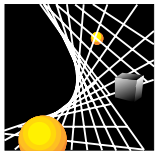


Ames Research Center Center Implementation Plan

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

October 1997
(Revised)

Ames Research Center
Moffett Field, CA 94035

Ames Research Center's Areas of Responsibility

Center of Excellence

Information Technology

Center Missions

Aviation Operations Systems
Astrobiology

Lead Center Programs and Responsibilities

Aviation Operations Systems R&T Base
Aviation System Capacity
Information Technology R&T Base
Rotorcraft R&T Base
High-Performance Computing and Communications
Gravitational Biology and Ecology
Supercomputer Consolidation
Simulation Facility Group

A Message from the Ames Center Director

Throughout Ames Research Center's nearly 60-year history, we have conducted our research and technology development activities with a consistent emphasis on excellence and relevance to mission. Despite a domestic economy characterized by downsizing, budget cuts, and the need to reinvent government, I am delighted to reaffirm Ames' continuing commitment to that path—to productive and cost-efficient service to the Nation in compliance with the spirit of the NASA charter.

This Center Implementation Plan is a visible manifestation of Ames' determination to achieve our responsibilities within the context of the NASA mission while simultaneously maintaining full accountability. We are dedicated to the successful implementation of the Agency and Enterprise Strategic Plans. And we are committed to the idea that all Ames employees will be able to trace their job functions and performance back to those enabling and defining documents. This plan is a vital link in making that goal a reality.

As a first priority, Ames is committed to leading the process of establishing and nurturing the Agency's Center of Excellence for Information Technology (COE-IT). We are spearheading NASA's implementation of partnership agreements with industry, academia, and other organizations to develop revolutionary information-technology-based approaches to aeronautics and space issues. Ames is leading the incorporation of these path-breaking technologies within each of the Agency's four Strategic Enterprises that encompass all aspects of NASA's aeronautics and space programs. It is our intention to promote and guide order-of-magnitude technology "forward leaps" that will dramatically reduce costs and enhance capabilities in the truest spirit of the Agency theme of "faster, better, cheaper."

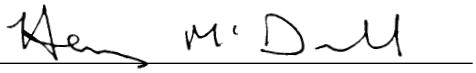
Ames is focusing its aeronautical research expertise on the Center's assigned mission in Aviation Operations Systems. We are leading the development and implementation of new air traffic management concepts and systems that will significantly improve the safety and productivity of America's air transportation system. Also, we are undertaking critical research in integrated design systems and leading NASA's rotorcraft and powered-lift technology development programs.

Ames' space activities focus on the Center's assigned mission in astrobiology. This encompasses inter- and multi-disciplinary research in exobiology, astrochemistry, gravitational biology, atmospheric physics and chemistry, and Mars science. Ames' leadership in astrobiology continues to extend into the academic and industrial communities, and benefits from emerging information technologies developed within Ames' COE-IT.

Ames is pursuing numerous other activities and programs in support of all of NASA's Strategic Enterprises, the Agency's nine other field centers, our partners and collaborators, and our customers.

I invite all employees and customers of Ames Research Center to familiarize themselves with this first edition of our Center Implementation Plan. Know what is expected of you, and know what Ames can be counted upon to provide.

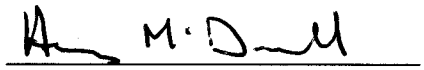
Please give us your feedback so that we may continue to develop this document and our planning process in the same way, and with the same resolve and commitment, that we evolve our programs.



Henry McDonald
Center Director
Ames Research Center

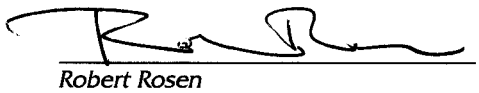
Ames Management Team Concurrence

We, the Senior Managers of Ames Research Center, are committed to working with the men and women of our Center and with our stakeholders, partners, and customers to implement this plan.

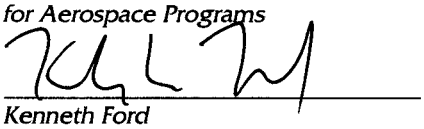


Henry McDonald
Center Director

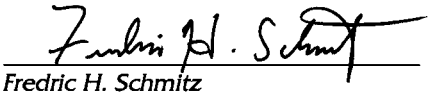
William E. Berry
Deputy Center Director
(Acting)



Robert Rosen
Associate Center Director
for Aerospace Programs



Kenneth Ford
Associate Center Director
for Information Technology



Fredric H. Schmitz
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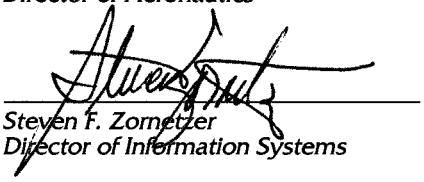
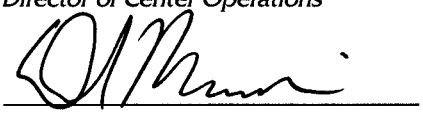
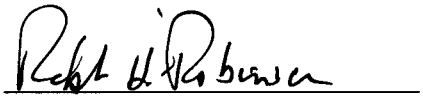


Steven F. Zornetzer
Director of Information Systems

Jana M. Coleman
Director of Center Operations

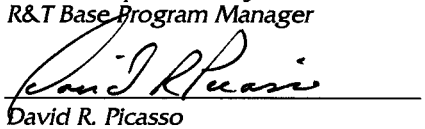


David Morrison
Director of Space

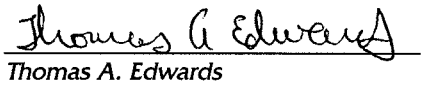


Ralph H. Robinson
Chief Financial Officer

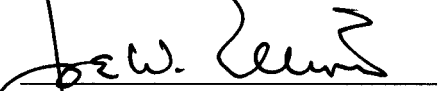
Cynthia H. Null
Aviation Operations Systems
R&T Base Program Manager



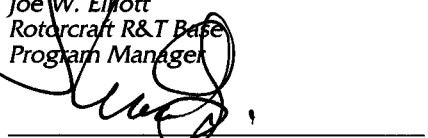
David R. Picasso
Aviation System Capacity
Program Manager (Acting)



Thomas A. Edwards
Information Technology
R&T Base Program Manager

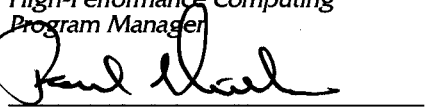


Joe W. Elliott
Rotorcraft R&T Base
Program Manager

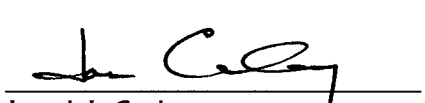


Robert D. MacElroy
Gravitational Biology and
Ecology Program Manager (Acting)

William J. Feiereisen
High-Performance Computing
Program Manager



Paul Kutler
CoSMO Director (Acting)



Joseph L. Conley
Simulation Facility Group Director

Contents

INTRODUCTION

This document presents the elements of a strategic implementation plan for Ames Research Center. It provides a snapshot of Ames facilities, capabilities, and resources and how this Center intends to bring them to bear in implementing its Center of Excellence responsibilities, Agency-assigned missions, and lead program and other roles in support of NASA's vision and mission.

This Center Implementation Plan is a work in progress. It is merely a first step in the process of conducting strategic planning and following through to implementation. It makes accountability and reality-based measurement against objectives achievable goals.

The section begins with an expanded statement of purpose, followed by a summary of NASA's and Ames' vision, mission, and goals, and their compatibility and interconnections. It also describes Ames' strategies for incorporating the new NASA way of doing business. The remainder of the document delineates how Ames will implement its assigned responsibilities. It provides a roadmap of the role that this Center intends to play in meeting the objectives of the Agency and NASA's four Strategic Enterprises over the next 3- to 5-year period, and beyond.

Purpose of this Document

This document will show Ames employees and contractors how their individual task assignments fit within, and are integral elements of, NASA's overall mission. It translates NASA strategy into Ames' action. It tells Ames' customers what they can expect from this Center.

In 1993, the Government Performance and Results Act directed all Federal agencies to implement a long-term strategic planning process that encompassed measurable outcomes and strict accountability. At NASA, that process is shaped by the Space Act of 1958 (which delineates the overarching Agency mission), annual funding appropriations, and other guidance from the Administration and Congress, as well as requirement inputs from NASA's external customers.

These elements constitute the building blocks of the NASA Strategic Plan which, according to Administrator Daniel S. Goldin, "is our top-level strategy" that "articulates what we do, who our customers are, where we are going, and why. "The Strategic Plan provides a common basis for NASA's senior management team to make decisions regarding program implementation and resource deployment. But how does that assist workers at the Agency's ten field centers?

It is the purpose of this implementation document to bridge that gap for Ames employees and customers. It provides a logical flow from the NASA Strategic Plan, through the various Strategic Enterprise plans, to Ames' Center of Excellence, primary missions, and lead center and program support responsibilities, to the role of the individual employee. Changes in strategy at the NASA and Strategic Enterprise levels will be reflected in updates to this Implementation Plan in concert with function and performance plan modifications at the employee level.

Background Information About Ames

Ames was founded on December 20, 1939, as an aircraft research laboratory by the National Advisory Committee for Aeronautics (NACA). The Center was named for Dr. Joseph S. Ames, NACA Chairperson from 1927 to 1939. Ames was NACA's second laboratory, and follows only the Langley, Virginia, facility in terms of longevity. In 1958, Ames and other NACA installations and Department of Defense (DOD) facilities became part of NASA.

Ames is situated on the border between the cities of Mountain View and Sunnyvale in the heart of northern California's Silicon Valley. The Center occupies 430 acres of land, and serves as host to other Federal, civilian, and military organizations on the adjoining 1,500-acre former U.S. Naval Air Station now called Moffett Federal Airfield. Located at the southern end of San Francisco Bay, the Center is an integral element of the "research cluster" of high-technology companies, universities, and national laboratories that define the region's character.

Ames serves as the Agency Center of Excellence for Information Technology (COE-IT) and plays an active role in most of NASA's major aeronautics and space programs with an emphasis on Aviation Operations Systems and astrobiology. Ames may be unique among NASA field centers in its support of all four of the Agency's Strategic Enterprises—Aeronautics and Space Transportation Technology, Human Exploration and Development of Space, Mission to Planet Earth, and Space Science. Ames research creates new knowledge and innovative technologies that span the spectrum of NASA interests and programmatic thrusts.

Ames is home to three national wind tunnel facilities, including the world's largest; the premier arc-jet facility in the United States; several advanced research flight simulators; a variety of supercomputers, including some of the world's fastest; and a suite of centrifuges that serve as a national resource. Ames has a wide variety of other facilities for life, Earth and space science research.

VISION, MISSION, AND GOALS

The NASA Vision

NASA represents an investment in America's future. It is the vision of NASA people to explore, pioneer, and innovate—to expand frontiers in air and space, while inspiring and serving the Nation and benefiting the quality of life on Earth.

NASA's Mission

To achieve this vision, NASA's defined mission encompasses three primary thrusts:

- *advancing and communicating scientific knowledge and understanding of the Earth, the solar system, and the universe, and using the environment of space for research*
- *exploiting, using, and enabling the development of space for human enterprise*
- *researching, developing, verifying, and transferring advanced aeronautics, space, and related technologies*

NASA's Goals

In its efforts to attain these objectives, NASA has a number of near-term goals. First and foremost is to be at the forefront of exploration and science. The Agency plans to develop cutting-edge technologies in aeronautics and space to fulfill America's national needs and to transfer this knowledge to industry. In addition, NASA will establish a permanent human presence in space, expanding and sustaining human exploration, use, and development of space in our solar system. This will provide benefits in science, technology, and commerce that will contribute to a better life on Earth for present and future generations. These accomplishments will serve to enrich American society and the domestic economy. Further, by communicating widely the content, relevancy, and excitement of the Agency's missions and discoveries, NASA will inspire people and increase both understanding and the broad application of science and technology in the national interest.

In the longer-term, NASA's goals are even more ambitious, including:

- *undertaking bold and noble challenges and sharing the excitement of NASA's future programs with the American public*
- *conducting international human missions to planetary bodies in our solar system, such as the Moon and Mars*
- *enabling advances to air and space systems in support of highways in the sky, smart aircraft, and revolutionary space endeavors*
- *supporting the maturation of established aeronautics and space industries and the development of new high-tech industries*
- *enabling humans to evaluate and forecast the health of the Earth's physical systems*
- *establishing a virtual presence throughout our solar system*

NASA programs and activities will contribute to economic growth and security, preservation of the environment, educational excellence, and peaceful exploration and discovery.

Ames' Role and Approach

Ames Research Center and its personnel work to develop technologies that enable the Information Age, expand the frontiers of knowledge for aeronautics and space, improve America's competitive position, and inspire future generations.

Ames' role and approach are a subset of the NASA vision, fully compatible with the Agency objectives and approach. The Ames' strategy focuses on this Center's unique facilities, human and other resources, capabilities, location, and program imperatives.

Ames' Missions

In contributing to NASA and America's goals, Ames' missions are:

- *to research, develop, and provide leading-edge aeronautical technologies and services to the American aviation community through the unique integration and application of computation, simulation, ground and flight experimentation, and information systems*
- *to answer fundamental questions concerning the health of our planet; the adaptation of living systems to space; and the origin and evolution of astronomical and planetary environments and life in the universe*
- *to develop technologies for space flight*
- *to design, develop, and deliver integrated information technologies (IT) and applications that enable bold advances in aeronautics and space, accelerating America's emerging IT revolution*

Ames' Goals

The following three specific goals address Ames' agencywide Center of Excellence and mission responsibilities.

