technology, and aerospace technology. The transformation of ARC's unused capacity into a unique environment for enhancement of NASA's programmatic initiatives, as well as the Agency's commercialization, education, and outreach goals, will integrate three key components:

- ***A World-Class Campus for Research, Education, and Learning***
  ARC will develop a world-class campus for research and learning that will utilize ARC's unique stock of buildings and partnerships with local government, academia, industry, and nonprofit organizations. With its notable military history, prominent architecture, and availability of land, ARC will be an ideal place where NASA, its collaborative partners, and the public can promote advances in aerospace and aviation technology, understand advances in information technology, and explore the outer limits of the universe. Public displays, interactive exhibits, school programs for students and teachers, and lecture programs will be featured on the campus.

- ***A Center for Entrepreneurship and Innovation***
  In partnership with academia and industry, NASA will promote entrepreneurship and innovation at ARC. By taking advantage of its proximity to leading entrepreneurs and heads of innovative organizations, NASA and its partners can support the development of business incubators focused on high-technology and biotechnology industries. Linkages can be formed with business education programs to provide forums, seminars, executive lecture series, and other venues to facilitate the exchange of information and experience to solve real-world business problems related to technology innovation, technology commercialization, and technology management.

- ***A Community of Scientists, Engineers, Students, and Educators***
  ARC will create a unique community of research scientists, students, and educators with a shared mission to advance human knowledge of space, the Earth, and society. A lively and vibrant community will attract industry. NASA will provide critical public safety services and other services typically furnished by municipal government.

An Integrated Development Plan will be issued in the first quarter of FY00. This plan will describe how portions of ARC will evolve into a shared-use campus with government, academia, industry, and nonprofit organizations. The plan will also outline the steps to optimally develop federal property and to balance NASA's programmatic goals against the financial requirements and infrastructure constraints. This plan will be formed with the cooperation of local governments to ensure that the plan is as sensitive to the surrounding community and environment as it is sensible for the nation.

Support Functions

A full array of institutional systems support the ARC Center of Excellence, missions, lead Center programs, and other research and technology development activities. These systems encompass a wide range of areas, including the following:

ACQUISITION/PROCUREMENT

Specialists work to maintain the Nation's technical and commercial standing and the Agency's priorities, and to support Center research and operational goals through acquisition management excellence.

DOCUMENTATION DEVELOPMENT

Professional Specialists who work under the Scientific and Technical Information (STI) Program acquire, produce, and distribute and archive scientific, technical, and nontechnical information using traditional and advanced technologies. Services provided include: printing and reproduction, photo and imaging, audiovisual and video production, graphics and exhibit design, publications, and library support.

HUMAN RESOURCES

Human Resource Specialists work to attract, enhance, and retain a highly effective workforce, properly balanced and trained to accomplish the Center's various missions. They work closely with ARC supervisors and managers, providing advice and assistance in planning and implementing proactive human resources programs within each organization. They also provide management and staff development programs to fully utilize the capabilities and potential of the Center's workforce.

FACILITIES MAINTENANCE AND OPERATIONS, LOGISTICS, AND SUPPLIES

Support is provided through two primary functions: 1) institutional facilities, base operations, and maintenance; and 2) supply and logistics services. In addition, as host for the ARC Moffett Complex, the necessary maintenance of infrastructure and buildings is provided to support office space and military housing utilized by Resident Agencies.

INFORMATION TECHNOLOGY SERVICES

Services include the development and maintenance of a secure, state-of-the-art computing infrastructure that can support researchers throughout NASA and the world. This infrastructure consists of networking, desktop, and other Information Technology services such as telephones, software repositories, digital audio, and e-mail.

PROTECTIVE SERVICES

A wide range of emergency and nonemergency services are provided, including security, police, fire, and emergency preparedness. Support includes coordination of Center access for all employees and visitors, security clearance processing, foreign travel briefings for personnel traveling overseas, and physical, technical, and information security throughout the Center.

Research and Development Services

Support is provided to the Center's R&D programs by providing wind tunnel testing operations, hardware development, systems engineering, and project management and facility construction. Utilizing concurrent engineering, rapid prototyping, advanced analysis tools, and experienced project management expertise, this organization serves the Center's programs as well as external customers in integrated product design and development. Its prototype development capability is centered on unique skills made possible by the advanced tools and expertise of its crafts people. Products range from highly accurate and detailed wind tunnel models to sophisticated spacecraft hardware to biological sensors. Wind tunnel testing utilizes national-class facilities, advanced instrumentation, and expert technical support for high-fidelity data acquisition and understanding, as well as highly productive testing time.

Commercialization and Technology Transfer

The Commercial Technology Office manages the transfer and commercialization of NASA technologies and the infusion of external technologies to enhance NASA programs, the U.S. economy, and the quality of life. Services to accomplish these goals include protection, patenting, and licensing of NASA-developed intellectual property; development of public/private partnerships and strategic alliances; and management of the Small Business Innovative Research/Small Business Technology Transfer (SBIR/STTR) programs and NASA-related small business incubation.

Equal Employment Opportunity

Equal employment opportunity, affirmative employment, and diversity in the workplace are promoted through a variety of mechanisms. Enforcement procedures ensure compliance with existing rules, policies, and mandates.

External Affairs, Outreach, and Education

An extensive array of educational programs, outreach activities, media services, and public relations and informational programs support Center and Agency goals. Many are explained within the foregoing sections.

Financial Systems

Effective, efficient, and economic financial and budgetary systems are developed and maintained to support the Center and Agency customers in line with established goals. High-quality, proactive business services help customers to operate effectively, efficiently, and economically, even with decreasing budgets and increasing requirements.

Legal Services

Legal Services provides advice and assistance to all ARC management and to all ARC organizations. Legal Services also furnishes timely and accurate legal advice on a wide range of topics; acts as legal representative for and on behalf of ARC in administrative and judicial proceedings; and participates in various management working groups.

