NASA SP-6101 (10)

ISSUES IN NASA PROGRAM AND PROJECT MANAGEMENT

Special Report: 1995 Conference

"Planning for NASA's Future"

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NASA Project Management Shared Experience Program

edited by

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Issues in NASA Program and Project Management

Special Edition: "Planning for NASA's Future"

from the NASA Project Management Shared Experiences Program, April 18-21, 1995

National Aeronautics and Space Administration **Autumn 1995**

Page

SP-6101(10) *Issues in NASA Program and Project Management* is tenth in a series from NASA's Program and Project Management Initiative. This series is collected and edited by Dr. Edward J. Hoffman with Dr. William M. Lawbaugh. Statements and opinions are those of the authors and do not represent official policy of NASA or the U.S. Government. Useful and enlightening material is welcome, and diversity of ideas is encouraged.

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Planning for NASA's Future

The Project Management Shared Experience Program

Hagerstown, Maryland **April 18-21, 1995**

Five Areas of Vital Change

by Dr. Edward J. Hoffman
PPMI Program Manager

Dr. Edward J. Hoffman, Program Manager of NASA's Program/Project Management Initiative (PPMI), welcomed the largest number of participants, 160, to the third biennial Project Management Shared Experience Program (PMSEP). Hoffman, who is responsible for training and development programs at NASA, briefly outlined the five areas of vital change to be covered in the next few days by speakers from NASA, industry, government and academia.

"Two years ago NASA was in the start-up phase of major change," Hoffman noted. "Today we are in the midst of profound transformation." There are five significant areas of change which will be highlighted in this workshop. First, we will look at the major impact on the Agency resulting from various "reinvention" efforts throughout Federal government. Second, we will explore NASA's efforts in strategic management planning. Third, we will explore the new global economy, where NASA is experiencing even greater international cooperation and partnerships. Fourth, new forms of industry and interagency collaboration are also taking place. Finally, the very nature of project management itself is changing, especially in the innovations required for managing complexity.

"In virtually every area of our organization we see the signs and impact of change. It is no longer an issue of whether things will be different," he noted. "Now the question focuses on *how* things will be different." With that, the sharing and networking began.

Major Space Policy Issues

by Dr. John Logsdon

In touching on several past and present space policy issues, Dr. John Logsdon, Director of the Space Policy Institute at The George Washington University, kept returning to his main point: To bring stability to the space program we must seek to use space not for political reasons but on its own merits.

In a document once marked "SECRET" and "CONFIDENTIAL," Logsdon showed NASA's first long-range plan of 1960, calling for unpiloted probes of Venus and Mars in 1962 and 1964, the building of a permanent near-Earth space station in 1965-67, and, of course, human flight to the moon beyond 1970. (Logsdon had just returned from the funeral of NASA's first Administrator, 1958-1961, T. Keith Glennan, who developed that plan.)

Then Logsdon showed a copy of a memorandum dated April 20, 1961, from President Kennedy asking Vice President Johnson to serve as Chairman of the Space Council and to make sure NASA was working around the clock to "win" the space race by "beating the Soviets" with "dramatic results." Another memo, from James Webb and Robert A. McNamara to Vice President Johnson on May 8, 1961, stressed planning for "specific missions aimed mainly at national prestige." All this culminated in a prepared speech for JFK to Congress on May 25, 1961, to which President Kennedy added that the Apollo Program in space "in many ways may hold the key to our future on Earth." NASA grew exponentially from this politically motivated space race.

By 1971, just a decade later, the political pressures had shifted to reduce Federal spending. Since 72% of that budget involved congressionally mandated entitlement programs and debt interest, NASA fell into the 28% of the budget that was controllable. In an August 12, 1971, memo to President Nixon, both Caspar Weinberger and George Shultz argued strenuously for completion of the Apollo Program (two more flights, 16 and 17) and the future of the Manned Space Program (Skylab and Space Shuttle), each marked for cancellation. They were spared because they "give the American people a much needed lift in spirit and because they show American superiority." The competing nuclear powered NERVA rockets, which would "secure substantial scientific fall-out" and assure that "large numbers of valuable scientists and technicians are kept at work," did not fly.

THE WHITE HOUSE

WASHINGTON

April 20, 1961

MEMORANDUM FOR

VICE PRESIDENT

In accordance with our conversation I would like for you as Chairman of the Space Council to be in charge of making an overall survey of where we stand in space.

1. Do we have a chance of beating the Soviets by putting a laboratory in space, or by a trip around the moon, or by a rocket to land on the moon, or by a rocket to go to the moon and back with a man. Is there any other space program which promises dramatic results in which we could win?

2. How much additional would it cost?

3. Are we working 24 hours a day on existing programs. If not, why not? If not, will you make recommendations to me as to how work can be speeded up.

4. In building large boosters should we put out emphasis on nuclear, chemical or liquid fuel, or a combination of these three?