- ***As NASA's Center of Excellence for Information Technology, Ames provides Agency research leadership and world-class capability encompassing the fields of supercomputing and networking, high-assurance software development, verification and validation, automated reasoning, planning and scheduling, and human factors.***

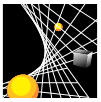
- ***As NASA's lead center in aeronautics for Aviation Operations Systems, Ames champions research efforts in air traffic control and human factors. Ames also leads the Agency's research efforts in rotorcraft technology, and has major responsibility for the creation of design and development process tools, wind tunnel testing, and simulation.***

- ***As NASA's lead center in space for astrobiology, Ames is responsible for science leadership, program coordination, the conduct of science research, and integration at the working level. Ames develops science and technology requirements for current and future flight missions that are relevant to astrobiology, including advanced concepts and technology development. This Center identifies and develops astrobiology mission opportunities, life sciences experiments for space flight, and space science research components of astrobiology. Ames also leads in information technology applications, and astrobiology education and outreach programs that inform and inspire the American public.***

The centerpiece of Ames' implementation strategy is to focus on the use of information technology as an enabling and integrating vehicle for the entire Agency. In addition, renewed emphasis is being placed on the development and extension of strong collaborative relationships and partnerships with industry, universities, and institutes. The Ames implementation paradigm

Data => Information => Knowledge => Informed Decisions

is being incorporated into all Ames research activities. This includes a renewed focus on such emerging and expanding research disciplines as origins/biogenesis, intelligent autonomous systems, human factors, and human-machine interface.



AMES' VALUES

In pursuing Center programs, Ames' management and supervisors recognize that people are the organization's most important asset. To ensure a work environment that accurately reflects that stance, Ames encourages and promotes adherence to the following core values:

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 ourselves and others. 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, the public's resources, and the public trust.

RELEVANCE

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

VENTURESOMENESS

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

BUSINESS STRATEGIES FOR THE TWENTY-FIRST CENTURY

NASA has a new way of doing business that is dramatically different from the traditional approach. Workforce downsizing, budget deficits, reduced availability of funds, increased accountability, frequent management reviews, and a host of other factors have all changed the nature of government. Within NASA, nothing is more significant than the decentralization of the Agency—the transition of program management responsibility from Headquarters to the field centers. At Ames, we have developed a series of strategies for dealing with this new reality.

Assumption of Program Management Responsibility

Ames has embraced the concept of moving the responsibility for program management from Headquarters to designated lead centers and has willingly assumed the accountability that goes with that management function. In fact, the bulk of this Center Implementation Plan is a roadmap to delineate how that responsibility will be implemented at Ames and how this Center will be accountable for the programs and activities it conducts—both as a lead center, and in support of the four Strategic Enterprises.

Ames implementation of the new way of doing business within NASA is firmly rooted in market-based strategies, quality organizations, and the use of full-cost accounting procedures. Each of these key elements in Ames' implementation strategy is discussed below.

Full-Cost Implementation

Ames is fully compliant with the agencywide initiative to implement full-cost practices centerwide. Conducted correctly, full-cost practices will strengthen the decision-making process and improve the cost effectiveness of mission performance. The full-cost initiative includes policy and practice improvements in the accounting, budgeting, and management areas. Ames has developed plans to associate all Center costs (including civil service personnel costs) with major projects and to budget and account for, report on, and manage these activities from a full-cost perspective.

Background

NASA's full-cost initiative integrates several fundamental accounting, budgeting, and management improvements. These include accounting for costs as either direct, service, or general and administrative (G&A); budgeting for full project costs; and managing projects from a full-cost perspective. Simply stated, direct costs can be physically linked to a particular project; service and G&A costs cannot. Under full-cost practices at Ames, service costs will be "charged" to projects based on project-controlled use of the service; G&A costs will be allocated in a consistent manner based on an indirect metric currently being developed.

The full-cost initiative supports "full disclosure" on activities and will improve the matching of costs with performance. It is consistent with sound business practice, and with recent legal and administrative guidance, including the 1990 Chief financial Officers Act, 1993 Government Performance and Results Act, 1993 national Performance Review, 1996 Federal Financial Management Improvement Act, and NASA's 1995 Zero-Base Review.

Objectives

Ames has chartered a full-cost implementation team to achieve the following objectives:

- ensure that the new system is fair and flexible
- minimize core institutional costs
- assess the impact on present and future Ames programs and costs
- identify the impact on Ames' ability to compete for new programs
- develop processes and data required to educate and train the Center
- work as a zero sum process
- develop prototype budget formulation processes
- develop models for G&A and Service Pools

Accomplishments

Ames established its full-cost team in October 1996. To date, the team has developed preliminary definitions of G&A elements and Service Pool structures, integrated full-cost processes into the budget cycle, and recast Ames FY97 and FY98 budgets in full-costs terms.

Plans

Ames' plans for implementing full-cost practices include providing centerwide training, establishing workforce allocation and civil servant costing methods, integrating full-cost practices into all programs, and rolling out the proposed implementation program to all Center employees.

ISO 9001 Implementation

Ames management and staff are committed to providing world-class quality products and services which consistently meet or exceed all customer specifications and expectations for technical, schedule and cost performance. To that end, Ames' management is committed to implementation and certification of an International Standards Organization (ISO) 9001 quality management system. In fact, it is a Center priority of the highest level. Ames' staff is being educated about the ISO 9001 system through class sessions.

Ames recognizes that ISO 9001 is mandatory to ensure systematic management and performance of core processes consistent with customer technical, cost, and schedule requirements. That is Ames' goal and commitment; ISO 9001 is the Center's implementing vehicle.

Mission

Ames' ISO 9001 mission is to increase the probability of success, optimize use of resources, increase productivity, facilitate timely delivery, and solicit and implement continuous improvement.

Goal

Ames' goal is to increase the quality of the Center's products and services via incorporation of quality management standards as part of the processes of this Center and its suppliers. ISO incorporation ensures that a minimum, self-consistent set of quality processes and standards are in place at Ames–a prerequisite to the attainment of quality products and services.

Scope

All core processes at Ames Research Center that design, develop, produce and/or directly support aeronautical and space research, and information technology services and products, will be subject to mandatory certification (as ISO 9001 compliant) by a third party internationally accredited register.

Objectives

Implementation of ISO 9001 is a key tool in the reinvention process at Ames. Applied in a top-down fashion, it will affect every individual and group at the Center and will be the bellwether of the new management system. Ames has two key objectives as they relate to ISO 9001:

- *to implement the ISO 9001 quality management standards centerwide, within all key processes that generate products and/or services for external customers*
- *to earn third-party certification of the ISO 9001 quality management system standards for the Center no later than April 1999*

Accomplishments

A centerwide Integrated Product Team (IPT) has developed an ISO 9001 implementation plan, and developed and undertaken initial awareness training for Center senior management. Center senior management has taken initial awareness training.

An ISO Program Manager has been named to support the development and implementation of a certified quality system. An ISO 9001 Implementation Team has been formed and is in the early action stages of preparing process model work flows and inventorying existing written procedures.

Directorates have named and assigned staff to support ISO implementation efforts throughout their organizations.

Budget and resource requirements have been estimated for FY 97-FY 01 and submitted to NASA HQ for funding action.

A gap analysis, to determine the extent to which the Center presently complies with ISO 9001, was conducted at Ames by certified auditors from STAT-A MATRIX, Inc. The audit was also accomplished at the Ames Software IV&V facility in Fairmont, WV. The report of the audit was provided to center management and is currently being used by the Centers' ISO Implementation Team.

Plans

The Ames ISO 9001 plan requires that the following activities be carried to completion:

- *documentation of the key process procedures required to comply with the standard*
- *full implementation of ISO 9000 by September 1999*
- *ISO 9001 tailored training for personnel with various implementation roles*
- *certification of Ames' ISO 9001 system by an accredited ISO third party registrar by April 1999*
- *implementation of continuous audits in order to maintain ISO certification for the Center*
- *identification of new opportunities for improvement*
- *revision and/or creation of necessary policy and/or process documentation*
- *selection of a registrar and preparation, performance, and closeout of the registration audit*

Commitment to Diversity and Multiculturalism in the Workplace

Ames Research Center supports NASA policy and has taken a proactive stance on the issue of encouraging workplace diversity and multiculturalism. Center managers and employees are encouraged to recognize diversity as a source of organizational strength. Workshops and seminars are conducted to show that diversity brings robustness to the workplace by challenging organizations to assess their perspectives with the goal of promoting innovation, productivity, and growth. Managers and employees are taught that diversity enables and encourages a broadening of existing concepts of harmony, motivation, and teamwork in the face of divergent backgrounds, needs, and expectations.

Ames' goals and missions require that everyone working at the Center be valued, and that no one be excluded on the basis of race, sex, ethnicity, sexual orientation, color, religion, age, disability, or any other non-merit-based factor. Ames 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. In that spirit, the Ames Center Director created his own policy statement on this subject. This policy ensures that the Ames' environment is a productive and healthy one, receptive and friendly to every individual.

The Center's commitment to diversity and multiculturalism is demonstrated by the support provided to the Multicultural Leadership Council (MLC), a grass-roots volunteer organization that nurtures diversity in all of its dimensions. Center management participates in the wide variety of short- and long-term MLC diversity activities, including the ongoing Diversity Dialogue Groups project, and the Ames-wide, on-site 1995 Diversity Conference. These activities attracted more than 600 people to presentations and discussion groups focused on diversity issues. In addition, Ames' management provided strong advocacy for the MLC's multicultural "street faire." It celebrated diversity through food, demonstrations, entertainment, and displays of cultural artifacts, and it provided "in-reach" to over 2,000 Center employees.

IMPLEMENTING NASA'S CENTER OF EXCELLENCE FOR INFORMATION TECHNOLOGY (COE-IT)

NASA's proposed bold missions in space exploration and aeronautics require significant advances in many areas of science and technology. Paramount among these needed enabling technologies are those in computer science and other related computational disciplines.

COE-IT Establishment

To ensure that NASA fully exploits this most critical enabling technology, Ames has been designated as the Center of Excellence for Information Technology. Both because of Ames' long history of computer science research excellence and because of its location in the heart of Silicon Valley, Ames is the logical place for NASA to focus its information technology research program.

Ames has identified seven discipline-based research areas as critical to support the future needs of NASA's Strategic Enterprises. They include: automated reasoning; human-centered computing and human/computer interaction (HCI); modeling and simulation; information management, and knowledge discovery and data (KDD) mining; smart sensor systems; advanced software technology; and high-performance computing (including networking and storage). Research is being, and will be, conducted in specific technology application focus areas.

Five Technology Applications Focus Areas

Five distinct technology applications focus areas are the current drivers of COE-IT requirements:

- *Researchers are seeking ways to put an unprecedented level of intelligence into the machines sent out to explore the universe. The machines sent into space will explore the cosmos and bring back information that will change our views of the universe and of ourselves. These machines need to be smart, adaptable, curious, and self-sufficient in harsh and unpredictable environments. Information technology research related to autonomous systems for space exploration will enable a new generation of spacecraft to do more exploration at much lower cost than traditional approaches.*
- *On Earth, many of these same information technologies will provide a catalyst for a new generation of embedded aviation operations systems that promise profound social and economic impact. President Clinton has announced a major initiative to enhance the safety of commercial aviation. A new generation of cognitive prostheses (computational aids designed to leverage human capacities) will be required to assist pilots and air traffic controllers to achieve progressively safer operation of aircraft in increasingly congested airspaces.*
- *In the integrated design systems focus area, new IT systems are being developed to accommodate globally distributed and increasingly complex design-team interrelationships. They will provide indepth knowledge for cost-effective, early-design decisions and will expedite aerospace products to market. This will reduce costs for American aerospace manufacturers and expand their market share. New space missions and space transportation vehicles will be made possible as the insertion of focused information technologies significantly reduces both risk and life-cycle costs.*

- *The use of information technologies in space systems operations will lead to dramatic reductions in launch and operational costs of space flight systems for orbiting and exploration platforms. Additionally, as humans contemplate journeys to Mars and beyond, research requirements clearly exist to develop a wide range of performance support systems (for both astronauts and ground operations personnel), diagnostic systems, condition-based maintenance systems, and other systems that operate autonomously in support of mission requirements.*
- *The challenge in the large-scale information management and simulation technology focus area is to use IT systems to manage increasingly vast data sets and convert them into information that can be accessed rapidly and securely for scientific and educational purposes. In addition to the need to construct high-capacity data storage and dissemination schemes, researchers must develop tools aimed at facilitating human understanding of these immense data sets. This IT research will enable scientists to model the Earth's complex, interactive systems and make predictions about the effects of human-induced changes.*

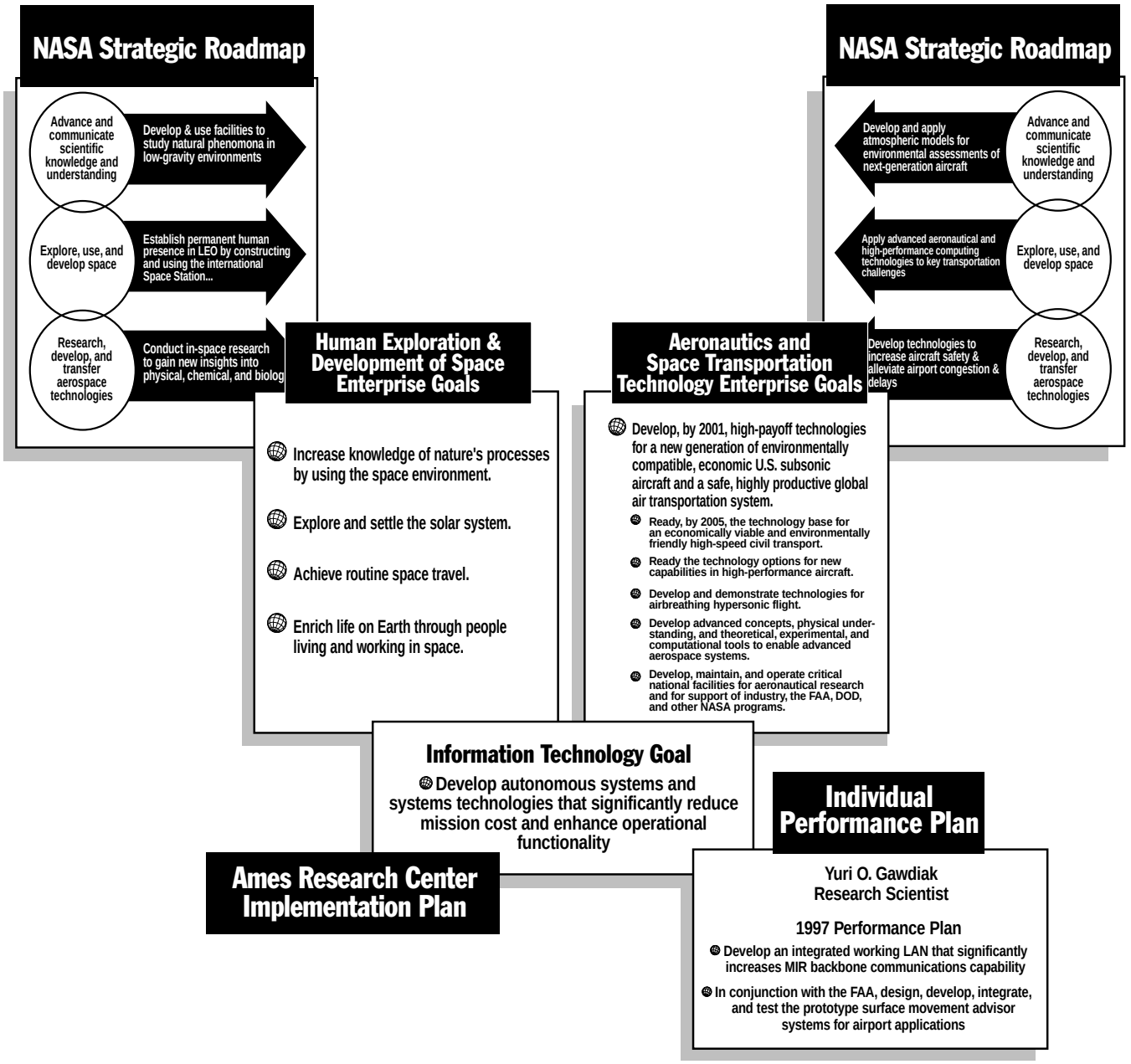
Accepting the Challenge

Ames Research Center has embraced its responsibilities as the NASA Center of Excellence for Information Technology. In particular, Ames is successfully recruiting the very best computer scientists available nationwide—researchers who comprise the intellectual engine that will drive NASA's information technology research now and in the future. Likewise, Ames has successfully recruited a new senior management team in Information Technology. To emphasize information technology's cross-cutting nature and that the "Center of Excellence" appellation applies to Ames as a whole, the Center has established the Office of Associate Center Director for Information Technology. Its twin purposes are to champion research excellence and to foster innovative IT research and development partnerships with industry, government, and academia.