Safety, Environmental, and Mission Assurance

A safe workplace, responsible stewardship of the environment, and reliable quality systems are promoted. Support includes effective advocacy, technical consultation, policy guidance, oversight training, regulatory interface, and risk assessment.

VI. FY99 Performance Highlights

Center of Excellence for Information Technology

- *The Remote Agent Experiment (RAX), the first successful demonstration of autonomous operation on a spacecraft, ran successfully on May 17–21, 1999, aboard the Deep Space One (DS-1) spacecraft. RAX was given primary command of the spacecraft the week of May 17, 1999. At 11:04 am PST on Monday, May 17, the DS-1 team received data confirming that the Remote Agent Experiment was active and autonomously controlling the spacecraft—a first in the history of spaceflight. By the afternoon of Friday, May 21, the DS-1 and RAX teams had successfully completed 100 percent of the technology validation objectives, including demonstration of onboard planning for operations, robust plan execution, and the diagnosis and recovery of three simulated failures, all without the help of controllers on Earth. RAX was a joint effort between the NASA ARC and the Jet Propulsion Laboratory.*

- *The Intelligent Flight Control Program recently met a Level I milestone when six of ten planned flight tests were completed in Q2FY99. The two most recent flight tests demonstrated a very important new capability of the neural controller, called Dial a Gain (DAG), developed by Boeing to leverage the unique capabilities of the neural control architecture. The DAG capability, which permits the pilot to change the behavior of the aircraft in flight, was successfully demonstrated with a very interesting result: when the "high-performance" DAG set was sent to the aircraft, the test pilots reported that they actually liked it better than the existing Advanced Control Technologies for Integrated Vehicles (ACTIVE) control system. This is an exciting spinoff benefit of Intelligent Flight Control (IFC), because it dramatically illustrates the design cycle reduction capability associated with control law development, and actually produced a feature that pilots like much better than the existing systems. As a point of comparison, development of the original F-15 controller required 1.7 million man hours, 500 test flights, and 100 software versions (at a cost of $138 million).*

- *The Crew Activity Tracking System (CATS) developed by ARC is a computer-based system originally developed to use as a model of desired operator performance to train or aid aviation automation operators. CATS has been successfully applied to the design and analysis of advanced Air Traffic Management (ATM) systems. Specifically, CATS has proved useful for analyzing full-mission simulation data to assess flight deck procedures proposed for the future ATM environment. CATS has also been used effectively for developing new air traffic control procedures and evaluating potential ATM automation benefits.*

- *The Automatic Dependent Surveillance-Broadcast (ADS-B) and Cockpit Display of Traffic Information (CDTI) technologies were evaluated by the Cargo Airline Association (CAA), FAA, NASA, the U.S. Navy, and others at Airborne Express Airpark on July10, 1999. ARC supported the FAA and the CAA in the planning for and assessment of CDTI implementations in the cockpit for the following applications:*
  - *Enhanced Visual Acquisition for "See & Avoid"*
  - *Enhanced Visual Approaches*
  - *Demonstration of Airport Surface Situation Awareness*
  - *Demonstration of Station Keeping and Enhanced In Trail Climb/In Trail Decent (ITC/ITD), Level Climb/Level Decent (LC/LD).*
  - *Demonstration of Departure Spacing*
  - *Demonstration of Final Approach Spacing*

- *Pilots training for "glass-cockpit" aircraft experience a much higher failure rate than those training for traditional "round-dial" aircraft. Therefore, a new training method for glass-cockpit aircraft not based on prior training programs for round-dial aircraft was developed by a major airline. ARC evaluated the new training program and found that it reduced the failure rate comparable to that for the older aircraft, while noting that pilots still made errors in managing flight deck automation. The study also included recommendations for incorporating human factors review of training and including computer-based training, as well as adequate consideration of training during the design of aircraft automation. The Flight Safety Foundation (FSF) is in the process of distributing the report to its 700+ members. In addition, the FSF is publishing the training report in its entirety on its web site for downloading.*

- *The IV&V Facility provided independent evaluation of critical General Purpose Computer (GPC) flight software and avionics block upgrades (e.g., Global Positioning System (GPS) for the Space Shuttle program). Software analyses have resulted in early requirement discrepancy identification, resolution, and the certification for each Space Shuttle mission. One major accomplishment was development of an IV&V analytical paradigm based upon formal methods specifications for evaluation of the Miniaturized Airborne GPS Receiver-Shuttle 3 String (MAGR-S3S) firmware—a commercial off-the-shelf (COTS) software product. Analyses of this COTS product resulted in the identification of numerous flight safety and performance issues prior to incorporation of GPS as a prime navigation sensor for the Space Shuttle.*

- *The IV&V Facility developed a new family of algorithms (called SP2 and SP3) to determine the least number of test paths necessary to effectively train and test intelligent systems treated as black-box units. Prototype implementations of these algorithms have been constructed and analyzed using Monte Carlo type simulations to validate claims of least test paths.*

Results indicate that software is easier to test than expected under specific conditions (low coupling between requirements and stable operational profiles). This work will lead to important ways to structure specifications and source code to improve the effectiveness of testing for determinate and indeterminate systems.