5. Are we making maximum effort? Are we achieving necessary results?

I have asked Jim Webb, Dr. Weisner, Secretary McNamara and other responsible officials to cooperate with you fully. I would appreciate a report on this at the earliest possible moment.

Figure 1. *President John F. Kennedy was anxious to find out how to catch up with and beat the Soviets, as indicated in this once-secret memo to Vice President Lyndon B. Johnson.*

In the next decade, James Beggs and Hans Mark briefed President Reagan that a Space Station bigger and better than the Mir would be "a highly visible symbol of U.S. strength," not for its own sake. After the President endorsed Space Station, the Congress endorsed lunar settlements, but neither were accomplished by the decade's end when, on Nov. 2, 1989 it was stated that the National Space Policy (NSPD-1) essentially "has been, and continues to be, space leadership." Although President Bush's last budget had projected $20 billion for NASA in FY1995, the 1990s brought in a great deal of instability and uncertainty for NASA, beginning with the Augustine Commission Report in 1990. The Space Station program experienced a series of changes, budgets were tightened, military use of space became questionable, and new ways of doing business changed the relationship between government and the private sector.

As for the future, Logsdon mentioned only two major space policy issues: the need for a new space transportation system and increased international cooperation involving interdependence and joint planning.

Discussion came full circle during a question-answer period when it was pointed out that President Kennedy did not have the whole nation and Congress in support of a human mission to the moon and back by the end of the decade. In fact, a Gallup Poll indicated 60% opposed to Kennedy's goal for Apollo, yet it flew. Logsdon, author of *The Decision to Go to the Moon: Project Apollo and the National Interest* and a 1992 member of the White House Space Policy Advisory Board, thinks that when space activity becomes depoliticized, viewed on its own merits, the space program will become stabilized.

The New Congress

by Nick Fuhrman

As a senior staff member for the Subcommittee on Space and Aeronautics of the House Committee on Science, Nick Fuhrman was appointed by Chairman Robert Walker (R-PA) in 1995 to oversee the budgets for the International Space Station, the Reusable Launch Vehicle program and various other international and launch issues involving NASA. Fuhrman first joined the subcommittee staff in 1991, specializing in space cooperation and trade with the former Soviet Union.

"Congress loves spin-offs," declared Fuhrman. Members of Congress, he said, find the NASA formula of seven dollars in return for every dollar invested in aerospace as "plausible," despite "a $5 billion cut hanging over your heads."

Spin-offs are usually defined as technology twice used. The technology is developed in government programs and projects, and then the technology is transferred to the private sector.

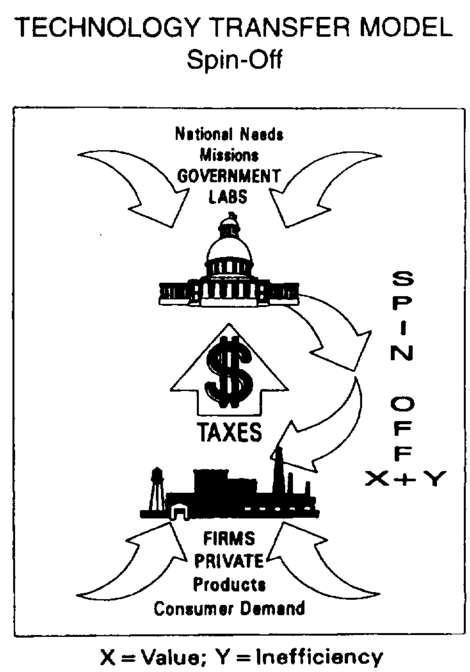


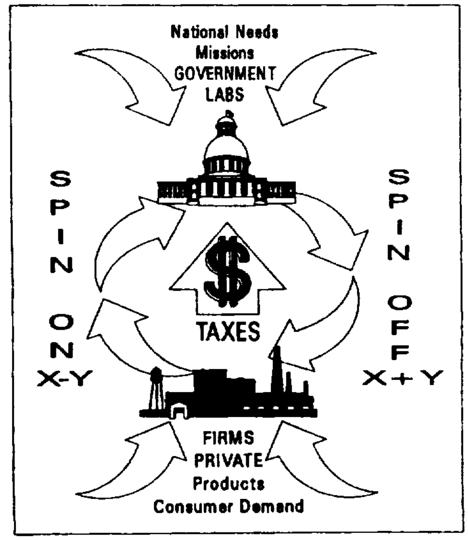
Figure 2. *Tax dollars create technologies transferred to the private sector in the Spin-Off model.*

However, "Spin-on is where it's at today," he said, pointing to "a lot of smart stuff in the streets we could use." Spin-ons would complete the circular motion of tax money moving in and out of both government and industry. When the Not Invented Here (NIH) attitude gives way to procurement of off-the-shelf items whenever possible, said Fuhrman, the government saves money and industry sales are stimulated. Industry also becomes encouraged to produce more state-of-the-art products as a supplier to government. "Inefficiency," he noted, "led to the downfall of the USSR."

Spin-ons, as described by advocates, tend to reduce inefficiency in technology transfer by incorporating current products and equipment rather than creating new-ones.