Alignment of Individual Performance Plans with Center and Agency Goals

Example:

Information Technology



IMPLEMENTING AMES' CENTER MISSIONS

Ames has Agency-assigned and defined missions in both aeronautics and space. In aeronautics, Ames' mission is in Aviation Operations Systems; in space, it is in Astrobiology.

Ames' Mission in Aviation Operations Systems (AOS)

Within the NASA strategic vision for aeronautics of pioneering the identification, development, verification, application, and commercialization of high-payoff aeronautical technologies, Ames has been assigned responsibility for Aviation Operations Systems.

Development of new air traffic management concepts and systems has become a national priority for the U.S. aeronautics community. This is because air traffic delays in the United States are estimated to cost over $4 billion each year with a correspondingly high level of frustration for the traveling public. Without action, the problem will only become worse—experts predict that the number of major delays at airports will double within 10 years. Technological advances based on information technologies for the generation, analysis, transfer, and management of data offer the prospect for major improvements in the present system with enormous corresponding savings.

The Federal Aviation Administration (FAA) is the government agency responsible for developing and operating the National Airspace System in the United States. NASA has committed to a partnership with the FAA in order to provide enabling technologies for new generations of air traffic management systems that will alleviate inhibitions to air travel.

Ames has an unsurpassed capability in the key applicable technology disciplines which, taken together, form a unique national resource. This includes guidance and control engineering, human factors engineering, information systems, simulation, artificial intelligence, and aircraft operational methods. Ames has demonstrated the ability to integrate these multiple disciplines to provide nonlinear-control and flight-path-centered-display concepts and methods. Ames' accomplishments in conducting field evaluations under operational conditions (in collaboration with regulators, airlines, and airframe manufac-turers) underscore this Center's ability to understand customers' problems, develop solutions, and ensure rapid transfer of the resulting technology and methods. These needs exist, and Ames has the ability and the opportunity to address them. For these reasons, Ames is leading NASA's technology development in Aviation Operations Systems.

Ames' approach to providing solutions to safer and more efficient airspace operations is to integrate into teams the Center's experience and disciplinary, facility, and operational capabilities with those of the Center's customers. This ensures use of a systems approach —from problem definition, through transfer of the resultant validated products, to the customer.

Goals

Ames' specific goals and objectives include the following:

- *Integrate emerging ground and airborne technologies with advanced operational procedures and training methods to significantly improve the productivity, safety, and robustness of global air transportation management from gate to gate. In conjunction with the FAA, develop and demonstrate the technology to allow aircraft operators to select and replan, as flight conditions change, their own optimal routes. In addition, timely decision-making can be shared between the aircraft and the ground for any mix of aircraft. Use "open system" architecture principles and standards to include computing, networking, and software interfaces/protocols to reduce the cost of development and ownership. Ensure the timely development, field evaluation, and technology transfer of the Center*

- *Terminal Radar Approach Control (TRACON) automation system to the FAA's Denver and Dallas-Ft. Worth Air Traffic Control (ATC) facilities.*
- *Develop and provide a full spectrum of tools, methods, and expertise in human factors to optimize human performance in advanced aviation operations. Human-system modeling tools, such as the Man-Machine Integration Design and Analysis System (MIDAS), are being applied to a broad spectrum of aircraft and operational scenarios. MIDAS is also being developed to provide hybrid models of continuous and discrete human-system interactions. Databases on human performance in aviation operations, such as the Aviation Safety Reporting System, will be extended to include high-volume, readily accessible data and will be used to identify and examine emerging operational concerns. Understanding of the operational impact of crew factors, such as fatigue and circadian rhythms, will be broadened by developing better performance measures and conducting detailed studies of shiftwork. Comprehensive research on training and communication will lay the foundation for the integration of flight crews, controllers, and advanced automation to maintain high safety standards while increasing global airspace capacity.*

In partnership with industry, Ames is meeting its commitments in flight deck and human factors research for the High-Speed Research and Advanced Subsonic Technology programs.

Strategy

The Ames strategy in Aviation Operations Systems is to weave the Center's strength as the NASA Center of Excellence for Information Technology into all products and services as an integral, necessary, and forward-looking element. The result is an innovative, information-systems-based aeronautics program that is relevant and in demand by Ames' customers, the aviation community, the DOD, the FAA, and other commercial and governmental organizations.

Ames is ensuring that its customers are an integral component in the planning and execution of its aeronautics programs. This includes identifying technology needs, planning research programs, reviewing technical work and program accomplishments, and transferring technology. Ames has also enhanced commercialization and technology transfer efforts with non-aerospace industries.

Ames continues to encourage and support university research in aeronautics and to sponsor innovative concepts and basic research in the university system. Universities are Ames' partners in carrying out the basic research elements of a balanced program of applied and long-term research. They also supply the human resources that ensure NASA's future research capabilities. Ames pursues the NASA leadership role in those select areas where this Center has core competence, unique facilities, and expertise. In programs led by Langley, Lewis, and/or Dryden, Ames provides active support and full cooperation.

Ames' Mission in Astrobiology

Astrobiology is defined in the 1996 NASA Strategic Plan as the study of the living universe. Studies are multidisciplinary in nature and are directed toward understanding:

- *the origin of life—how life began in the context of the formation and diversity of planetary systems*
- *the evolution of life—how living systems have adapted to and changed Earth's environment*
- *the distribution of life—the search for other biospheres in our solar system and beyond*

- *the destiny of life—how life may adapt to environments beyond the Earth, thus laying the foundation for understanding and managing future changes in the Earth's environment*

In the 1996 NASA Strategic Plan, Ames Research Center was formally assigned as the Agency lead in astrobiology. This was in recognition of Ames' historical strength in multidisciplinary research of the living universe involving the life, space and Earth sciences, and Ames' unique involvement in all four of NASA's Strategic Enterprises. Astrobiology is closely related to Ames' lead center program role in Gravitational Biology and Ecology, in which this Center manages and coordinates multidisciplinary research on the effects of gravity on biological systems.

Ames has a long history of leadership in life science research dating back to the formation of the Life Science Directorate in 1964. For almost three decades, Ames has pioneered exobiology, the study of the origin of life and its possible detection elsewhere in the universe. Since the 1970s, Ames has drawn on its airborne science and information systems resources to make unique discoveries about Earth's biosphere and important contributions to protecting its resources. However, the study of the living universe is broader than any of these fields. The metadiscipline of astrobiology emphasizes the complex multidisciplinary opportunities provided when space, Earth, and life scientists work together to investigate a wide spectrum of topics related to the living universe—from our own planet Earth, to our egress into space, to the distant regions where stars and planets are born.

Goals

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. These include:

- *How do habitable worlds form and how do they evolve?*
- *How did living systems emerge from molecular chaos?*
- *How have the Earth and its biosphere influenced each other over time?*
- *How can we find other biospheres?*
- *What is the potential for biological evolution beyond the planet of origin?*
- *How do rapid changes in the environment affect emergent ecosystem properties and their evolution?*

Efforts to answer these questions form the initial complement of research and development activities in astrobiology. Progress requires access to data from airborne and space missions and integration of the knowledge, technologies, and mission capabilities accessible through NASA's four Strategic Enterprises. In return, advances in astrobiology will provide new insights and capabilities to astrobiology's parent programs in a relationship that is inherently symbiotic.

Strategy

The national Astrobiology Program encompasses research, technology development, participation in mission opportunities, and integration studies that synthesize elements of space, Earth, and life sciences disciplines into promising new research directions that can return valuable results over a 5- to 10-year period. The Astrobiology Program will continue to collaborate with the university community to develop undergraduate and graduate cross-training programs that enable the next generation of multidisciplinary scientists to

conduct astrobiology explorations into the next century. In recognition of the widespread public interest in astrobiology research questions, World-Wide-Web-based public education and outreach efforts will be key features of the program.

An Astrobiology Institute is being established at Ames to carry out world-class, multidisciplinary research; to coordinate and catalyze astrobiology across a range of disciplines and organizations; to develop and demonstrate modern communications technologies in support of multidisciplinary research; to provide advice to and technologies for NASA missions; to train students; and to provide outreach to the general public. Multiple partners throughout the research community will be linked via the Next Generation Internet (NGI) to facilitate collaborative ventures.

Annual integration workshops, composed of NASA and external scientists, will be convened to establish the current state of knowledge in all disciplines relevant to astrobiology development, and to initiate discussions about promising new research directions stimulated by workshop reports. In coordination with NASA Headquarters, selected new ideas will be the subject of focused workshops. The findings and recommendations from these workshops will provide the basis for recommending new research directions, developing solicitation announcements, initiating technology developments, and communicating mission requirements.

To realize the potential of astrobiology depends heavily on external contributors and the extent of interaction and integration among individuals, disciplines, organizations, and institutions. This is possible today because of the exceptional capabilities offered by the computer revolution and enabled by Ames' Center of Excellence for Information Technology. An integral part of the astrobiology development strategy will be to take advantage of the following features:

- *the range of communication options*
- *the fidelity of data-driven models and virtual environments*
- *the ability to share databases of exceptional size and complexity*
- *the capability for teleoperation of shared and remote (and even space-based) facilities*
- *the potential for Web-based curriculae and public education*
- *the vast improvements offered by the NGI*

Implementing Ames' Lead Center Programs and Responsibilities

Each NASA program is assigned to a lead center for implementation. The lead center directors have full program management responsibility and accountability for assigned programs and areas of responsibility, ensuring that they are managed to agreed-upon schedules, milestones, budget guidelines, technical requirements, and safety and reliability standards. Ames serves as a lead center in eight areas, for five aeronautics programs, one space program, and two facility areas. These include: aviation operations systems research and technology (R&T) base, aviation system capacity, information technology R&T base, rotorcraft R&T base, high-performance computing and communications, gravitational biology and ecology, supercomputer consolidation, and the simulators facility group.

Ames' activities as the lead for the aeronautics computations facility group are detailed in the writeup for the Consolidated Supercomputing Management Office (COSMO) and are not discussed separately. The remaining eight areas for which Ames has lead center responsibility are addressed below.

Aviation Operations Systems R&T Base Program

The Aviation Operations Systems R&T Base Program focuses on the ground, satellite, and aircraft systems, and the human operators that determine the safety, efficiency, and capacity of aircraft operations in a given airspace. It specifically encompasses:

- *communication, navigation, and surveillance systems*
- *air traffic management systems, interfaces, and procedures*
- *relevant cockpit systems, interfaces, and procedures*
- *operational human factors, their impact on aviation operations, and their mitigation*
- *systems for weather and hazardous environment characterization, detection, and avoidance*

Goals

The overall goal of the AOS R&T Base Program is to enable major increases in the efficiency, flexibility, and capacity of the Nation's air transportation system in a safe manner. The program requires the integration of multiple-discipline research to ensure a sound scientific base for development that supports the wide range of operational concerns in AOS. The systems that control the increasing flight demands for our national airspace are rapidly reaching the saturation level, which has the potential to erode the current level of aviation safety.

NASA recognizes that a shift in the focus of research in AOS is needed to ensure airspace capacity that is sufficient to absorb increased demand while maintaining a safe, preeminent U.S. airspace system. Improvements in performance, efficiency, environment, and aviation safety must consider both the aircraft and the airspace systems in order to achieve better, faster, and safer air transportation. In addition, the airspace system must be able to safely accommodate various aircraft types, from general aviation to supersonic transports, that vary widely in equipage, capability, and handling requirements. The increase in aircraft automation is expected to be mirrored by increases in automation in other airspace operations. Although aircraft automation has reduced some safety incidents, it has also created new incidents and complexities.

Scope

Research addresses specific national needs where NASA expertise and facilities can provide technology improvements, including projects that focus on aircraft icing, human factors, system safety, and atmospheric hazard avoidance. Research investigating human factors and stresses in aviation scenarios seeks to develop countermeasures to reduce and compensate for stress-induced human performance issues.

The flying public benefits from the AOS R&T Base Program because airframe manufacturers and others in the aircraft industry, the airlines, the FAA, and the National Transportation Safety Board (NTSB) use AOS technology products. The nature of the benefits includes an increased level of flight safety, more efficient use of the national airspace system, and increased capability of airspace operations in coping with severe weather.