Mission in Astrobiology

- *ARC established a management office and began operation of the NASA Astrobiology Institute. In numerous workshops, ARC scientists worked with over 300 members of the diverse astrobiology research community to define a roadmap for the new NASA Astrobiology Program.*

- *The ARC proposal for interdisciplinary research in astrobiology was selected by the Office of Space Science, making ARC one of 11 initial members of the new NAI. The proposed work involved scientists from across the Space, Earth, and Life Sciences, both at ARC and in collaborating institutions.*

Aero-Space Technology Enterprise

- *The RTCA Select Committee has recommended to the FAA that all ARC-developed air traffic management tools be implemented at air traffic control facilities managed by the FAA. These tools, which aid air traffic controllers in sequencing and scheduling aircraft in cruise and on approach and landing, increased airport capacity by up to 10 percent and reduced delays by an average of 3 minutes. The software associated with the air traffic management tools was the recipient of the NASA 1998 Software of the Year Award. The FAA has already selected several of these tools for accelerated implementation into numerous airports throughout the United States as part of the "Free Flight Phase I" National Airspace System modernization program.*

- *ARC successfully modeled density-gradient quantum corrections in two-dimensional simulations of ultra-small (30 nanometer (nm) gate length) MOSFET electronic devices. Previous quantum corrections were possible only in one-dimensional simulations. The error in computing capacitance was decreased from as much as 30 percent to less than 1 percent in comparison with experimental data. The ability to account for nonuniform tunneling through the oxide gate, lateral transport, and vertical tunneling effect all contribute to the improved accuracy of the simulations.*

- *Design problems affecting the development of an axial flow Ventricular Assist Device (heart pump) were resolved by ARC using computational fluid dynamics (CFD). The new pump design reduces blood damage by an order of magnitude and helps prevent blood clotting by reducing zones of recirculation. These devices have been implanted in more than 7 patients awaiting transplant operations, in one case for 75 days. This technology is expected to greatly reduce the $50,000 cost per unit for the 60,000 people requiring some form of ventricular support each year.*

- *The ability to improve the stability and performance of control systems has been demonstrated in two design studies using the CONDUIT control system design software tool set. The optimized designs for two rotorcraft, a SH-2F and UH-60 RASCAL, identified significant increases in stability margins, performance, and handling qualities while reducing actuator energy and saturation.*

- *ARC has demonstrated through simulation that carbon nanotubes are feasible for use as writing instruments to perform nanolithography. Ten-nm-diameter carbon nanotubes were shown to have a 0.5-millimeter-per-second (mm/s) writing rate for silicon dioxide on a silicon substrate, five times faster than previous methods. The reduced wear of the carbon nanotube tips will remove one of the barriers to the development of nanofabrication.*

- *ARC led a partnership with NASA Dryden and Boeing in the development of an adaptive flight control system that was flight demonstrated on the F-15 ACTIVE aircraft. The results of the flight test showed equal or better handling qualities when compared with the conventional F-15 controller. Capable of adapting to unforeseen flight conditions or vehicle failures, this neural-net-based controller has the potential to dramatically improve the safety of future military and commercial aircraft.*

- *The high-performance computing testbed at ARC consisting of a single-image 256-processor SGI ORIGINS system demonstrated over 100 gigaFLOPS performance in benchmark tests. Complex aerospace simulation codes have demonstrated scalable performance on this architecture, and they show significant progress toward achieving sustained teraFLOPS capability.*

Space Science Enterprise

- *The Lunar Prospector Discovery Spacecraft completed both its primary and extended science missions during FY99. Science results continue to provide strong evidence for water ice in cold traps near both poles of the Moon. In addition, Lunar Prospector has provided the first precise gravity map of the entire lunar surface, confirmed the presence of local magnetic fields, and developed the first global maps of the Moon's elemental composition. Lunar Prospector is a partnership between Lockheed Martin, the Lunar Research Institute, and Ames Research Center.*

- *The Stratospheric Observatory for Infrared Astronomy (SOFIA) Project completed Preliminary Design Reviews (PDRs) for both the Telescope Assembly and for the U.S. Systems/Observatory. The stability and control wind tunnel tests of the Observatory were completed successfully. The light-weighting of the telescope primary mirror blank was completed. SOFIA is scheduled to begin flights with a 2.5-meter telescope (provided by Germany) in 2002.*

Human Exploration and Development of Space Enterprise

- *ARC managed experiments aboard both STS-95 (the John Glenn Flight) and STS-93. One of the STS-95 experiments was a study of alterations in the cell cycle of cartilage, which leads to a change in the mechanism of subsequent cell growth and differentiation of cartilage. The second was a continuation of a Neurolab collaborative experiment with the Japanese National Space Development Agency. The experiment centered on performance of the vestibular organs and the central nervous system via electrodes, which were implanted in toad fish nerves connecting the vestibular (inner ear) organs and the brain. The STS-93 experiment utilized Drosophila (fruit flies) in neurobiology studies.*

- *In May 1999, the first NASA Virtual Collaborative Clinic was established between ARC, the Cleveland Clinic John Glenn Center, Salinas Valley Memorial, Stanford University, and the Navajo nation. This activity was spearheaded by the Life Sciences Division's Center for Bioinformatics. Physicians were able to see and rotate 3-D, high-resolution, 24-bit color stereo images constructed from electron microscopy, computer topography (CT) and/or magnetic resonance imaging (MRI) scans. The capability provides near-real-time collaboration for consultation, diagnosis, and planning for remote areas such as the Navajo nation. Additionally, the telemedicine tool will be essential to long-term human presence on the Space Station and (future) Mars.*

Earth Science Enterprise

- *Microphysical measurements aboard the DC-8 in the Corrective and Moisture Experiment (CAMEX) allowed for the first time the determination of condensed water (determining the latent heat that provides the energy of the storms) in hurricanes Bonnie, Danielle, and George at a 37,000-foot altitude during Fall 1998. Cloud particle concentrations of several hundred per liter and particle volumes exceeding one cubic centimeter per cubic meter (yielding mass concentrations of ice exceeding 0.5 gram per cubic meter assuming a density of 0.5 gram per cubic meter) agree with models. This mass of ice, however, is concentrated in small crystals of several hundred microns modal radius rather than larger snowflakes and graupel particles.*