In a question-answer period late that first evening, John Logsdon and Nick Fuhrman both observed that "there is more money in the space industry than in NASA."

TECHNOLOGY TRANSFER MODEL
Spin-On/Spin-Off



X = Value; Y = Inefficiency

Figure 3. *Spin-ons stimulate growth of private sector technologies for federal projects.*

Reinventing NASA

by Alan Ladwig

The second day of "Planning for NASA's Future" began with a snapshot of reinvention efforts at NASA and how the Centers fit in. "We're not planning to close any Centers," declared Alan Ladwig, Director of Policy and Plans at NASA Headquarters.

Today NASA has a field center infrastructure designed for an annual mission of about $20 billion, but by FY2000 NASA will have a total budget projected at only $13 billion. Thus, considerable restructuring was in progress for an integrated strategic plan in the FY1997 budget process.

Ladwig outlined the five independent reviews that would feed into the NASA Zero Base Review. (See Figure 4.) Guiding principles for each included:

- Eliminate duplication and overlap. Consolidate.
- Stop doing what we don't have to do. Transfer those functions to the private sector or universities.
- Emphasize objective contracting. Define specific product and deadlines.
- Change regulations to reduce engineering oversight reporting. Streamline procurement.
- Return NASA to a research and development (R&D) agency.

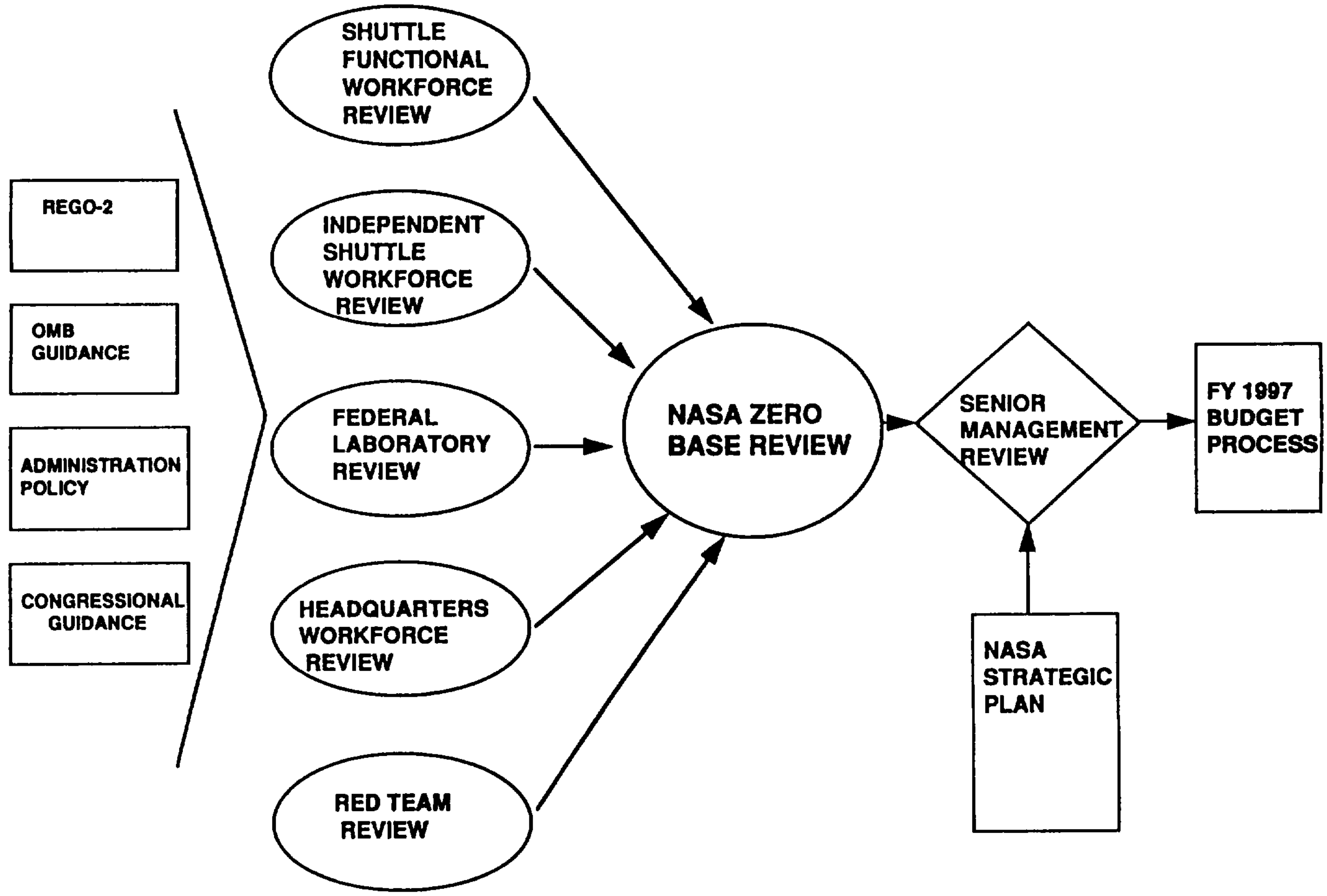


Figure 4. *NASA Reinvention Process.*

The Comprehensive Zero Base Review was initiated by NASA Administrator Daniel Goldin in September 1994 in response to the National Performance Review and the second phase of the White House Reinventing Government (REGO-2) effort, with additional guidance from the Office of Management and Budget (OMB).