Objectives

AOS research includes supporting the national goals for aircraft safety in the following areas:

- *developing analytical and experimental icing simulation tools for use by the aeronautics community, studying aircraft icing effects, and fostering development of advanced ice protection/detection/avoidance systems*
- *developing analytical and experimental tools for designing and evaluating integrated air-ground displays and procedures, human performance metrics in nominal and off-nominal operations, and training approaches that address human factors considerations for air-ground communication*
- *studying basic issues of human-machine interactions, and fostering the development of human-centered aeronautics systems*
- *developing methods to assess human performance (including three sub-elements: human perception, hazardous states of awareness, and psychophysiological research)*
- *developing methods for analysis of systems stability and safety with a focus on three coordinated development efforts: hybrid control theory, analytical methods for new-generation air traffic management systems, and measuring complex human performance*
- *developing technology and procedures to avoid or mitigate the atmospheric factors that influence the safety of aircraft operations (this effort is focused predominately on developing remote sensing technology to detect atmospheric hazards and quantifying their potential effect on the safety of aircraft flight operations)*

Technology Transfer—The Ultimate Bottom Line

An important program objective is to ensure rapid and effective dissemination of technology to the U.S. aviation community and other U.S. industries. Technology is transferred by various means. These include cooperative activities (in which research tasks for a specific technology development effort are shared between NASA and its customers) and participation at annual technical conferences, periodic specialist workshops, working group meetings, and a variety of other technical events. This approach to technology transfer of current research results is supplemented by the long-established methods of publications development and technical society presentations.

Aviation System Capacity Program

The Aviation System Capacity (ASC) Program is designed to increase the capacity of major U.S. (and international) airports so as to support dramatic increases in the throughput of national and global aviation systems while continuing to meet FAA safety guidelines. To achieve this objective, the ASC program encompasses activities in three primary R&T areas: Terminal Area Productivity (TAP), Advanced Air Transportation Technologies (AATT), and the Civil Tiltrotor.

Background

Recent studies of the national airspace system by state and local transportation authorities and private industry paint a worrying picture. They suggest that insufficient capacity at major airports is now a costly problem that will only get worse over the next 10 to 20 years. Limited access, air traffic congestion, and excessive regulations and restrictions all lead to increasing operating costs, delays, and reduced efficiency for U.S. airlines and their customers. In fact, the current situation is estimated to cost U.S. airlines at least $3.5 billion annually in increased operating costs (exclusive of reduced productivity and passenger inconvenience). Further, the problem is global, in that lack of capacity may restrict the growth of overseas markets for U.S. airframe manufacturers. The ASC Program seeks to alleviate this situation with R&T activity on three fronts.

Mission

The mission of the TAP element of the ASC program is to achieve the same level of traffic throughput and safety for both clear-weather operation and IMC. To that end, TAP is integrating flight and ground taxi management systems on aircraft with ground-based automation. This is to greatly reduce aircraft separation buffers and improve the efficiency of surface operations, thereby increasing capacity without adversely impacting safety, or pilot/air traffic controller workloads.

For safety reasons, all flight operations within the national airspace system are subject to tight control. Allowing users the freedom to select their own flightpaths, a phenomenon referred to as “free flight,” has the potential to increase flexibility and capacity. However, it also raises concerns about safety, particularly around busy airports and as the density of flight operations increases. The mission of the AATT element of the ASC program is to substantially increase the effectiveness of national and global air transportation systems by developing and testing automation aids to assist decision-making among pilots, air traffic controllers, and dispatchers.

Civil tiltrotors can take advantage of the fuel efficiency of aircraft flight in combination with the benefits attributable to short takeoff vertical landing (STOVL) vehicles. Development of a civil tiltrotor would increase capacity and relieve air traffic congestion at major airports by off-loading a large portion of their short-haul traffic. The mission of the civil tiltrotor element of the ASC program is to advance the technology to support a civil tiltrotor capability.

Goals

Overall, the Aviation System Capacity Program is taking on the challenge, on behalf of NASA and the Nation, of increasing the throughput of the U.S. aviation system by a factor of three over the next 10 years while maintaining present safety levels.

More specific goals of the various ASC Program elements are:

- *for TAP: increase current, non-visual operations for single-runway throughput by 15%; reduce lateral spacing between aircraft below 3,400 feet for independent operations on parallel runways; expedite taxi operations; and demonstrate equiva-*

lent instrument/clear-weather, runway-occupancy time while meeting FAA safety guidelines

- *for the AATT element: reduce operating costs by letting users conduct time and routing trade-offs; improve the effectiveness of high-density vehicle operations on the ground and in the air; enable operation across free-flight boundaries and in capacity-constrained flight regions; provide system improvements that can be deployed globally; and improve the simulation of advanced capabilities in the airspace system*
- *reduce or eliminate inhibitors to the use of civil tiltrotors through the development of a short-haul civil tiltrotor*

Current Activities

The TAP program is currently developing sensors and three-dimensional numerical simulations of weather-dependent, wake-vortex behavior; investigating pilot/controller roles in electronic flight information-sharing between the aircraft and ground control; and conducting flight demonstrations of the Taxi-Navigation and Situational Awareness (T-NASA) system.

AATT activities encompass six areas, including: seeking to define the air traffic management system of the future; developing computer models to assess technology benefits; studying pilot/controller responses to a range of displays, decision aids, and operating environments; developing computer-based analysis, prediction, and display tools; and designing tools that can predict conflicts between en-route traffic.

In the civil tiltrotor element, R&T activity is proceeding in four critical technology areas. These include: developing efficient, low-noise proprotor concepts; investigating noise minimization methodologies and cockpit technologies in the terminal area; achieving one-engine-inoperative capability anywhere within the flight envelope; and integrating technology.

Plans

Further development of the cited technologies, and their subsequent transfer to industry, highlight planned efforts in the ASC program beyond the current 3-to-5-year time horizon delineated.

Information Technology R&T Base Program

Throughout the latter half of this century, the U.S. aeronautics industry has been one of the undisputed success stories in global competitiveness. From the end of World War II into the last decade, U.S. aircraft, engines, and parts have been the leading sellers in both domestic and foreign markets for use in subsonic transports, general aviation, commuter, and military aircraft. The aeronautics industry is the largest positive contributor to the U.S. balance of trade, plays a vital role in maintaining the safety and convenience of global air travel, and provides important contributions to the defense of U.S. interests.

Program Framework

The Information Technology R&T Base program is sponsored by the NASA Headquarters Office of Aeronautics and Space Transportation Technology (OASTT) to develop and transfer IT solutions that support Enterprise goals. The program is part of the implementation of NASA's Strategic Plan and the Strategic Plan of the Aeronautics and Space Transportation Technology Enterprise.

The IT R&T Base Program enables advanced, high-end computational capabilities, fundamental advances in simulation and test techniques, and software technology. As

currently structured, the program consists of four major elements: modeling, analysis, and design; integrated instrumentation and testing systems; intelligent system controls and operation; and advanced computing, networks, and storage.

The first two elements are focused on the development of tools and integrated systems for the design and manufacture of flight vehicles. The third element is focused on the development of flight systems. All of these activities, and many others within OASTT, rely on ever-increasing computational capabilities. It follows that the fourth element of the IT R&T Base Program addresses advanced capabilities of computing systems. The unique role of this program is its emphasis on integrated supercomputing systems capabilities.

Specific objectives of the Information Technology R&T Base Program include:

- *develop tools, environments, and infrastructures to enable integrated design, manufacturing, and certification of flight vehicles*
- *develop prototype systems that integrate simulation and experimental design methods*
- *develop and demonstrate intelligent flight control systems for flight vehicles*
- *develop procedures for efficiently designing, producing, and verifying high-integrity, sophisticated software*
- *pioneer balanced, high-performance computing systems to support aeronautics computing requirements*
- *develop technology to interconnect geographically disparate, heterogeneous computing platforms in a metacenter*
- *investigate critical enabling technologies for radical advancements in computing system performance*

Current Activities

All of these objectives are either being pursued currently, or will be, beginning in FY98 and continuing for the next 3-5 years.

Rotorcraft R&T Base Program

The goal of this activity is to provide the technology leadership required to ensure the economic competitiveness and technical superiority of the U.S. rotorcraft industry. In partnership with the DOD, the program will produce the technology that ensures the supremacy of U.S. military rotorcraft. Finally, in partnership with the FAA, the program will provide the technology to ensure the safety and environmental compatibility of civil rotorcraft.

Objectives

This Ames program's objectives are as follows:

- *By 2002, provide validated aerodynamic and active control technologies that enable significant improvements in rotorcraft performance (for example, a 35% increase in payload).*
- *By 2002, provide technology solutions, such as crash safety and icing protection, that clearly demonstrate the value of a collaborative, national-team approach to customer-defined, near-term needs.*
- *By 2003, provide validated aerodynamic and active control technologies that enable the development of control system guidelines, flight and propulsion control laws, control inceptors, and helmet-mounted displays.*

- *By 2005, develop structural technologies and manufacturing processes, and provide accurate, validated modeling and design tools for rotorcraft systems, to enable a 15% reduction in the development and manufacturing-time costs and operating costs of rotary wing aircraft, referred to as the Design for Efficient and Affordable Rotorcraft (DEAR).*
- *By 2005, provide drive-system, cockpit, and operational technologies that will ensure safe and efficient rotorcraft operations, known as Safe All-Weather Flight Operations for Rotorcraft (SAFOR). For military missions, the objective is to provide (in collaboration with the U.S. Army) the technology necessary to reduce the rate of major accidents. For civil missions, the objective is to provide the technology necessary to reduce the accident rate for commercial carriers and U.S. civil helicopters.*

  To these ends, NASA will:
  - *By 2005, develop the physical models and tools to enable the design of ultra-safe and highly reliable transmissions that are lightweight, quiet, and affordable.*
  - *By 2005, develop cockpit technologies, sensors, control laws, terrain awareness, procedures, and an understanding of human-machine interactions to ensure safe and efficient integration of rotorcraft into free-flight operating environments and Nap-of-the-Earth military environments.*
- *By 2005, provide analytical methods, advanced technologies, and operational procedures to improve ride quality, and community and passenger acceptance, by reducing rotorcraft system noise and vibration (called Select Integrated Low-Noise Technologies, or SILNT).*
- *By 2005, provide technology solutions to customer-defined, near-term needs that clearly demonstrate the value of a collaborative, national team approach (called Fast-Response Industry Assistance Requests, or FRIAR).*

Current Activities

The NASA Rotorcraft R&T Base Program is national in scope involving work at all four Agency aeronautics centers, with management responsibility residing at Ames. Program goals include economic competitiveness, technical and military superiority, and environmental compatibility in the rotorcraft domain. To satisfy customer needs, NASA provides technology advances, analytical tools, innovative concepts, and relevant technology products. The rotorcraft program meets the technology leadership challenge through both short- and long-term activities.

The short-term rotorcraft technology development focus is implemented through a unique government/industry partnership—the National Rotorcraft Technology Center (NRTC). This effort is being co-funded by NASA and the DOD to ensure the continuing economic competitiveness and military supremacy of U.S. rotorcraft. The rotorcraft industry matches all government investments on a dollar-for-dollar basis, and shares equally in the resulting technology developed. Projects are selected from an annual research portfolio proposed and co-funded by industry members, with participation of sub-tier manufacturers and academia.

Long-term rotorcraft research programs will be implemented in close coordination with both industry and academia through the aeronautics strategic planning process and direct customer interaction. These efforts will be performed largely inhouse (but with considerable industry participation, and with a strong continuing collaboration between Ames, Langley, Lewis, and the U.S. Army research labs located at each Center). As civil and military rotorcraft technology needs are often similar, many ongoing rotorcraft R&T

programs are jointly planned, funded, and executed by the U.S. Army and NASA. A bold and significant reorganization has been undertaken at Ames to create an integrated NASA/U.S. Army rotorcraft division. This combines the rotary-wing research expertise of both organizations into a shared-management approach. Joint planning and implementation will enhance efficiency in resource utilization.

Plans

Ames will continue to promote teamwork and partnerships across the Agency (with the DOD, FAA, industry, and academia) to provide a well-balanced and technically excellent rotorcraft research program. Ames will further efforts to develop the concept of a National Rotorcraft Research Alliance (NRRA) in order to coordinate and facilitate the research activities of NASA, the U.S. Army, the FAA, and industry to the maximum extent possible.

Ames will endeavor to increasingly apply advanced information technologies, information management methods, and computational analysis methods developed by the COE-IT in solving complex, multidisciplinary analyses of rotorcraft challenges.

A system-level benefits analysis will be performed to assess the customer value and the return on investment of the various elements of the current rotorcraft base program plan. This analysis will guide prioritization and redirection of the program as it evolves.

High-Performance Computing and Communications (HPCC) Program

NASA's HPCC Program is an integral part of the Federal High-Performance Computing and Communications Program. The main goal of the Federal HPCC Program is to accelerate the development of high-performance computers and networks and the use of these resources in the Federal government and throughout the American economy. This infrastructure is essential to national competitiveness and will enable the United States to strengthen and improve the environment and civil infrastructure, digital libraries, and remote sensing databases, as well as education and lifelong learning, health care, manufacturing, and national security.

The NASA HPCC Program is structured to contribute to broad Federal efforts while addressing Agency-specific computational problems that are beyond near-term projected computing capabilities. The NASA HPCC Program manages work at eight NASA field centers in support of the research and development needs, and cross-cutting educational applications of computing technology, for all of the NASA Strategic Enterprises.

The program goal is to accelerate the development, application, and transfer of high-performance computing technologies to meet the engineering and science needs of the U.S. aeronautics; Earth, life, and space sciences; and spaceborne research communities; and to facilitate the commercialization and distribution of these technologies.

Objectives

Primary objectives of the HPCC Program, as implemented at Ames, include:

- *development of algorithm and architectural testbeds that use high-performance computing and networking concepts and increase end-to-end performance*
- *development of high-performance computing architectures scalable to sustained performance at 10^{12} floating point operations-per-second*
- *development of high-performance networking architectures scalable to enable gigabits-per-second of aggregate applications traffic*

- *demonstration of HPCC technologies on U.S. aeronautics, Earth and space sciences, and spaceborne community research problems*
- *development of services, tools, and interfaces essential to distributing technologies to the American public*
- *operation of pilot programs in education that demonstrate innovative technologies*

Current Activities

NASA's HPCC Program currently encompasses the computational aerosciences (CAS) project, the Earth and space sciences (ESS) project, the remote exploration and experimentation (REE) project, the information infrastructure technology and applications (IITA) project, and the national research and education network (NREN) project.