Support Functions

- *ARC revitalized its workforce by attracting a high-quality cadre of over 150 new permanent employees in critical skill areas such as astrobiology, Information Technology, and key supporting functions.*
- *ARC awarded 100 percent of the 36 SBIR Phase I contracts and 12 SBIR Phase II contracts on or before the deadlines established by Headquarters.*
- *The ARC IT Security Development team was awarded the Software of the Year award for its PKI electronic messaging plug-in software development effort.*

VII. GPRA Metrics

SPACE SCIENCE ENTERPRISE FY 2000 PERFORMANCE PLAN – CHART 1

Enterprise FY 2000 Performance Plan	00#	Ames Contribution
Complete the SOFIA 747 Section 46 mockup test activity during June 2000 with no functional test discrepancies that would invalidate CDR-level designs and cause significant design rework with attendant cost and schedule impact.	0S43	Management review and oversight of the SOFIA Project to assure that the contractor team meets technical performance and programmatic metrics.
Deliver the SIRTF Infrared Array Camera (IRAC), Multiband Imaging Photometer (MIPS), and Infrared Spectrograph (IRS) instruments during April 2000. The instruments shall perform at their specified levels at delivery.	0S5	Develop and characterize IRAC detectors; serve as IRS Deputy PI and SIRTF Facility Scientist.
Deliver the Mars 01 Orbiter and Lander science instruments that meet capability requirements by June 1, 2000; prelaunch Gamma Ray Spectrometer (GRS) tests shall determine abundances in known calibration sources to 10% accuracy.	0S29	Co-Investigator on Mars Environment Composition Assessment instrument; team members on oxygen production unit.
Assuming the Mars Surveyor program architecture is confirmed, meet the milestones for the Mars 03 instrument selection and initiate implementation of the lander mission. Deliver engineering models of the radio-frequency subsystem and antennas for the radar sounder instrument to ESA (if ESA approves the Mars Express Mission), and select the contractors for the major system elements of the Mars Surveyor 05 mission.	0S30	1. Co-investigator on Mars 03 Athena instrument; investigators on several proposals submitted for Mars 03 HEDS payload. 2. Enable an increased level of rover autonomy that is required for the '03 Mars Surveyor mission.
Complete Genesis spacecraft assembly and start functional testing in November 1999.	0S31	Participate as member of Standing Review Board.
MPL will successfully land on Mars in December 1999 and operate its science instruments for the 80-day prime mission with at least 75% of planned science data returned.	0S41	Co-investigator on MPL Thermal Emission Gas Analyzer instrument.
The Mars Global Surveyor (MGS) will acquire 70% of science data available, conduct at least two 5-day atmospheric mapping campaigns, and relay to Earth at least 70% of data transmitted at adequate signal levels by the Deep Space-2 Mars microprobes.	0S46	Interdisciplinary Scientist on MGS.
Continue Cassini operations during the quiescent cruise phase without major anomalies, conduct planning for the Jupiter gravity-assist flyby, and explore early science data collection opportunities. The following in-flight activities will be completed: Instrument Checkout #2; uplink Articulation and Attitude Control Subsystem (AACS) software update with Reaction Wheel Authority capability; Command and Data Subsystem Version 8; and Saturn tour designs for selection by the Program Science Group.	0S34	1. Cassini Interdisciplinary Scientist for rings and member of Program Science Group; co-investigators on Huygens Probe Atmospheric Structure Instrument; team member on Visible IR Mapping Spectrometer. 2. Develop an automated mission scheduling assistant to increase effectiveness of Cassini ground operations.
Continue Stardust spacecraft cruise operations without major anomalies and perform interstellar dust collection for at least 36 days.	0S37	Serve as co-investigator on Stardust interstellar dust collection mission.
The Remote Exploration and Experimentation element of the HPCC program will demonstrate software-implemented fault tolerance for science teams' applications on a first-generation embedded computing testbed, with the applications' sustained performance degraded by no more than 25% at fault rates characteristic of deep-space and low-Earth orbit.	0S50	Program-level management review and oversight of this activity to ensure completion of technical and programmatic metrics.
Conduct Research and analysis.	0S68	Conduct approximately 150 individual research, technology development, and analysis tasks in the Space Science Enterprise with emphasis on astrophysics, planetary studies, and exobiology/astrobiology.