While the NASA Zero Base Review was not scheduled for completion until May 1995, Alan Ladwig did provide a few glimpses into the future. He noted that NASA had committed to work with an $8.1 billion reduction in "buying power" over the next five years, nearly a 25% budget reduction by FY2000. NASA's civil service work force, already reduced by 1,500 full time equivalents (FTEs) over the past two years, could expect a further reduction of another 2,000 FTEs by FY2000.

The NASA Reinvention Process would continue with a Senior Management Review before final adoption into the FY1997 budget. Guiding senior management is the *NASA Strategic Plan*, which calls for five strategic lines of business, five enterprises that the delegates to the Project Management Shared Experience Program explored and discussed in their second day of meetings.

But first, Alan Ladwig's colleague at the Office of Policy and Plans discussed NASA's "new way of doing business."

NASA's Evolving Strategy

by Gary Steinberg

Gary Steinberg, Director of Strategic Management for NASA, borrowed from Peter Drucker to define strategic management as "an iterative, interactive and disciplined process whereby the vision, mission and goals of an organization are determined . . . so that fundamental decisions of policy, strategy and action can be made in an integrated fashion to shape and guide the future direction of the organization." For NASA, he says, "it's the smart way to do business" and a new way, after the Agency had been drifting essentially without a strategic plan since Apollo days.

Figure 5 depicts the vision, interlocking missions and five "strategic enterprises" of the latest NASA Strategic Plan. Figure 6 shows the framework of NASA's plan, beginning and ending with the American public as ultimate provider and beneficiary, not just the aerospace industry. The public benefits mainly through advances in human resources, physical resources and space communication. In an even more elaborate chart, Figure 7, Steinberg shares a draft version of near-, mid- and long-term goals for NASA, stretching 21 years into the future.