Plans

In the next 3 to 5 years, the HPCC focus will be on:

- *continuing current applications of high-performance computing and networking in the areas of aeronautics, Earth and space sciences, and spaceborne research*
- *continuing demonstrations of educational applications of computing and communications technologies*
- *being an active participant in the President's NGI initiative*

Gravitational Biology and Ecology Program

The Gravitational Biology and Ecology Program is an element of NASA's Human Exploration and Development of Space (HEDS) Enterprise. This program focuses on research designed to improve human understanding of gravity's role in biological processes. These effects range from the direct (such as the attraction of an organism to the Earth) to the indirect (for example, the "upward" growth of a plant or human perceptions of "up"). Gravity effects can also extend to subtleties, such as their roles in determining liquid pressure or gas densities. Both pressure and density, in turn, can affect organism metabolism, growth, and development.

Research tasks within the Gravitational Biology and Ecology Program range from the molecular level, through whole organisms, to multi-organism, multi-species ecological systems. This program is unique in its capability to provide scientists with an opportunity to manipulate gravity as an experimental, independent variable. Examples of Ames' capabilities include:

- *a suite of centrifuge facilities that can deliver controlled levels of hypergravity—up to 20 times Earth gravity—to biological systems ranging from cells in culture through adult humans*
- *ground-based experimental and computational models that can simulate and characterize many biological changes found in spaceflight (capabilities ranging from human head-down bed rest, to parabolic flight in an aircraft, to state-of-the-art computer models)*
- *ground-based models and simulations that can be transitioned to microgravity experiments in an orbiting capsule, the Shuttle, Spacelab, or the Space Station*

Goals

The goals of the Gravitational Biology and Ecology Program are to:

- *enable human exploration of space through the investigation of the major force—gravity—that differentiates life on Earth from life in space*
- *advance understanding of the influence of gravity on biological systems*
- *advance fundamental knowledge of the biological sciences by using gravity as a tool*
- *develop the technologies needed to conduct essential studies of gravity effects*
- *improve the quality of life on Earth*

Objectives

Overall, this program will oversee, facilitate, and sustain a robust research program that supports NASA's strategic objectives by improving human understanding of gravity's role in biological processes. It is essential to ensure that NASA maintains cutting-edge and world-class capabilities for fundamental scientific investigations, either on the ground or during spaceflight. Specific program objectives are to promote, secure, and guarantee that NASA has:

- *an up-to-date, contemporary, ground-based research and analysis program in gravitational biology and ecology*
- *modern, well-maintained and well-staffed, state-of-the-art gravitational ground research facilities including centrifuges, linear sleds, the Ames Biocomputation Center, and the Vestibular Research Facility*
- *robust advocacy and support for gravitational biology and ecology NASA Specialized Centers of Research and Training (NSCORT)*
- *a state-of-the-art, global monitoring and disease prevention program, including the Center for the Health Applications of Aerospace-Related Technologies (CHAART) at Ames*
- *an efficient and effective life sciences outreach, technology transfer, and relevant data-archiving effort*
- *a vigorous space flight research experiments program in gravitational biology and ecology*
- *excellence in gravitational biology and ecology science, engineering, space flight experiment development, and experiment operations of international biosatellite space flights*
- *efficient and effective technical and programmatic support for experiments scheduled for the Neurolab mission, life sciences laboratory equipment, and non-human small payloads*
- *relevant guidance and support for science experiments and experiment-unique equipment for the gravitational biology and ecology portions of the International Space Station (ISS), as well as the fundamental biology experiments for the NASA/Mir Program, and the centrifuge and gravitational biology facility aboard the ISS*
- *appropriate and effective representation for the NASA Office of Life and Microgravity Science and Applications in the new NASA initiative in astrobiology*

Current Activities

Work sponsored by the Gravitational Biology and Ecology Program includes:

- *identification of program goals and concomitant research opportunities*

- *conduct of fundamental, ground-based research, education, and outreach*
- *support of University-based research organizations, such as NSCORTs*
- *maintenance of specialized research facilities, such as research centrifuges*
- *development of hardware to support selected research flight opportunities*
- *conduct of flight experiments*
- *analysis of data derived from measurements made during flight experiments*

Plans

While Ames pioneered gravitational biology and ecology research, and still maintains a high concentration of talent, facilities, and capabilities in the field, other NASA field centers are involved in program implementation, including Marshall, Kennedy, and Johnson.

Research areas that further Gravitational Biology and Ecology Program goals will be identified in periodic NASA Research Announcements (NRA). Proposals submitted in response will be peer reviewed, and it is anticipated that research will be conducted at universities, nonprofit research organizations, and NASA field centers. NRAs will also be used to select experiment tasks to be conducted in the gravitational biology and ecology facilities on the ISS.

Consolidated Supercomputing Management Office (COSMO)

As part of the new way of doing business being driven by government reinvention and constrained budgets, NASA is striving to reduce its costs of operations and improve its efficiency. One way to accomplish this is to consolidate NASA's supercomputers—this is the objective of COSMO.

COSMO 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. 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-compute engines.

COSMO's mission is to meet NASA's supercomputing requirements for each Strategic Enterprise office, while realizing an overall cost saving via effective and efficient management of Agency supercomputing resources through the end of the decade and into the next century.

Goals and Objectives

COSMO goals for consolidated agencywide management of supercomputing include:

- *satisfy the supercomputing requirements of the NASA Enterprises*
- *improve the cost effectiveness of NASA supercomputing*
- *consolidate operations across NASA and design an optimal supercomputing architecture to reduce the number of physical locations for supercomputing*
- *co-locate supercomputing platforms within large data centers, where applicable*
- *modernize data centers to improve service and reduce life-cycle costs*
- *outsource supercomputing activities, when cost effective*
- *form partnerships with Centers by using matrix management principles*
- *participate in NASA's transition to full-cost accounting methods by designing a market-based approach for the use and costing of supercomputing resources*

Plans

In the near-term, COSMO has staffed up, begun a study of optimal supercomputing sites, initiated a capital investment strategy development process, and begun work on a "Year 2000" compliance study. Future plans call for implementing optimal supercomputing architectures, developing a disposal/acquisition strategy for assets, initiating a "1-800" help desk activity, convening a customer review board, studying the use of a master operations contract, and initiating a meta-center (virtual computing) development process.

Simulation Facility Group

In May 1995, NASA decided that central management of major aeronautics facilities was in the national interest. Six classes of facilities were included for implementation within the facility central management concept. Ames has been designated the lead center for two such facility classes, including simulation. The simulation class currently includes five facilities:

Facility	Location
Cockpit Motion Facility (CMF)	*Langley*
Crew-Vehicle Simulation Research Facility (CVSRF)	*Ames*
Differential Maneuvering Simulator (DMS)	*Langley*
Surface Development and Test Facility (SDTF)	*Ames*
Vertical Motion Simulator (VMS)	*Ames*

These facilities are state-of-the-art, high-fidelity tools that are critical throughout the life cycle of aerospace vehicles, to flight operations systems, and to the U.S. aerospace community. The hardware resources for the flight simulators (CMF, CVSRF, DMS, and VMS) include cockpits, cockpit systems, image and graphics generation systems, host computers, simulation support systems, and operations/control labs. The CMF, CVSRF, and VMS also employ motion systems (the VMS has the highest-fidelity system in the world). The DMS is an air-to-air simulation facility, consisting of two 40-foot domes used for military technology programs. The flight operations simulator (SDTF) will use similar hardware resources but will focus on simulating flight operations from the air traffic controller's perspective and, therefore, will not require a motion system. Because of their unique, high-performance capabilities, the VMS and SDTF are categorized as world-class aerospace facilities.

Simulation facilities that are lower fidelity or do not focus on real-time, human-in-the-loop flight research testing (for example, training or product development simulators) are not part of the Simulation Facility Class.

Objectives

The six facility classes were established to:

- *provide an "aerocentric" approach to evaluating requirements and developing investment plans*
- *ensure integration of facilities with programs, and responsiveness to customer needs*
- *reflect budget and management strategies in facility-sizing and operating decisions*
- *provide a process for periodic assessment of facilities and determination of whether facilities should be maintained, modified, or removed from operational status*
- *provide coherent processes tailored to each group of facilities*
- *provide a common voice to customers and stakeholders in planning for facilities, applying operating policies, and handling data*

- *provide leadership for sharing of best practices and re-engineering efforts*
- *provide leadership for national alliances with other agencies and industry*

Current Activities

The Simulation Integration Task Team (ITT), led by the Simulation Facility Group director, is currently developing a strategic management plan. The plan will provide a vision and an approach, with metrics for assessing the effectiveness of the implementation.

Consistent with the current NASA Aeronautics strategic planning process, this plan will describe a 25-year vision for the simulation facilities and will include both the 5-year investment plan and the operations and maintenance plan needed to achieve the vision. The strategic planning team is soliciting inputs from management, the various NASA aeronautics programs, and aeronautics customers with whom NASA conducts cooperative work. Ames will update this plan annually to accommodate changes in aeronautics strategy, program requirements, external environments, and the underlying assumptions used in its development. The Simulation Facility Group director is responsible for leading the planning process, and for both monitoring the plan's implementation and measuring its overall effectiveness.

In addition, the simulation ITT is developing a program in support of the Office of Aeronautics and Space Transportation Technology with the following objectives:

- *develop tools to dramatically reduce the time to build simulation models, including simulation code standardizing*
- *develop simulation performance metrics and standardized simulation models (for example, atmospheric models and turbulence)*
- *produce baseline comparisons of simulation tests for vehicle design assessments versus flight tests for various classes of vehicles and specific piloting tasks*

The ITT is advocating the Simulation Technology Plan, participating in the facility budget process, and reviewing NASA, DOD, FAA, and industry simulation capabilities and requirements.

Plans

Future activities will consist of implementing the plan and completing the elements of the simulation technology program. Each will be reviewed and revised annually.

Implementing Ames' Support of NASA's Strategic Enterprises—Overview

Ames and the Four Strategic Enterprises

NASA's four Strategic Enterprises comprise an integrated national aeronautics and space program. Each Strategic Enterprise has a unique set of goals, objectives, and strategies; yet each must ensure synergy with the strategies of the others. Unique in its ability to support all four of these Strategic Enterprises, Ames frequently acts as a technical bridge among the Enterprises, their host organizations, and the implementing centers to ensure that the insights, technologies, mission opportunities, and results from each Enterprise are easily accessible for use by other public and private communities. This approach reveals important new research directions, produces innovative technologies, and enables more cost-effective missions.

Ames accomplishes these objectives by premier science, engineering, and mission competence in aeronautics and space transportation technology, and the Earth, space, and life sciences. This competence is coupled with cross-cutting efforts—particularly, the Center of Excellence for Information Technology and Ames' primary missions in Aviation Operations Systems and astrobiology—that serve to unite these disciplines both at Ames and across the Agency.

In the future that Ames is working to create, breakthroughs in aeronautics and information technologies will enable safer, more economically competitive, and environmentally friendly aircraft and operations. The biology of space exploration will be defined, the barriers to space settlement removed, and the mysteries of the galaxy revealed. Robotic and human missions to the planets will expand, and our knowledge of the Earth and its biosphere will increase dramatically. These developments, and the methodologies for achieving them, will form the basis of a comprehensive education program directed at nurturing a scientifically literate citizenry.

Ames' contributions to the national aeronautics and space programs within each Enterprise are summarized in the following overview, and described in greater depth in the sections that follow.

Aeronautics and Space Transportation Technology (ASTT) Enterprise

The OASTT has developed a set of bold objectives for the future to reflect national priorities for aeronautics and space, as outlined by the National Science and Technology Council in a series of three aeronautics reports within the National Space Policy. The resulting ten goals, described within the OASTT 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 outline these goals and Ames' involvement in them.

Pillar One: Global Civil Aviation

Before 1974, large commercial transport manufacturing was the domain of the United States, with this country having more than 90% of the world market share. Today, with over 11,000 airplanes in commercial service worldwide, the United States faces much stronger international competition in this vital area whose products are the largest positive industrial contributor to the U.S. balance of trade. Projects linked to world economic growth suggest

that air travel demand will triple over the next 20 years. So to preserve our Nation's economic health and the welfare of the traveling public, NASA must provide high-risk technology advances for safer, cleaner, quieter, and more affordable air travel.

The Global Civil Aviation pillar encompasses the following five goals:

- *reduce the aircraft accident rate by a factor of five within 10 years, and by a factor of 10 within 20 years*
- *reduce emissions of future aircraft by a factor of three within 10 years, and by a factor of five within 20 years*
- *reduce the perceived noise levels of future aircraft by a factor of two (from today's subsonic aircraft) within 10 years, and by a factor of four 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% within 10 years, and by 50% within 20 years*

Ames' significant involvement in the Safety goal includes human factors, information technology, and condition-based maintenance. The Aviation Safety Reporting System is also a key component to safety. Toward the Emission goal, Ames is conducting research in combustion turbulence as well as atmospheric chemistry research and flight expeditions. Under the Noise goal, Ames has significant aeroacoustic research and testing capabilities, the most recent advance being the Aeroacoustic Modification Project at Ames' National Full-Scale Aerodynamics Complex (NFAC) currently being completed. Ames' major effort in research and development of air traffic management automation represents virtually all of NASA's work under the Capacity goal. Under the Affordability goal, Ames' contributions come from rotorcraft, national tasking facilities, and research and development of integrated design systems to dramatically improve the design process.

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.

The Revolutionary Technology Leaps pillar contains three goals:

- reduce the travel time to the Far East and Europe by 50% 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

Under the High-Speed Transport goal, Ames has diverse activities in wind tunnel testing and simulation, external visibility, sonic boom minimization, and wing aerodynamic optimization. In the General Aviation Revitalization goal, there are small efforts in business jet wing optimization and aircraft impacts to aviation operation systems. Under the Next-Generation Design Tools/Experimental Aircraft goal, Ames has significant work in integrated design systems and the X-36.

Pillar Three: Access to Space

In coming decades, NASA envisions the space frontier as a busy crossroads of U.S.-led international science, research, commerce, and exploration. Our experience with this vast resource has already yielded new treasures of scientific knowledge, life-enhancing applications for use on Earth, and fantastic celestial discoveries. The potential for the future seems almost limitless.