EARTH SCIENCE ENTERPRISE FY 2000 PERFORMANCE PLAN - CHART 2

Enterprise FY 2000 Performance Plan	00#	Ames Contribution
Continue the development of a global land-cover/use change data set based on Landsat and EOS instrument at seasonal refresh rate.	0Y1	Develop leaf/canopy RT model to permit physical interpretation/inversion of these data.
Continue to collect near-daily global measurements of the terrestrial biosphere (index of terrestrial photosynthetic processes from which calculations of carbon uptake are made) from instruments on EOS AM-1.	0Y2	Incorporation of these products into global carbon model and biogenic trace gas production model for climate feedbacks.
Produce near-real-time fire monitoring and impact assessment based on Landsat and EOS inventory and process monitoring to provide an observational foundation for monitoring change in ecosystem productivity and disturbances. Post near-real-time assessments on a web site for quick access by researchers and regional authorities.	0Y7	ARC will contribute its airborne fire monitoring and assessment data for North and South America into this data base.
Develop/improve methods to couple state-of-the-art land surface and sea ice models to a global coupled ocean-atmosphere model and use to predict regional climactic consequences of El Nino or La Nina occurrence in the tropical Pacific. Results of research will be published in the open literature and provided to NOAA's National Climate Prediction Center and the U.S. Navy's Fleet Numeric Prediction Center. Ultimate goal: develop a capability to significantly improve the prediction of seasonal-to-interannual climate variations and their regional climate consequences. The main focus is on North America.	0Y10	Under Astrobiology, ARC will examine how historical El Nino climate variations and glacial transitions affect vegetation distribution across South America; by 2000, this 40,000-year time series will be initiated with pollen analyses.
Measure production and radioactive properties of aerosols produced by biomass burning in Africa based on SAFARI 2000 (field experiment) and EOS instruments. Includes extensive international participation. This burning is estimated to contribute one-half of global atmospheric aerosols.	0Y11	1. ARC Radiometric Sensors will be deployed on two airborne platforms and at surface sites to monitor the influence of atmospheric aerosols on the solar radiation energy budget. 2. Ames will provide a Western Hemisphere comparison for tropical biomass burning in conjunction with Brazilian colleagues.
Provide for the continuation of the long-term, precise measurement of the total solar irradiance with the launch of EOS ACRIM.	0Y15	ARC will apply improved spectral measurements of the solar source function toward resolving discrepancies in atmospheric absorption.
Implement the SAGE III Ozone Loss and Validation Experiment. Measurements will be made from October 1999 to March 2000 in the Arctic/high-latitude region from the NASA DC-8, ER-2, and balloon platforms. Will acquire correlative data to validate SAGE III data and assess high-latitude ozone loss.	0Y22	1. ARC will manage the SOLVE airborne mission to meet the science objectives on time and within budget. 2. Ames scientists will provide data on tracers and meteorological data for the Project.
Achieve a 50% reduction in mass for future land imaging instruments.	0Y33	ARC is miniaturizing its airborne instruments with >50% reduction.
Transfer at least one technology development to a commercial entity for operational use.	0Y34	GRAPES follow-on: grape quality/maturity.
Implement at least five joint applications research projects/partnerships with State and local governments in remote-sensing applications.	0Y43	ARC is part of the planning. The CaLSIP work could be one good example.
Focus EOCAP joint commercial applications research to develop 20 new market commercial products (e.g., oil spill containment software by EarthSat and map sheets products by ERDAR, Inc.).	0Y44	Two efforts, but only one under Com'l R.S. prog. Effects of N fertilization on crop yield and runoff under Hyperspectral Program; other is disaster work of Brass for Natural Hazards.
Develop two new validated commercial information products as a result of verification and validation partnerships with industry.	0Y46	Two efforts, but only one under Com'l R.S. prog. Effects of N fertilization on crop yield and runoff under Hyperspectral Program; other is disaster work of Brass for Natural Hazards.

HEDS ENTERPRISE FY 2000 PERFORMANCE PLAN - CHART 3

ENTERPRISE FY 2000 PERFORMANCE PLAN	00#	AMES CONTRIBUTION
In coordination with other Enterprises, develop and implement test and demonstrations of capabilities for future human exploration in the areas of advanced space power, advanced space transportation, information and automation systems, and sensors and instruments.	0H38	1. Perform domain analysis of human exploration during field work in harsh environments. 2. Enable an increased scientific level of rover autonomy that is required for preparation of human presence on Mars (e.g., emplacement of habitat, ISPP, and power generator).
Support an expanded research program of approximately 935 investigations, an increase of ~17% over FY99. Publish 100% of science research progress in the annual OLMSA Life Science and Microgravity Research Program Task Bibliography and make this available on the Internet.	0H1	The Life Sciences Division coordinated all efforts for the International Technical Review of the 98HEDS NRA; 11 new flight experiments were assigned to ARC. The Life Sciences coordinated and submitted all input for experimenters both at ARC and throughout the U.S. who are funded by the GB&E program within OLMSA.
Complete data reduction from the STS-95 Research Module mission. Begin to explore new cooperative efforts with the National Institutes of Health in the area of aging and transfer space-derived research data for industry development of a new drug to treat Chagas' disease.	0H9	ARC managed 2 experiments aboard STS-95. All data will be available by 11/99 (one year postflight).
Have in place an aggressive Shuttle program that ensures the availability of a safe and reliable Shuttle system through the ISS era.	0H15	ARC has submitted all documentation and is currently completing training of the Passive Dosimeter System slated for assembly flight 5.A.1 and the Biomass Production System aboard UF-1. The Avian Development Facility will transition in the mid-deck, but will not transfer to the ISS.
Complete preparations for the initial ISS research capability through the integration of the first rack of the Human Research Facility (HRF-1), five EXPRESS racks with small payload research, and the Microgravity Science Glovebox.	0H20	ARC has developed and implemented all operations supporting the integration of the Biomass Production System within the EXPRESS Rack aboard UF-1.

AERO-SPACE TECHNOLOGY ENTERPRISE FY 2000 PERFORMANCE PLAN – CHART 4

Enterprise FY 2000 Performance Plan	00#	Ames Contribution
Demonstrate, in a laboratory combustion experiment, an advanced turbine-engine combustor concept that will achieve up to a 70% reduction of oxides of nitrogen emissions based on the 1996 ICAO standard.	0R1	Collaborate with LES/combustion groups to predict hot streak migration in coupled combustor/turbine systems.
Validate the technologies to reduce noise for large commercial transports by at least 7 decibels relative to 1992 production technology.	0R2	Conduct a large-scale semispan wind tunnel investigation of airframe noise-reducing concepts.
Conclude the Terminal Area Productivity project by field demonstrations of the complete suite of technologies and procedures that enable a 12% increase over 1994 nonvisual operations for single-runway throughput.	0R4	1. Demonstrate electronic transfer of flight plan updates from the ATC CTAS systems directly into the aircraft Flight Management System (FMS) to decrease approach and taxi times. 2. Demonstrate the Airborne Information for Lateral Spacing (AILS) tool for conducting independent parallel approaches to runways spaced less than 3400 ft apart via a full-mission simulation.
Demonstrate in flight an airframe-integrated, dual-mode, scramjet-powered vehicle.	0R6	Computational tool development for RBCC-powered second-generation RLVs.
Demonstrate a prototype heterogeneous distributed computing environment.	0R8	Provide system tools and software to link multiple computing testbed (heterogeneous and distributed) into a single computing system.
Complete vehicle assembly and begin the flight test of the second X-34 vehicle.	0R12	1. Deliver TPS nosecap and wing leading edges. 2. Deliver an IVHM flight experiment developed by an ARC/GRC/KSC team.
Conduct the flight testing of the X-33 vehicle.	0R9	1. Complete TPS support and testing during flight tests. 2. Complete IV&V of X-33 flight software. 3. Conduct flight IV&V. 4. Develop a method for rapidly defining the aerothermal design environment for a given flight trajectory. 5. Conduct pre- and postflight aerothermal and TPS thermal analyses, the Surface Catalysis flight experiment.
Complete small payload focused technologies and select concepts for flight demonstration of a reusable first stage (Bantam).	0R17	1. Conduct SHARP B2 flight test to verify ultrahigh temperature ceramics. 2. Develop IVHM systems and ISE tools for application to second- and third-generation RLVs. 3. Evaluate vehicle design sensitivities evaluated for candidate concepts.
Complete 90% of all Enterprise-controlled milestones within 3 months of schedule.	0R13	1. AATT intends to satisfy its portion of this goal. 2. Participate in summer/fall rescope of program and refocus for second- and third-generation launch vehicles. ARC principal contributions will be in TPS and IVHM. 3. ARC will conduct the second SHARP flight test to obtain Ultra High Temperature Ceramic Aerothermal Performance Data on Strakes.