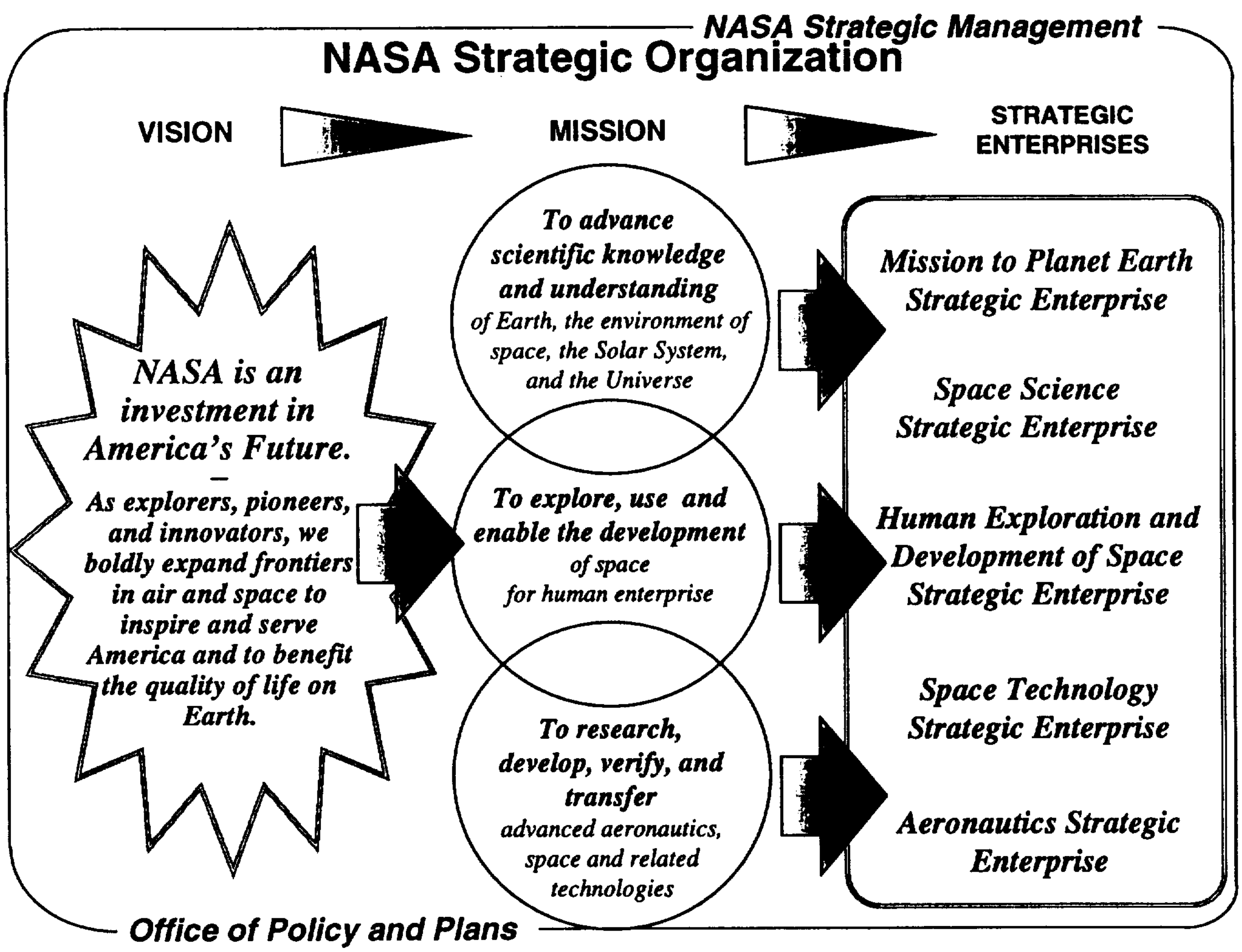


Figure 5. NASA Strategic Organization.

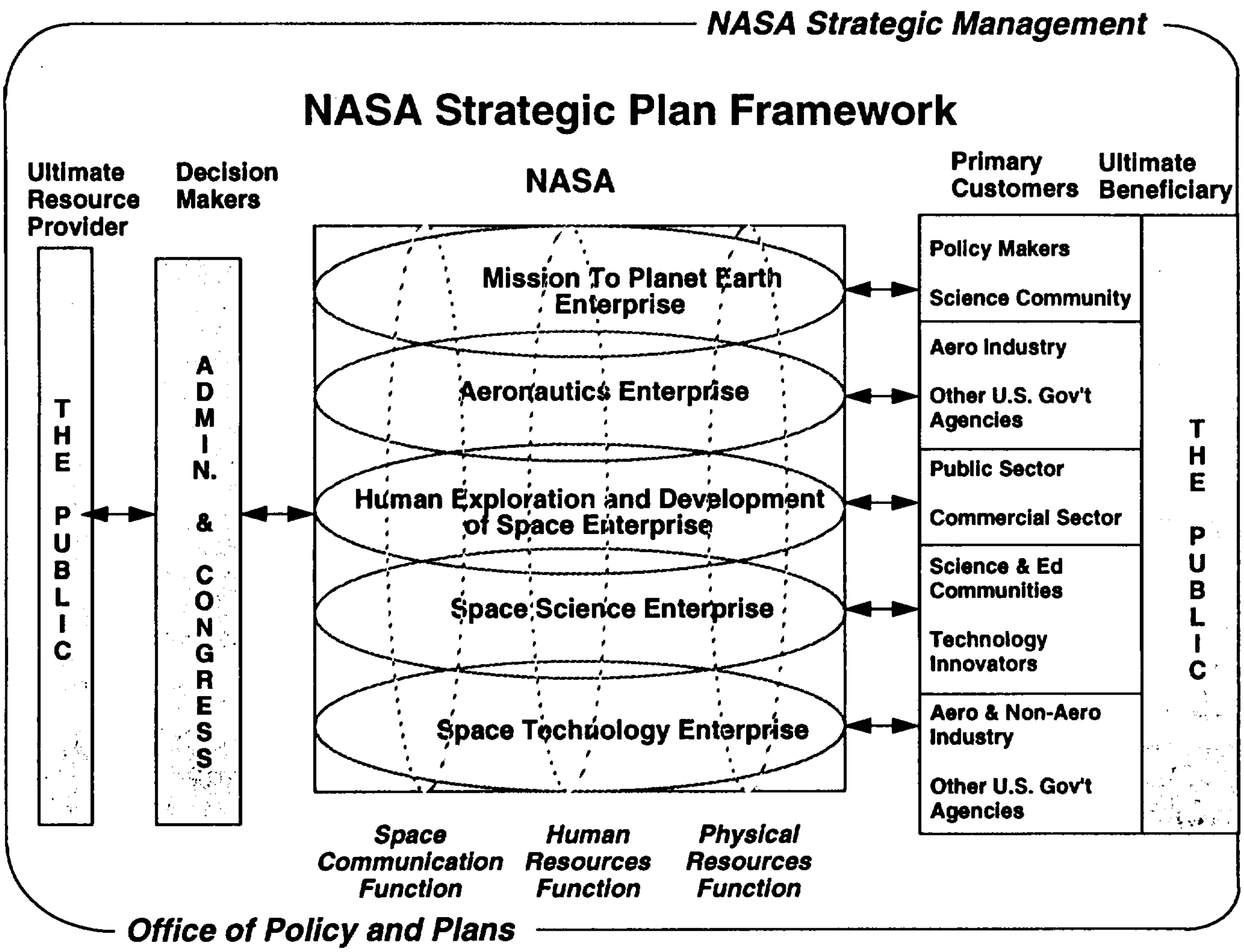


Figure 6. *NASA Strategic Plan Framework.*

Readers of *Issues in NASA Program and Program Management* will recall earlier versions of NASA goals, outlined in the Special Report for 1993, "Perspectives in Program and Project Management" (SP-6101-07). Steinberg presented four customer-focused outcomes of NASA's mission, each keyed to national goals:

- Economic Growth and Security,
- Preservation of the Environment,
- Educational Excellence, and
- Peaceful Exploration and Discovery.