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 $1,000 per pound, within 10 years*
- *reduce the payload cost to low-Earth orbit by an additional order of magnitude, from thousands-of-dollars to hundreds-of-dollars per pound, by 2020*

The goals differ in the degree of cost reduction and the timeframe. Most of Ames' efforts under this pillar apply to both goals. The development of advanced thermal protection system materials, unique arc-jet testing facilities, and hypersonic vehicle, aerothermodynamic analysis and synthesis methods are principal examples. Wind tunnel testing and piloted simulation are activities that apply more to the longer-term goal, when completion of present facility modifications will improve their availability.

Mission to Planet Earth (MTPE) Enterprise

The goals of the Mission to Planet Earth Enterprise are to understand the total Earth system, and the effects of natural and human-induced changes on the global environment, in a manner that enables the productive use of Mission to Planet Earth science and technology in the public and private sectors. Ames' earth systems science and applications program continues to provide the scientific community with access to unique aircraft research platforms. With national and international partners, Ames designs, develops, and implements coordinated research campaigns on atmospheric dynamics, remote sensing, public health, and the role of biota in biogeochemical cycling. These studies involve aircraft and/or satellite remote sensing, coupled with computer modeling and measurements made in the field, to determine how natural and human-induced changes affect critical functions of the biosphere.

Ames supports this effort through its Earth Systems Science Division, Space Projects Division, Center of Excellence for Information Technology, and through the NASA Science Internet, and the Commercial Technology Office. The synthesis of these elements enables Ames to provide a public service during disasters (fires, floods, earthquakes, etc.) by identifying deployment strategies for monitoring and relief, and supporting analyses for assessing and mitigating damage.

Ames also supports this Enterprise through its computer science and IT capabilities. For example, the Center is developing new methods for discovering underlying features in very large data sets gathered by Earth observing satellites. Additionally, the improved computing and networking capabilities under development at Ames will permit improved collaboration among geographically distributed teams of scientists as they study such large data sets and corresponding models.

Human Exploration and Development of Space (HEDS) Enterprise

The goal of the Human Exploration and Development of Space Enterprise is to bring the frontier of space fully within the sphere of human activity to build a better future for humanity. Ames supports this goal through a space technology and gravitational biology program involving scientists, engineers, and mission developers in the Life Sciences, Space Projects, Space Technology, and Space Science Divisions, as well as in its Center of Excellence for Information Technology.

As lead center for the Gravitational Biology and Ecology Program, Ames provides fundamental science knowledge about the relationships of gravity, life, and natural and artificial environments through research, technology development, and provision of enabling space flight research opportunities. Ames focuses on efforts to understand basic processes and mechanisms that cause adverse biomedical effects of space flight, and then supports JSC in the development of appropriate countermeasures. In addition, Ames provides the required thermal protection technologies, aerobrake, aeroassist, and advanced life support concepts and technologies to enable and protect space crews on increasingly sophisticated, distant, extended, and affordable explorations beyond Earth's orbit.

Ames' Center for Mars Exploration (CMEX) provides a forum for focusing research and technology development toward scientific exploration strategies, advanced concepts, enabling technologies, and mission implementation options for both human and non-human Mars exploration. All parties can participate through the CMEX World Wide Web page.

Together, these efforts provide the insights essential to design human exploration missions and determine the precursor information for assessing potential evolution of terrestrial species beyond Earth. Because these research and technology development efforts are designed to support life in extremely harsh environments, they can be readily transferred to help solve health, environmental, and economic problems on Earth.

Space Science Enterprise

The Space Science Enterprise goals are to seek answers to fundamental questions about some of humanity's oldest riddles—the origin and evolution of the universe, the galaxy, the solar system, and life, and to share the knowledge and technologies resulting from this research for educational and other public benefits. Ames supports the Space Science Enterprise through research, technology development, flight projects, and education and outreach performed by the Space Science Division, Space Projects Division, Space Technology Division, Information Systems Directorate, the Commercial Technology Office, and the Office of External Affairs.

Ames conducts and enables fundamental ground and flight research in exobiology, including research to understand how life originates and evolves, and to apply this knowledge to search for and identify evidence of life and its chemical origins elsewhere in the solar system and beyond. The results from these studies are amplified because of Ames' unique pioneering research into the dynamics and interactions of galaxies, planetary systems, and the Sun. This research provides the context for understanding the evolution of life by detailing the cosmic environment within which life develops. Through internal and external collaborations, Ames develops new research capabilities for the national science community, emphasizing airborne observatories; laboratory, computational, and information systems techniques; spaceborne instrumentation; and techniques for the teleoperation of planetary surface vehicles.

Ames' Space Projects Division develops, characterizes, and tests large-format, high-efficiency sensors for use in low-background environments in support of astronomy, planetary, and laboratory applications. As the Agency expert in planetary protection, Ames plays a major role in this area, influencing international policy and mission design.

Enterprise Synergies

Ames' primary mission in astrobiology provides the scientific foundation to understand life's origin, evolution, and destiny in the context of the fundamental structure of matter, the origin and diversity of planetary systems, the co-evolution of life and the environment, and the migration of life from its planet of origin. In this endeavor, astrobiology links all of

the Enterprises with insights, multidisciplinary research and technology development, access to novel space and airborne research opportunities, education, outreach, and synergy.

Ames' Center of Excellence for Information Technology is a "virtual organization" that uses IT to link geographically separated groups at NASA centers, industry, and academia into close-knit teams. The primary objective is to develop, in consort with other NASA centers, advanced information technologies to support all of NASA's Strategic Enterprises.

Public Service—Community and Educational Outreach

All technical endeavors at Ames contain strong educational components developed to promote scientific and technological literacy from pre-school through post-graduate school. In addition, Ames is committed to promoting maximum use of its knowledge and technologies for public benefit through a proactive program of commercialization and technology transfer.

Ames' Role in the Region's K-12 Educational System

In today's knowledge-based economy, it is vitally important that all K-12 students receive a quality education in order to compete in high-technology job markets. Education also ensures availability of a trained workforce needed in the next millennium by the regions' companies and research institutions. This awareness has been embraced and brought into sharp focus at Ames.

The NASA educational vision, as spelled out in the Agency Strategic Plan for education, is "to promote excellence in America's education system through enhancing and expanding scientific and technological competence." Ames is actively implementing that vision. The Center is drawing upon its technical expertise in information systems technologies; aeronautics; the space, Earth and life sciences; and engineering; as well as the other talents of its skilled workforce to pursue the following educational goals:

- *enable educators to increase their knowledge and understanding of concepts in science, mathematics, and technology, and the interconnections among them*
- *provide educators with support materials, including information technology applications, that enable them to more effectively present these concepts*
- *encourage students to study and pursue careers in science, mathematics, and technology*
- *assist schools, school systems, and higher education institutions in the pursuit of educational reform goals*

Ames' Educational Team

The primary educational forces at Ames encompass the team in the Office of External Affairs, the IITA/K-12 Internet education program, and student support programs within the Human Resources and Life Sciences Divisions. Through these centerwide efforts, Ames is joining with its strategic partners from academia and industry to dramatically improve education within the Bay Area region and beyond.

In its efforts to implement NASA goals in the western states, Ames sponsors over 50 educational programs which can be clustered into a number of categories.

Educational Program Overview

Ames operates an on-site teacher resource center (TRC) which provides educators with instructional materials suitable for use in the classroom. The materials reflect NASA research and technology development while relating to school curriculum areas in mathematics, the sciences, and engineering. Materials are provided free of charge and include

publications, lesson plans, video programs, Internet access, classroom activities, slides, computer programs, and reference and curriculum documents. These valuable educational aids are available at each of the 15 regional TRCs that Ames coordinates in the region.

The Ames Aerospace Encounter hosts fourth- through sixth-grade classes in an interactive, hands-on environment designed to teach the basics of science, mathematics, and technology. Located in a renovated supersonic wind tunnel, the program involves students in activities focused on four areas: aeronautics, space science, space station/mission control, and Earth science/remote sensing. Students can design aircraft in computers, experiment with table-top-size wind tunnels, locate geographic features on high-altitude photographs, and simulate a mission aboard an orbiting space station. This one-half day, space-camp-like experience is provided free of charge to educational groups of up to 40 students.

Ames also sponsors a wealth of teacher and student workshops and educator conferences. These include Internet training classes; on-site, summer workshops for elementary school and mathematics, science, and technology teachers; the annual "Space Down to Earth" workshop; and a host of symposia and conferences on specialized topics (such as asteroids, comets, infrared astronomy, and the Galileo Probe mission to Jupiter).

The Center provides numerous opportunities for research internships to both teachers and students, and supports National Engineers' week; science and engineering fairs; the "Live from . . ." educational series; the JASON virtual exploration projects; and a plethora of multimedia, on-line and hands-on activities. Extensive support is also provided by Ames for a range of computer networks; a large number of homepages, World Wide Web sites, and computer chat sessions; distribution of educational publications; educational tours; and an active speakers' bureau.

A suite of grants, fellowships, apprenticeships, mentoring programs, and on-site work-study opportunities complete the Ames educational package. To ensure diversity and inclusion of women, Ames orients a set of programs towards underrepresented minorities (including Historically Black Colleges and Universities, or HBCUs; the National Hispanic University; and the D-Q University for Native Americans). Through its IITA program, Ames offers a mentoring function accessible to young women (and men). This allows students to interact directly with the "Women of NASA" Web site through periodic, advertised, on-line Web-chat computer sessions conducted by accomplished female scientists, engineers, and technologists at the Center.

Ames cooperates with private purveyors of educational services. Within a few days of acquisition, the information and data from space and Shuttle missions are made available on line, with minimal processing, to all parties. Students, educators, and the general public can access these data for themselves on the Internet, or work with value-added companies who perform additional processing and packaging services for educational and other uses.

Finally, Ames worked with the City of Mountain View to collocate Space Camp California at the Center for the benefit of the region's children. This nonprofit facility is neither operated by NASA nor Ames. However, on-site land and a range of services are made available to the Space Camp Foundation to make this "educational adventure" readily accessible to California families.

AMES' ROLE IN SUPPORT OF THE AERONAUTICS AND SPACE TRANSPORTATION TECHNOLOGY ENTERPRISE

Aeronautics Aspect of the Enterprise

The goals of the Aeronautics portion of the Enterprise are to promote economic growth and national security through safe, superior, and environmentally compatible U.S. civil and military aircraft that are supported by a safe and efficient national aviation system.

To meet these aeronautics goals, Ames will provide the following major products:

- *knowledge-based tools that enable air traffic controllers to manage larger volumes of traffic within 250 miles of airports*
- *external visual systems that enable pilots to operate safely without windows in the cockpit*
- *design tools that enable a 50% reduction in aircraft design and development*
- *supercomputers at workstation prices that provide a 1,000-fold increase in computing capability, and a 100-fold increase in communications capability*
- *improved safety through human/automation integration, human factors, and psychological/physiological countermeasures for flight crews*
- *an operational computing system by 2003 that can simulate an entire aerospace vehicle within one to several hours*

Approach

Research and development conducted by the ASTT Enterprise has been structured to be led by specified NASA research centers according to the primary roles and missions that have been assigned to each Center. Ames is the lead center for the HPCC Program and for the R&T base programs in Aviation Operations Systems, Information Technology, and Rotorcraft. In addition, Ames leads the Enterprise core competencies in the areas of human factors, air traffic management, information system technologies, integrated aeronautics design tools, and rotorcraft R&T.

Ames has identified and prioritized research areas to maximize their impact on the Agency's programs. These strategic investment areas are air traffic management, human factors, rotorcraft, integrated design systems, critical national research facilities, high-performance computing, and environmental research and modeling. High-performance aircraft survivability is also a key capability and priority.

The goals and objectives of the ASTT Enterprise are expressed as thrusts that are based on customer segments, product lines, or flight regimes. These thrusts include: subsonic transportation, high-speed transportation, high-performance aircraft, hypersonic flight, critical disciplines, and national facilities.

Goals

The following goals address Ames' plans within each of these thrusts as they pertain to the Center's own strategic program areas.

Goal: Develop, by 2001, high-payoff technologies for a new generation of environmentally compatible, economic U.S. subsonic aircraft and a safe, highly productive, global air transportation system. To support this goal, Ames will:

- *develop knowledge-based tools that enable air traffic controllers to manage larger volumes of traffic within 250 miles of airports*
- *increase traffic throughput of existing airports by reducing taxi time, approach spacing, and operations in reduced visibility*
- *enable airport ground controllers at large airports to handle much larger numbers of aircraft simultaneously*
- *permit an air transport to determine its own optimal course enroute (beyond the reach of the TRACON automation system) without controller involvement*
- *develop technologies for a practical civil tiltrotor alternative to fixed-wing transports that must operate from large, typically remote airports*
- *validate methods for integrated designs of high-lift wing systems to improve the design processes for future passenger transports*
- *provide detailed data to develop and validate analytical methods for complex wing geometries under highly nonlinear flight conditions (for example, landing)*

Goal: Ready, by 2005, the technology base for an economically viable, and environmentally friendly, high-speed civil transport. To support this goal, Ames will:

- *provide external visual systems that enable pilots to operate safely without windows in the cockpit*
- *identify aircraft configurations that can fly supersonically without creating major sonic boom disturbances under the flight path*
- *perform essential atmospheric chemistry modeling and in situ experiments to identify destructive chemical processes within the atmosphere, and the role played by supersonic transports flying within the stratosphere*

Goal: Ready the technology options for new capabilities in high-performance aircraft. To support this goal, Ames will:

- *investigate the flight characteristics of highly maneuverable fighter aircraft that have no tail surfaces (X-36)*
- *enable assessment of hypersonic and transatmospheric vehicle concepts to produce viable candidates for future missions*