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AERO-SPACE TECHNOLOGY ENTERPRISE FY 2000 PERFORMANCE PLAN – CHART 4 (CONT.)

ENTERPRISE FY 2000 PERFORMANCE PLAN	00#	AMES CONTRIBUTION
Transfer at least 12 new technologies and processes to industry during the fiscal year.	OR15	1. AATT will transfer to the FAA's Free Flight Phase One Program, through its contractor teams, the following decision support tools: passive Final Approach Spacing Tool (pFAST), Traffic Management Advisor (TMA), and Surface Management Advisor (SMA). 2. Nine Cooperative Research and Development Agreements (CRDAs) ongoing to transfer Control Design Users Interface (CONDUIT); three CRDAs for Man-Machine Integration Design & Analysis System (MIDAS).
Achieve a facility utilization customer satisfaction rating of 95% of respondents at "5" or better and 80% at "8" or better, based on exit interviews.	OR14	ARC will meet or exceed the stated customer satisfaction level in all its wind tunnel and simulator operations.

MANAGE STRATEGICALLY FY 2000 PERFORMANCE PLAN – CHART 5

Enterprise FY 2000 Performance Plan	00#	Ames Contribution
Reduce the civil service workforce level to below 18,200.	0MS1	1. ARC was one of the first NASA Centers to reach its assigned downsizing target, and to be allowed to begin the workforce revitalization process by doing targeted hiring in critical areas. 2. ARC judiciously managed the R&PM budgets and FTE limits to ensure compliance with the Center's workforce targets.
Reduce the number of Agency lost workdays (from occupational injury or illness) by 5% from the FY94-96 3-year average.	0MS3	ARC will continue its aggressive safety program that has contributed to a significant reduction in lost time accidents.
Achieve a 5% increase in physical resource costs avoided from the previous year through alternative investment strategies in environmental and facilities operations.	0MS12	1. By conversion to performance-based contracting for facility maintenance, ARC has achieved a 5% cost avoidance in FY99 compared with FY98 costs for the same work. 2. ARC has been pursuing an energy conservation contract that is almost complete and will become effective in FY00. This contract will avoid about $400K in costs per year against an annual bill of about $5M, which is about 8% savings. However, for the first few years of the program, much of the cost avoidance will be used to offset the cost of the actual conversion work. The resultant savings will be a little below 5% per year during these years. 3. In a smaller project, ARC has employed the alternative strategy of placing a small herd of goats within a several-acre munitions storage enclosure, thereby avoiding the cost of vegetation control.
Cost 70% or more of available resources.	0MS4	ARC has continually improved the Center's management processes to meet the cost-performance metric and has typically achieved accruals in excess of 83%.
Begin the implementation at NASA installations of the Integrated Financial Management System following the completion of system testing.	0MS11	ARC is supporting the Agency's on-going IFMP activities and is pursuing the necessary actions in preparation for the June 2001 implementation at ARC.
Of funds available for PBC, maintain PBC obligations at 80% (funds available exclude grants, cooperative agreements, actions <$100,000, SBIR STTR, FFRDCs, intragovernmental agreements, and contacts with foreign governments or international organizations).	0MS5	ARC achievements in PBC obligations for FY96, FY97, and FY98 were 25%, 40% and 47%, respectively. FY99 achievement to date is 66%. At the current rate, achievement of the 80% goal is expected for FY00.
Achieve at least the congressionally mandated 8% goal for annual funding to small disadvantaged businesses (including prime and subcontracts, small disadvantaged businesses, HBCUs, other minority institutions, and women-owned small businesses).	0MS8	1. ARC continues to exceed this goal by a significant margin. FY99 performance to date is 23.5%. FY00 performance is expected to exceed the 8% plan as well. 2. The new Labor Contract for CoSMO (the ITOP) will be managed to maintain an 8% target.
Improve information technology infrastructure service delivery to provide increased capability and efficiency while maintaining a customer rating of "satisfactory" and holding costs per resource unit to the FY98 baseline.	0MS10	Budgets remain constant; satisfaction is improving.