As Dr. Charles J. Pellerin Jr. observed in 1993, the "shared vision" of NASA has changed significantly since the end of the Cold War and numerous studies, panels and commissions. Traditionally, NASA strived first to "provide inspiration and hope for the future."

Gary Steinberg then described the planning process, emphasizing that the *NASA Strategic Plan* is the product "not of a senior management group but all of us." Seven thousand employees participated in the process that resulted in the NASA vision, mission and values. All of the NASA Associate Administrators and Center Directors hammered out a draft plan in a series of two-day offsite retreats over an eight-month period. A draft plan was published in February 1995. Subsequently, several things were added to the plan, including additional focus on technology transfer and commercialization issues, plus an Agency-level goal to communicate the results of NASA science and technology development to the public.

In progress was a *NASA Strategic Management System Handbook* to show a new way of doing business at NASA, including the use of metric performance evaluation and improvement. "If we can't measure it, we can't manage it," noted Steinberg.

He concluded with practical suggestions, urging participants to study the forthcoming NASA Strategic Plan, "know who our customers are and what they require . . develop measurable objectives to satisfy customer requirements . . . measure our own performance . . . [and] operate as part of the NASA team to support the Agency's mission, goals and objectives at all levels."

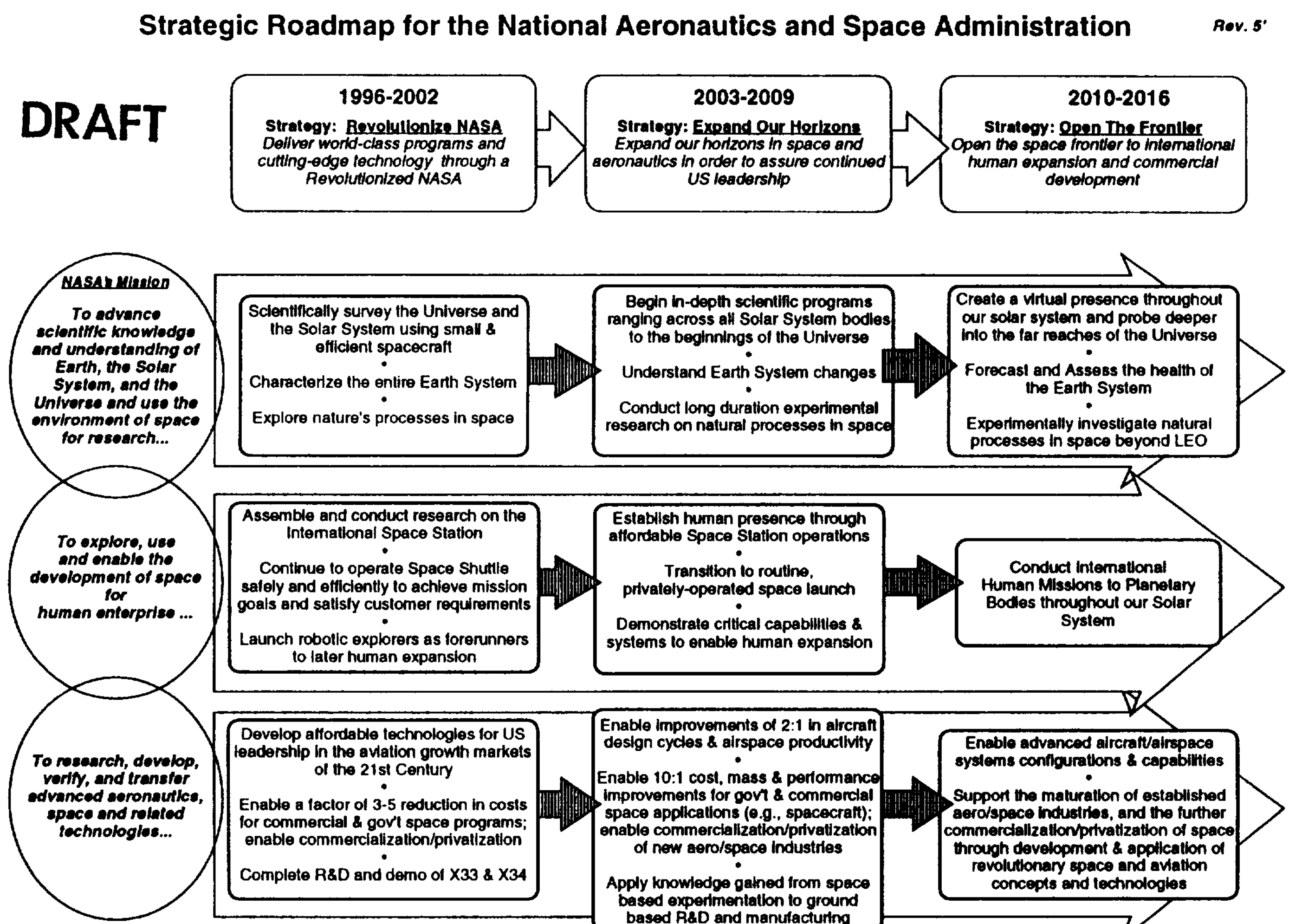


Figure 7. Draft NASA Strategic Roadmap.