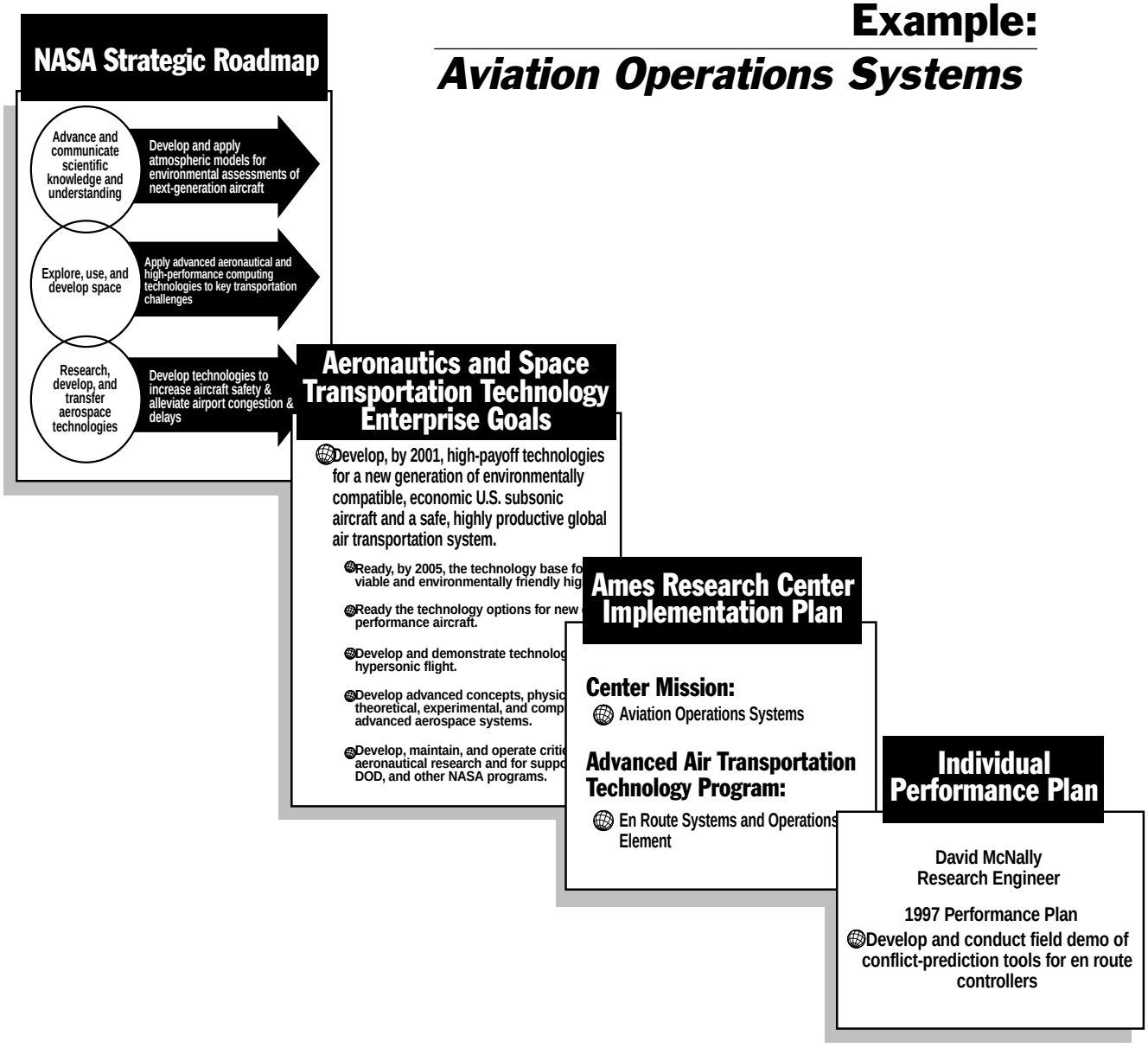
Goal: Develop advanced concepts, physical understanding, and theoretical, experimental, and computational tools to enable creation of advanced aerospace systems. To support this goal, Ames will:

- *reduce the time required for aircraft design and development up to 50%*
- *improve safety by improving human/automation integration, human factors, and psychological/physiological countermeasures for flight crews*
- *develop and apply a 1,000-fold increase in computing capability*
- *develop and apply a 100-fold increase in communications capability*
- *provide supercomputing capability at workstation prices*
- *provide, by 2003, an operational computing system that can simulate an entire aerospace vehicle within one to several hours*

Alignment of Individual Performance Plans with Center and Agency Goals

Example:

Aviation Operations Systems



Space Transportation Technology Aspect of the Enterprise

Ames will support the Space Transportation Technology portion of the Enterprise by developing the thermal protection systems (TPS) necessary for the nation's future space vehicles. Ames will also operate and make available such unique capabilities as large-scale, high-temperature, arc-jet ground-test facilities, and TPS sizing and computational chemistry, to provide properties of gases and gas-surface interactions in support of the U.S. aerospace community.

To meet Space Transportation Technology goals over the next 5 years, Ames will:

- *Provide TPS designs, technologies, and test data for developing the next generation of Reusable Launch Vehicles (RLV) to Lockheed-Martin (for the X-33) and to Orbital Sciences Corporation (for the X-34). This technology package is necessary to meet the goal of an order-of-magnitude reduction from present launch costs, 2-week turnaround time on flight frequency, and extended life cycles.*
- *Participate in the new Future X Reusable Space Transportation Program by providing TPS technologies that will enable new vehicles to deliver space cargo to low-Earth orbit at 1/100th of today's cost.*
- *Provide the design and new ceramic heat-shield materials to Lockheed-Martin that will allow the Stardust spacecraft to re-enter Earth's atmosphere after rendezvous with a comet (in 2003) and to collect materials from the comet's tail. Planned for launch in 1999, Stardust will re-enter Earth's atmosphere in 2006 at 13.5 kilometers/second (hotter than the Apollo re-entry), requiring protection from this heat for both the spacecraft and the returned samples.*
- *Enable a new class of high-performance entry vehicles by providing ultra-high-temperature ceramics that can be shaped to exceptionally sharp leading edges (millimeter radii) that will stay sharp at very high heating conditions. These materials will allow cross-range precision landing and maneuvering at hypersonic speeds in planetary atmospheres (Earth and others). These materials will also support the construction and use of more efficient launch vehicles with much lower drag.*
- *Provide the enabling aeroassist and heat-shield technologies for the Mars 2001 mission. This includes placing a spacecraft in orbit, using aerocapture with a heat shield that Ames will instrument, and participating in another vehicle that will make the first attempt at a Mars precision landing.*

Approach

Vehicles flying at hypervelocities (between 3 kilometers/second and 50 kilometers/second) within Earth's atmosphere, and within the atmospheres of other planetary bodies in the solar system, require thermal protection systems to survive the convective and radiative heating from flow fields surrounding them. As NASA's lead center for TPS technology, Ames is charged with developing new thermal protection systems that will enable vehicles of the future to be built more economically and existing ones to be upgraded at reduced cost.

Atmospheric transit technologies in development at Ames offer great potential. For example, life-cycle vehicle costs for reusable space launch vehicles can be reduced 20% or more. For planetary entry probes, payload capabilities can be increased significantly through reductions in thermal protection mass (25-50%). Payoffs also appear as multimillion-dollar savings when aerocapture, rather than rocket propulsion, is used to modify orbital parameters. These technologies will be required for future human and robotic exploration of the solar system.

Goals

Over the next 5 years, Ames will provide proven technologies in support of access to space; the RLV program; the new, integrated Mars exploration program; the Discovery program for solar system exploration; the Space Shuttle program; and the Human Exploration and Development of Space Enterprise.

To achieve this, Ames is conducting an aggressive program to integrate all technology elements. For planetary entry probes, Ames makes very-lightweight, ceramic ablator materials and both flexible and rigid TPS materials. A major focus is on lower life-cycle cost, reduced maintenance, increased temperature capability, and enhanced durability/water-proofing. However, successful thermal protection systems require more than merely high-temperature materials. They also need state-of-the-art computer programs capable of accurately predicting the flow environment, such as the Ames-produced flow models for advanced, real-gas computational fluid dynamics codes based on experimental and thermochemistry databases.

Various TPS components must be tested in arc jets that closely simulate the entry environment. Testing on curved, three-dimensional panels is especially important. Other components which must be tested include nose caps, wing leading edges, and flat panels. The working element of a typical arc jet is similar to that of a wind tunnel, and it provides the heat flow data required to simulate entry conditions. Ames maintains one of the world's premier arc-jet complexes for providing realistic simulations of entry environments essential for technology development, system validation, and system qualifications.

A new effort, called Integrated Design Systems for Space Transportation vehicles, has begun that involves emerging information systems technology. The concept combines new technologies (such as intelligent agents and data fusion schemes) with increasingly powerful, high-fidelity tools (such as real-gas computational fluid dynamics) and existing databases to produce reliable vehicle designs in weeks. This is a multi-center activity wherein each center is responsible for maintaining its area of expertise (for example, TPS at Ames; propulsion at Marshall; and guidance, navigation, and control at Langley). The expected outcome is that the Agency will be able to provide new transportation vehicles at much lower cost and much more rapidly than is currently possible. Also, concept "errors" (which often appear late) will be avoided by having rapid turn-around, high-fidelity designs available early in the development cycle.

The use of quantum techniques from computational chemistry from the outset will enable development of better analytical models and an enhanced understanding of the complex phenomena involved in atmospheric entry and heat-shield performance.

Ames' Role in Support of the Mission to Planet Earth Enterprise

The ability to make Earth observations from space is one of the great achievements of the space age. The Mission to Planet Earth Enterprise is dedicated to advancing scientific understanding of the entire Earth system by developing a deeper comprehension of its components and their interactions. It is also 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, polar regions, and the life among them.

The Enterprise is directed toward acquiring scientific knowledge relevant to formulating and implementing environmental policy—both nationally and internationally. Ames supports this effort through the Earth Science Division, its role as NASA's Center of Excellence for Information Technology, the NASA Science Internet, and the Commercial Technology Office.

Requirements

The goals of the Mission to Planet Earth Enterprise are to develop understanding of the total Earth system and the effects of natural and human-induced changes on the global environment.

To meet these goals, Ames will provide the following major products by 2002:

- *observational data sets, and data-driven models of atmospheric chemistry and physics, to determine the rates for the global-scale distribution and effects of exhaust (in both the lower stratosphere and the upper troposphere) from subsonic, high-speed civil transport systems*
- *miniaturized and automated science instruments, integrated on remotely piloted aircraft, to reduce the technical and economic risk for doing high-altitude, long-distance and duration monitoring of atmospheric and ecological chemical and physical systems*
- *data-driven models of global inventories of land use and development to predict biological productivity and diversity in a format that can be used by policy makers at the local, state, regional, and national levels*
- *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*
- *data-driven models to help understand the effects of micro-organisms and their ecology on the global processes that affect long-term climate, in terms of sequestration and release of nitrogen and carbon compounds*
- *a Center for Airborne Studies in Earth Sciences (CASES) to build, test, and calibrate sensors in support of the science community for airborne data collection and verification campaigns*

Approach and Goals

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

- *design, formulate, and perform experimental measurements; remote sensing; in situ data analyses; computer simulations of atmospheric processes (radiation physics, cloud physics, tropospheric chemistry, and stratospheric chemistry) and ecosystem processes (primary productivity, nitrogen and carbon cycling, land-use changes and disturbances, and infectious disease vectors); and exchanges between the biosphere and the atmosphere (trace gas emissions, aerosol production, and boundary layer transport) using both airborne and satellite sensor data*
- *conceive and develop advanced instrumentation to satisfy the measurement requirements of the Mission to Planet Earth Enterprise and related Enterprises, emphasizing both airborne and selected spacecraft sensors*
- *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*

The Center of Excellence for Information Technology at Ames enables the creation of the most advanced and computationally demanding models necessary to simulate Earth processes. These models include complex atmospheric chemistry calculations, for both homogeneous and heterogeneous reactions, and simulations of radiative transfer through the atmosphere.

Ecosystem models pose a different challenge—dealing with the huge data arrays typically encountered in studies of the biosphere when using remote sensing. Earth scientists have collaborated with information scientists to develop intelligent systems for data management and model building, in data visualization and in expert systems for data analysis.

Ames scientists engaged in research related to the Mission to Planet Earth Enterprise typically combine airborne and satellite observations with image processing, geographic information systems, data analyses, and computer simulations to address major environmental issues. The research is collaborative, involving scientists worldwide.

Ames' Role in Support of the Human Exploration and Development of Space Enterprise

NASA's Human Exploration and Development of Space Enterprise is dedicated to the long-term exploration, use, development, and settlement of space for the benefit of humanity. Ames supports these goals through a gravitational biology research and flight experiments program, advanced life support technology development, astrobiology and evolutionary biology research program, and advanced concepts for lunar and Mars explorations.

These efforts are carried out by scientists, engineers, technologists, and mission support personnel in the Life Sciences, Space Projects, Space Science, and Space Technology Divisions, and the Center for Mars Exploration. Together, they provide world-class research selected through peer-reviewed proposals; unmatched facilities (open to the science community at large) for gravitational biology and astrobiology research on Earth; space science strategies and advanced concepts for human exploration missions; and user-friendly access by outside communities to Ames facilities and to space exploration mission opportunities.

Requirements

In support of the Human Exploration and Development of Space Enterprise, Ames will undertake the following activities and/or provide the following major products over the next 5 years:

- *enable comprehensive examination of the nervous system and brain functions in space, in partnership with the National Institutes of Health*
- *provide the scientific community with access to biological research opportunities on the ground and in space by developing space laboratory technologies and techniques, flight laboratory equipment, and operations protocols that maximize the science return from human exploration missions (including the Space Shuttle, Bion, Mir, and the International Space Station)*
- *make available to clinical scientists the knowledge/facts/data about physiologic and anatomic mechanisms that underlie human adaptation to altered gravity (all such knowledge/facts/data acquired in the Gravitational Biology and Ecology Program and in the Astrobiology Program will become part of the corpus of general knowledge, and some will be used to improve the practice of clinical medicine and the health and well-being of space explorers)*
- *provide a virtual environment surgery workbench that will enable surgeons to plan and practice complex surgery before attempting it on a patient (this advance results from collaborations, through Ames' Biocomputation Center, involving gravitational biologists and information technologists, that will provide interactive virtual environments allowing surgeons to visualize the results of a surgical strategy, evaluate alternatives, and interact with colleagues located elsewhere so as to work under the direction of a specialist at a different location)*
- *provide advanced concepts and technologies for initial studies to determine the potential for the evolution of terrestrial life beyond Earth, a key element of the Astrobiology Program (this includes provision of the artificial ecosystems, research instruments, and microgravity laboratory techniques to enable the first suite of molecular biology, genetic, and life-cycle studies on representative terrestrial organisms)*
- *provide advanced life support concepts and technologies that enable increasing autonomy from resupply of consumables*

- *provide thermal protection technologies, including aerobrake and aeroassist strategies, that enable expeditions of the Moon and Mars at significantly reduced costs*
- *provide advanced concepts for the exploration of Mars by developing science requirements and strategies; countermeasures to physiological problems encountered during planetary exploration; advanced thermal protection, life support, and information systems technologies; planetary protection requirements and strategies; and education, outreach and advocacy*

Approach and Goals

Ames' life sciences activities are focused on investigating biomedical problems affecting human performance in space (relative to the amount of time spent there), then assisting in the development of countermeasures that can be transferred to the human flight program. Ames provides a primary scientific focus for human exploration missions by using space biological laboratories to reveal new information about the role and influence of gravity on living systems. This work establishes the necessary foundation to evaluate the potential for expanding terrestrial life beyond Earth.