PROVIDE AEROSPACE PRODUCTS AND CAPABILITIES FY 2000 PERFORMANCE PLAN – CHART 6

Enterprise FY 2000 Performance Plan	00#	Ames Contribution
Meet schedule and cost commitments by keeping the development and upgrade of major scientific facilities and capital assets within 110% of cost and schedule estimates, on average.	0P1	Integrate NRTC/RITA HUMS into Rotorcraft Aircrew Systems Concepts Airborne Laboratory (RASCAL) helicopter testbed.
Ensure the availability of NASA's spacecraft and facilities by decreasing the FY99 unscheduled downtime.	0P2	Futher implement condition base maintenance and preventive maintenance programs in wind tunnels, simulators, and arc jets.
Dedicate the percentage of the Agency's R&D budget that is established in the FY99 process to commercial partnerships.	0P6	1. With SGI 512 Machine, develop shared-memory architectures for high-performance computing. 2. Ten CRDAs focused on transfer of helicopter flight control and human factors technologies.
Increase the amount of leveraging of the technology budget with activities of other organizations, relative to the FY99 baseline that is established during the process development.	0P7	1. Leveraged NASA-funded flight control and human factors activities with Army-funded work directed toward meeting Army TDA goals. 2. MSFC, JSFC, JPL

COMMUNICATE KNOWLEDGE FY 2000 PERFORMANCE PLAN - CHART 7

Enterprise FY 2000 Performance Plan	00#	Ames Contribution
Support no less than 800 portable exhibit loans and send portable exhibits to a minimum of 175 targeted events per year.	0C11	1. Rotorcraft exhibits at Space Shuttle Development Conference. 2. Rotorcraft exhibits for Moffett Field Air Show.
Seek to maintain a level of participation involvement of approximately 3 million with the education community, including teachers, faculty, and students.	0C1	ARC will conduct direct outreach to educators, nationwide, to encourage and guide their use of ARC-generated outreach material, including video and televised programming featuring current NASA science and technology.
The Office of Public Affairs is acquiring the capability to provide the media with digital, high-definition video when broadcasting industry converts to digital broadcasting in the next decade. It will also add a searchable online digital version of the NASA Headquarters photo archive to the NASA Home Page.	0C12	ARC can provide media with digital; HDV will be limited to support of PAO only.
Provide the public with internal access to listings (1) existing and upcoming communications events, activities, and products and (2) best communications practices within NASA.	0C7	Accomplished through the ARC external web presence.
Increase the NASA-sponsored, -funded, or -generated report documents for the scientific community and public from 11,600 to 13,920.	0C4	Thirty publications and presentations on rotorcraft flight control and human factors.
Increase the capability of the NASA Home Page to meet public demand by providing for a 5% per year increase in download capacity, using FY99 figures as baseline.	0C18	Accomplished.
Maintain a baseline of five video file elements per week, issuing raw video and animation daily on NASA Television.	0C20	1. ARC will work directly with leaders in the broadcast television industry to co-produce original programming that communicates NASA's knowledge and scientific progress in meeting national and Agency information technology goals. 2. ARC will work for the broadest possible dissemination of its scientific knowledge and progress via nationwide distribution of its outreach material. This will include national distribution of original television programming via the Public Broadcast System and custom-designed web sites.
Produce 12 new historical publications chronicling and placing NASA's activities and achievements in perspective for the American public.	0C3	History of flight research at ARC was published.

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ACRONYMS

AACS	Articulation and Attitude Control Subsystem
AATT	Advanced Air Transportation Technologies
ACTIVE	Advanced Control Technologies for Integrated Vehicles
ADS-B	Automatic Dependent Surveillance – Broadcast
AILS	Airborne Information for Lateral Spacing
AIO	Astrobiology Integration Office
AIRES	Airborne Infrared Echelle Spectrometer
aiTPS	adaptive intelligent Thermal Protection System
ALS	Advanced Life Support
AOS	Aviation Operations Systems
APCM	Aerosol Physical Chemistry Model
APPL	Academy of Program and Project Leadership
ARC	Ames Research Center
ARPS	Advanced Radioactive Power Source
ASC	Aviation System Capacity
ASTER	Advanced Spaceborne Thermal Emission and Reflection Radiometer
AT	Aero-Space Technology Enterprise
ATC	Air Traffic Controller
ATD-B	Advanced Technology Development Biosensors Project
ATM	Air Traffic Management
AVOSS	Aircraft Vortex Spacing Separation
CAA	Cargo Airline Association
CAMEX	Convective and Atmospheric Moisture Experiment
CAN	Cooperative Agreement Notice
CAS	Computational Aerosciences Project
CASC	California Air and Space Center
CATS	Crew Activity Tracking System
CCHR	Catastrophic/Critical/High Risk

CCU	Cell Culture Unit
CDTI	Cockpit Display of Traffic Information
CFD	Computational fluid dynamics
CHAART	Center for Health Applications of Aerospace-Related Technologies
CIC	Federal Computing Information and Communications Program
CIO	Chief Information Officer
CMEX	Center for Mars Exploration
CNES	Centre National d'Etude Spatiales
CNS	Communication, navigation, and surveillance systems
COE-IT	Center of Excellence for Information Technology
CONDUIT	Control Design Users Interface
CoSMO	Consolidated Supercomputing Management Office
COTS	Commercial off the shelf
CRDA	Cooperative Research and Development Agreement
CSA	Canadian Space Agency
CT	Computer Tomography
CTAS	Center Terminal Radar Approach Control Facilities (TRACON) Automation System
CTR	Civil Tiltrotor
DAG	Dial a Gain
DASI	Digital Array Scanned Interferometer
DDG	Diversity Dialogue Group
DEAR	Design for Efficient and Affordable Rotorcraft
DFRC or Dryden	Dryden Flight Research Center
DLR	Deutsche Forschungsanstalt fur Luft- und Raumfahrt, Germany
DOD or DoD	Dryden Flight Research Center
DS-1	Deep Space One mission
EOS	Earth Observing System
EOSDIS	Earth Observing System Data and Information System
ERC	Educator Resource Center