Five Enterprise Strategic Plans

1. Human Exploration and Development of Space

by Stephen Cook and Stephan Fogleman

Since joining NASA in 1985, Stephen Cook has been involved in numerous teams studying management issues and advanced planning. He was previously the Advanced Studies Manager for Space Station Freedom and, in 1993, Chief of Staff for the Associate Deputy Administrator for Strategic Planning. He explained that "HEDS is an enterprise, not a program," and that programs and projects respond to Enterprise goals. "Our business creates opportunities," he said, "in developing space for science, technology, commerce and adventure."

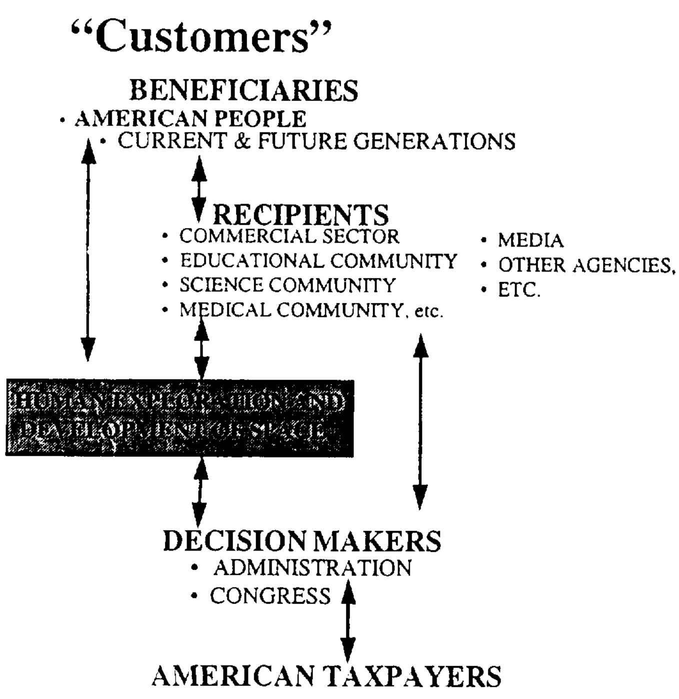


Figure 8. Human Exploration and Development of Space enterprise "customers" begin and end with american citizens.

Vision:
To expand the human experience into the far reaches of Space

Mission:
To open the Space frontier by exploring, using and enabling the development of Space

Stephan Fogleman, manager of the Human Systems and Strategic Development Mission from Planet Earth (MFPE) study office, outlined the draft goals and objectives of the HEDS effort:

Goal 1: Understand and use nature's processes in space, especially gravity and countermeasures.

Goal 2: Explore and settle the solar system through robotic probes and human missions, using the International Space Station.

Goal 3: Achieve routine space travel through improved Shuttle operations, new transportation systems and space medicine.

Goal 4: Enrich life on Earth through achievements in science, math, engineering and medicine with broader opportunities and international cooperation.

Fogleman added, "We will not settle the solar system until commercial gains are determined," emphasizing the need to eliminate barriers to viable space commercialization.

2. Aeronautics

by Jay Henn

Jay Henn, director of strategy and policy in NASA's Office of Aeronautics, outlined the Aeronautics Enterprise Strategic plan "for a safe and efficient national aviation system." He noted that U.S. airlines have lost $12 billion and 100,000 jobs in the past five years, with much of the loss attributed to technically competent, government-supported foreign competition.

To implement the Aeronautics Enterprise goals and objectives, Henn stressed relevance to customers, academia as a full partner, technology transfer and "synergy with other NASA Enterprises."

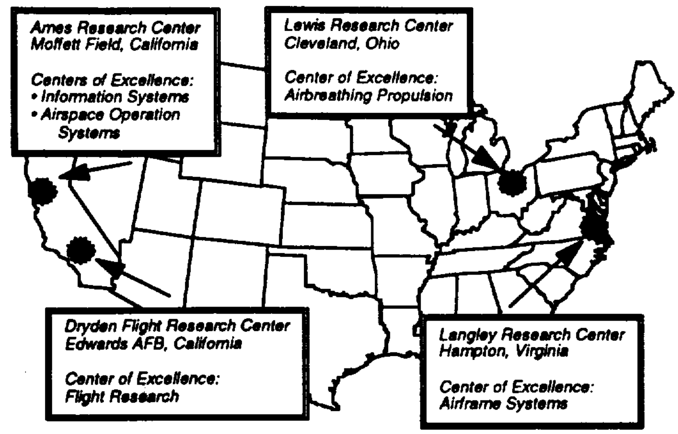


Figure 9. Aeronautics Enterprise Centers.