Ames' Space Projects activities in support of this Enterprise are dedicated to providing the science community with access to biological laboratories in space by developing the habitats, techniques, and technologies for studying life in space. The space flight projects at Ames—which include Life Sciences payload development for the Space Shuttle and the International Space Station, the U.S./Russian unmanned biosatellite program (Bion), fundamental biology experiments on Mir, as well as space sciences robotic missions—provide significant leveraging for resolving issues and enabling the human exploration and development of space.

The space technology elements of the NASA Strategic Plan at Ames include the development of advanced life support technologies essential for the establishment of a sustained human presence in space. One of NASA's strategic missions is to explore, use, and enable the development of space for human enterprises. In order to achieve this mission, advanced life support systems must be developed to close spacecraft air and water loops, to achieve systems and capabilities that enable human presence expansion, and to demonstrate the feasibility of utilizing local resources.

Development of advanced life support systems provides 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 research conducted by Ames' Regenerative Life Support Branch concentrates primarily on physicochemical processes, air revitalization, water recovery, and waste processing/resource recovery.

Ames' Biocomputation Center merges the insights and talents of biologists, physicians, and information scientists to create (using data obtained from Earth and space research) the capabilities to visualize previously hidden biological processes. The Center provides numerous medical benefits that are pursued through collaboration with universities and hospitals nationwide.

Ames' life scientists conduct a basic research program that spans the spectrum from zero-G to hypergravity. A suite of ground and flight facilities, coupled with the program's scientific and technical staff, comprise the heart of the program. Ames makes its unique facilities available to the scientific community to study the effects of gravity on living things—from single cells, through plants and animals, to humans. Ames' capabilities span space exploration, life science basic research, flight project management, sensor technology, instrument development, advanced computational techniques, and biological computation.

Alignment of Individual Performance Plans with Center and Agency Goals

Example:

Astrobiology

NASA Strategic Roadmap

- Advance and communicate scientific knowledge and understanding → Use lower-cost missions to complete the initial survey of the universe across the electromagnetic spectrum...
- Explore, use, and develop space → Send robotic missions to the Moon, Mars, and near-Earth Asteroids, and demonstrate systems for reliable space weather forecasting
- Research, develop, and transfer aerospace technologies → Demonstrate new instruments and technologies in operational systems

Space Science Enterprise Goals

- Complete the initial capability to observe across the electromagnetic spectrum.
- Determine the abundance and distribution of biogenic compounds conducive to the origin of life.
  - Survey cosmic rays and interstellar gas as
  - Carry out basic new tests of gravitational th
  - Develop the means to understand solar var
  - Complete initial exploration of the inner heliosphere.
  - Complete solar system reconnaissance
  - Survey and begin surface exploration o accessible planetary bodies.
  - Begin a comprehensive search for plan other stars
  - Complete the inventory of near-Earth o diameter.
  - Identify locations in the solar system w have existed.

Ames Research Center Implementation Plan

Center Mission:

- Astrobiology: the study of the living universe

Astrobiology Mission Program:

- Stratospheric Observatory for Infrared Astronomy (SOFIA)

Individual Performance Plan

Paul Davis
Optical Systems Engineer

1997 Performance Plan

- Serve as SOFIA Systems Engineer with emphasis on optical analysis and leading technology

Ames' Role in Support of the Space Science Enterprise

NASA's Space Science Strategic Enterprise explores and seeks to answer fundamental questions about the galaxy and the universe, about the Sun-Earth-Heliosphere connection, about the origin and evolution of planetary systems, and about the origin and distribution of life in the universe. Ames supports the Enterprise through research, technology development, and flight projects performed by the Space Science Division; Space Projects Division; and Information Systems Directorate. The Space Science Enterprise has designated Ames as its lead center for astrobiology and astrochemistry, with supporting roles in planetary exploration and other areas of basic research.

Ames focuses on the origins theme in Space Science: a cross-cutting examination of the origins of the universe, galaxies, stars, planets, and life. Pioneering work in exobiology is focused on understanding the origin, evolution, and distribution of life within the context of cosmic processes. Basic research on molecular gases and clouds, the origin and evolution of our solar system, and the nature of planetary surfaces and atmospheres, provides critical knowledge about the cosmic environment within which life evolves. In the future, Ames will expand its leading role in astrobiology—concentrating on revealing new knowledge about the origin, evolution, and destiny of life in the universe; developing technology to support flight missions; and transferring knowledge and technology products for public education and other benefits.

Requirements

To meet Space Science Enterprise goals, Ames will provide the following products by 2002:

- *flight results from the Lunar Prospector Discovery mission, including results of a definitive search for water near the lunar poles*
- *science and technology developments that enable the next-generation airborne observatory—the Stratospheric Observatory for Infrared Astronomy, or SOFIA—to begin operations that achieve orders-of-magnitude improvement in capabilities over its predecessor*
- *research that will help to settle the question of life in the ALH84001 Mars meteorite, and which will pave the way for establishing both the analytical methodology with which a returned Mars sample will be analyzed and the information technologies that will permit relatively autonomous science operations on a Mars rover*
- *a tracing of the path of carbon from interstellar molecules through molecular clouds and dust into planetesimals and other small bodies*
- *scientific understanding of the relationship between the evolving primitive Earth and the Earth's earliest life forms*
- *spectrophotometric technology that will permit the detection and characterization of Earth-size extrasolar planets in orbit around other stars*
- *assessment of the biological potential of other solar system bodies, including Mars, Titan, and Europa*
- *aeroassist technologies to enable cost-effective exploration of Mars and the outer planets*

Approach and Goals

To meet the goals described above, Ames will develop new research capabilities for the national science community that emphasize SOFIA and supporting instrumentation; laboratory, computational and information systems techniques; spaceborne instrumentation; and techniques for the teleoperation of planetary surface vehicles. Ames will provide overall NASA management of the Lunar Prospector mission, provide the facility scientist and technical support in detector systems to the Space Infrared Telescope Facility (or SIRTF), and contribute leadership in ring studies and mission operations strategies for the Cassini mission. Ames will support the Jet Propulsion Laboratory and Goddard Space Flight Center in science and technology for the planetary exploration and origins programs of the Space Science Enterprise.

To investigate fundamental questions about the origin and evolution of the stars, planets, and life throughout the universe, Ames will conduct collaborative multidisciplinary research on:

- origin and evolution of planetary systems
- evolution of biogenic elements throughout the universe
- fundamental properties of molecular gases and clouds, interstellar dust, and ices in a variety of astrophysical environments
- composition and dynamics of planetary atmospheres, with emphasis on Mars, Jupiter, and Titan
- past history and present conditions on Mars, with emphasis on possible environments that could support life, either today or in the distant past
- dynamics of rings and disks, with application to the rings of Saturn as well as to the formation of planetary systems from circumstellar disks
- composition of interstellar materials, comets, and meteorites to determine the roles of these components in prebiotic chemistry
- the nature and possible origin of key biological processes (such as membrane structure and membrane transport) that are necessary for initial development of living systems
- strategies for detection of fossil life on Mars, and for the selection, screening, and transport to Earth of samples of martian rock and soil
- policies and practices for avoiding possible contamination of extraterrestrial environments with terrestrial life, as well as possible contamination of Earth with possibly hazardous species in extraterrestrial samples

In the process of this research, Ames will develop, use, and transfer technologies that provide scientific and globally competitive economic returns to the United States. Ames will also establish a national NASA Astrobiology Institute to promote, conduct, and lead integrated multidisciplinary astrobiology research and technology development, addressing fundamental questions concerning life in the universe while enabling collaboration of geographically diverse research teams in pursuit of common goals.

One major element of the Ames Space Science Program is the use of knowledge and discoveries resulting from its work to enhance science, mathematics, and technology education and to promote the scientific and technological literacy of all Americans.

AMES' INSTITUTIONAL SYSTEMS

A full array of institutional systems support the Ames 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

Thorough and sound acquisition planning and management are exercised in support of the Nation's technical and commercial standing, Agency priorities, and Center research and operational goals.

Commercialization and Technology Transfer

Timely transition of NASA-developed technologies to the U.S. economy, and the effective infusion of appropriate commercially developed technologies into NASA projects and programs is ensured. Partnerships for the joint development of technology to mutually benefit NASA and industry are promoted. To aid technology transfer and commercialization efforts, a database of technology under development is maintained.

Documentation Development

Professional Information Specialists acquire, produce, and distribute scientific, technical, and non-technical information using traditional and advanced technologies. Services provided are: printing and reproduction, photo and imaging, video production, graphics, publications, and library.

Equal Employment Opportunity

Equal employment opportunity, affirmative employment, and diversity in the work-place 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.

Facilities Maintenance and Operations, Logistics, and Supplies

Support is provided by two primary functions: 1) institutional facilities, base operations, and maintenance; and 2) supply and logistics services. In addition, as host for Moffett Federal Airfield (MFA), the necessary infrastructure and building maintenance is provided to support military housing and office space utilized by Resident Agencies on MFA property.

Financial Systems

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

Human Resources

Every effort is made to attract, enhance, and retain a highly effective workforce, properly balanced to accomplish the Center's various missions. Compliance with Headquarters' directives, the budget process, and the Zero-Base Review ensures that workforce targets are met and maintained.

Legal Office

Provides legal advice and assistance to all Ames organizations, and furnishes legal representation for and on behalf of the Center in administrative and judicial proceedings. Members of the Chief Counsel's Office also participate in various Ames management working groups.

Manufacturing

Provides electronic instrument fabrication, printed circuit board design and fabrication, model development, prototype and general machining, instrumentation, and metals fabrication services.

Protective Services

Ames is committed to providing a safe and secure workplace for all NASA employees, visitors, and contractors. To that end, 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.

Safety, Reliability, and Quality 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.

Systems Engineering

Design, development, and construction of unique experimental research facilities, equipment, and flight systems are provided. Brings together design and engineering in aircraft modifications and flight experiments, integrated design/development of research hardware, research facility design/construction, and multidisciplined project management.

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ACRONYMS

ARC, or Ames	*Ames Research Center*
AOS	*Aviation Operations Systems*
ASC	*Aviation System Capacity*
ASTT	*Aeronautics and Space Transportation Technology*
AATT	*Advanced Air Transportation Technologies*
ATC	*Air Traffic Control*
CAS	*Computational Aerosciences*
CASES	*Center for Airborne Studies in Earth Sciences*
CHAART	*Center for the Health Applications of Aerospace-Related Technologies*
CMEX	*Center for Mars Exploration*
CMF	*Cockpit Motion Facility*
COE-IT	*Center of Excellence for Information Technology*
COSMO	*Consolidated Supercomputing Management Office*
CVSRF	*Crew-Vehicle Simulation Research Facility*
DEAR	*Design for Efficient and Affordable Rotorcraft*
DFRC or Dryden	*Dryden Flight Research Center*
DMS	*Differential Maneuvering Simulator*
DOD	*Department of Defense*
D-Q	*(A University for Native Americans)*
ESS	*Earth and Space Sciences*
FAA	*Federal Aviation Administration*
FRIAR	*Fast-Response Industry Assistance Requests*
FY	*Fiscal Year*
G&A	*General and Administrative*
GSFC, or Goddard	*Goddard Space Flight Center*

HBCU	*Historically Black Colleges and Universities*
HCI	*Human/Computer Interaction*
HEDS	*Human Exploration and Development of Space*
HPCC	*High-Performance Computing and Communications*
IITA	*Information Infrastructure Technology and Applications*
IMC	*Instrument Meteorological Conditions*
IPT	*Integrated Product Team*
ISO	*International Standards Organization*
ISS	*International Space Station*
IT	*Information Technologies*
ITT	*Integration Task Team*
JASON	*(A name, but established as all capitals.)*
JPL	*Jet Propulsion Laboratory*
JSC, or Johnson	*Lyndon B. Johnson Space Center*
KDD	*Knowledge Discovery and Data (mining)*
KSC, or Kennedy	*John F. Kennedy Space Center*
LARC, or Langley	*Langley Research Center*
LeRC or Lewis	*Lewis Research Center*
MFA	*Moffett Federal Airfield*
MIDAS	*Man-Machine Integration Design and Analysis System*
MLC	*Multicultural Leadership Council*
MSFC, or Marshall	*George C. Marshall Space Flight Center*
MTPE	*Mission to Planet Earth*
NACA	*National Advisory Committee for Aeronautics*
NFAC	*National Full-Scale Aerodynamics Complex*

NGI	*Next Generation Internet*
NRC	*National Research Council*
NREN	*National Research and Education Network*
NRRA	*National Rotorcraft Research Alliance*
NRTC	*National Rotorcraft Technology Center*
NSCORT	*NASA Specialized Centers of Research and Training*
NTSB	*National Transportation Safety Board*
OASTT	*Office of Aeronautics and Space Transportation Technology*
REE	*Remote Exploration and Experimentation*
R&T	*Research and Technology*
RLV	*Reusable Launch Vehicles*
SAFOR	*Safe All-Weather Flight Operations for Rotorcraft*
SDTF	*Surface Development and Test Facility*
SILNT	*Select Integrated Low-Noise Technologies*
SIRTF	*Space Infrared Telescope Facility*
SOFIA	*Stratospheric Observatory for Infrared Astronomy*
STOVL	*Short Takeoff Vertical Landing*
TAP	*Terminal Area Productivity*
T-NASA	*Taxi-Navigation and Situational Awareness*
TRACON	*Terminal Radar Approach Control*
TPS	*Thermal Protection System*
TRC	*Teacher Resource Center*
VMS	*Vertical Motion Simulator*