ESS	Earth and Space Sciences Project
EVA	Extravehicular activity
FAA	Federal Aviation Administration
FANS	Future Air Navigation System
FAST	Fast Award Snapshot explorer
FBRP	Fundamental Biology Research Program
FIRE	First International Cloud Climatology Regional Experiment
FMS	Flight Management System
FRIAR	Fast-Response Industry Assistance Requests Project
FSF	Flight Safety Foundation
FTE	Full-time equivalent
FY	Fiscal Year
G&A	General and Administrative
GB&E	Gravitational Biology and Ecology Program
GIS	Geographic Information System
GPC	General Purpose Computer
GPS	Global Positioning System
GRC	Glenn Research Center
HCC	Human-Centered Computing
HEDS	Human Exploration and Development of Space Enterprise
HEPM	Hazardous Environment Prediction and Mitigation
HHR	Habitat Holding Rack
HPC	Human Performance and Countermeasures
HPCC	High-Performance Computing and Communications
HRF	Human Research Facility
HSO	Hungarian Space Office
ICAO	International Civil Aviation Organization
IDP	Integrated Development Plan
IFC	Intelligent Flight Control
IFM	Integrated Financial Management
IFMP	Integrated Financial Management Program

IMP	Interplanetary Monitoring Platform
INC	Incubator habitat
IRAC	Infrared Array Camera
IR	Infrared
IS	Intelligent Systems
ISO	International Standards for Organization
ISRU	In Situ Resource Utilization
ISS	International Space Station
ISTP	International Solar-Terrestrial Physics Program
IT	Information Technology
ITC	In trail climb
ITD	In trail descent
ITS	Information Technology Security
ITT	Integration Task Team
IVHM	Integrated Vehicle Health Management
IV&V	Independent Verification and Validation
JASON	(A name, but established as all capitals.)
JPL	Jet Propulsion Laboratory
JSC or Johnson	Lyndon B. Johnson Space Center
KSC	Kennedy Space Center
LBA	Large-Scale Biosphere Atmosphere project
LC	Level climb
LD	Level descent
LLES	Launch-entry suit
LSG	Life Sciences Glovebox
LT	Learning Technologies Project
MAGR-S3S	Miniaturized Airborne GPS Receiver-Shuttle 3 String
MASTER	MODIS/ASTER Airborne Simulator
MCO	Mars Climatic Orbiter
MGS	Mars Global Surveyor

MIDAS	Man-Machine Integration Design and Analysis System
MIP	Mars-In-Situ Propellant Production Precursor
MIPS	Multiband Imaging Photometer
MLC	Multicultural Leadership Council
MMMD	Micro Mass Measurement Device
MODIS	Moderate-Resolution Imaging Spectrometer
MRI	Magnetic Resonance Imaging
MSFC or Marshall	George C. Marshall Space Flight Center
NAI	NASA Astrobiology Institute
NAC	Non-Advocate Review
NAS	National Airspace System
NASA	National Aeronautics and Space Administration
NASDA	National Aerospace Development Agency of Japan
NASIRC	NASA Automated Security and Response Capability
NAVOCEANO	Naval Oceanographic Office, Stennis Space Center, Mississippi
ND/SD	New Derived/Shuttle Derived
NGI	Next-Generation Internet
NGST	Next Generation Space Telescope
NIX	NASA Image eXchange
NOAA	National Oceanic and Atmospheric Administration
NPG	NASA Procedures and Guidelines
NRA	NASA research announcement
NREN	National Research and Education Network
NRTC	National Rotorcraft Technology Center
OAT	Office of Aero-Space Technology
OCTS	Ocean Color Temperature Sensor
OES	Office of Earth Science
OLMSA	Office of Life and Microgravity Sciences and Applications
OSSE	Oriented Scintillation Spectrometer Experiment
PCA	Principal Component Analysis

PC-ITS	Principal Center for Information Technology Security
PDR	Preliminary Design Review
PDS	Planetary Data System
pFAST	passive Final Approach Spacing Tool
PIs	Principal investigators
PKI	Public Key Infrastructure
PMC	Program Management Council
PST	Pacific Standard Time
RASCAL	Rotorcraft Aircrew Systems Concept Airborne Laboratory
RAX	Remote Agent Experiment
REE	Remote Exploration and Experimentation Project
RESAC	Regional Earth Science Applications Center
RLV	Reusable launch vehicle
R&PM	Research and program management
R&T	Research and Technology
SAFARI	Southern African Fire/Atmosphere Regional Science Initiative
SAFOR	Safe All-Weather Flight Operations for Rotorcraft Project
SAGE	Self-Adhesive Grid Code
SBIR	Small Business Innovative Research
SDAR	Systems Design, Assessment, and Reliability
SFG	Simulation Facility Group
SHARP	Slender Hypersonic Aerothermodynamic Research Probe
SHEBA	Surface Head Budget of the Arctic Ocean
SILNT	Select Integrated Low-Noise Technologies Project
SIM	Space Interferometry Mission
SIRTF	Space Infrared Telescope Facility
SMA	Surface Management Advisor
SMEX	Small Explorer
SMMD	Small Mass Measurement Device
SOFIA	Stratospheric Observatory for Infrared Astronomy
SOLVE	Sage III Ozone Loss and Validation Experiment

SSBRP	Space Station Biological Research Project
STB	System Testbed
STI	Scientific and Technical Information Program
STS	Space Transport System
STTR	Small Business Technology Transfer
SUCCESS	Subsonic Aircraft: Contrail and Cloud Effects Special Study
TAP	Terminal Area Productivity Project
TIR	Thermal infrared
TMA	Traffic Management Advisor
TPF	Terrestrial Planet Finder
TPS	Thermal Protection System
TRACE	Transition Region and Coronal Explorer
TRACON	Terminal Radar Approach Control Facilities
TRMM	Tropical Rainfall Measuring Mission
UNEX	University Explorer
USFS	United States Forest Service
USGS	U.S. Geological Service
USRA	Universities Space Research Association