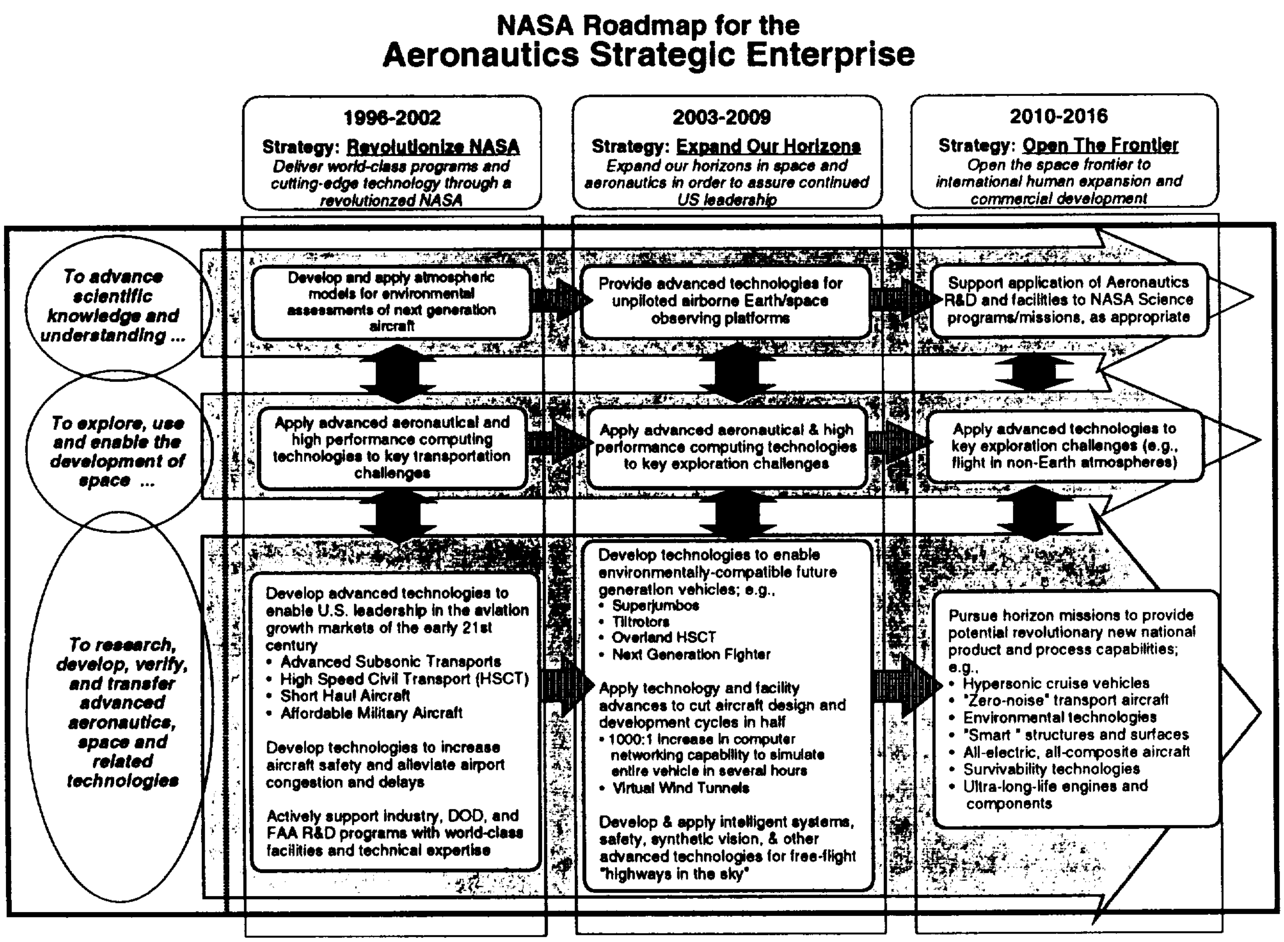


Figure 10. Aeronautics Enterprise Roadmap.

3. Mission to Planet Earth

by Doug Norton

Douglas Norton, Assistant Associate Administrator for Program Integration in the Office of Mission to Planet Earth (MTPE), spoke of "the effects of natural and human-induced changes on the global environment." The MTPE Enterprise involves more than 27 spacecraft in the Earth Observing System alone and 20 agreements with more than 60 countries. With half the world's population living within 50 miles of seashore and more than half the oxygen produced by Amazon rainforests, global change study takes on increasing importance.

Norton indicated that the MTPE Enterprise is "science-driven and policy-relevant," so enhanced customer definition and communication become particular challenges in the strategic planning process.

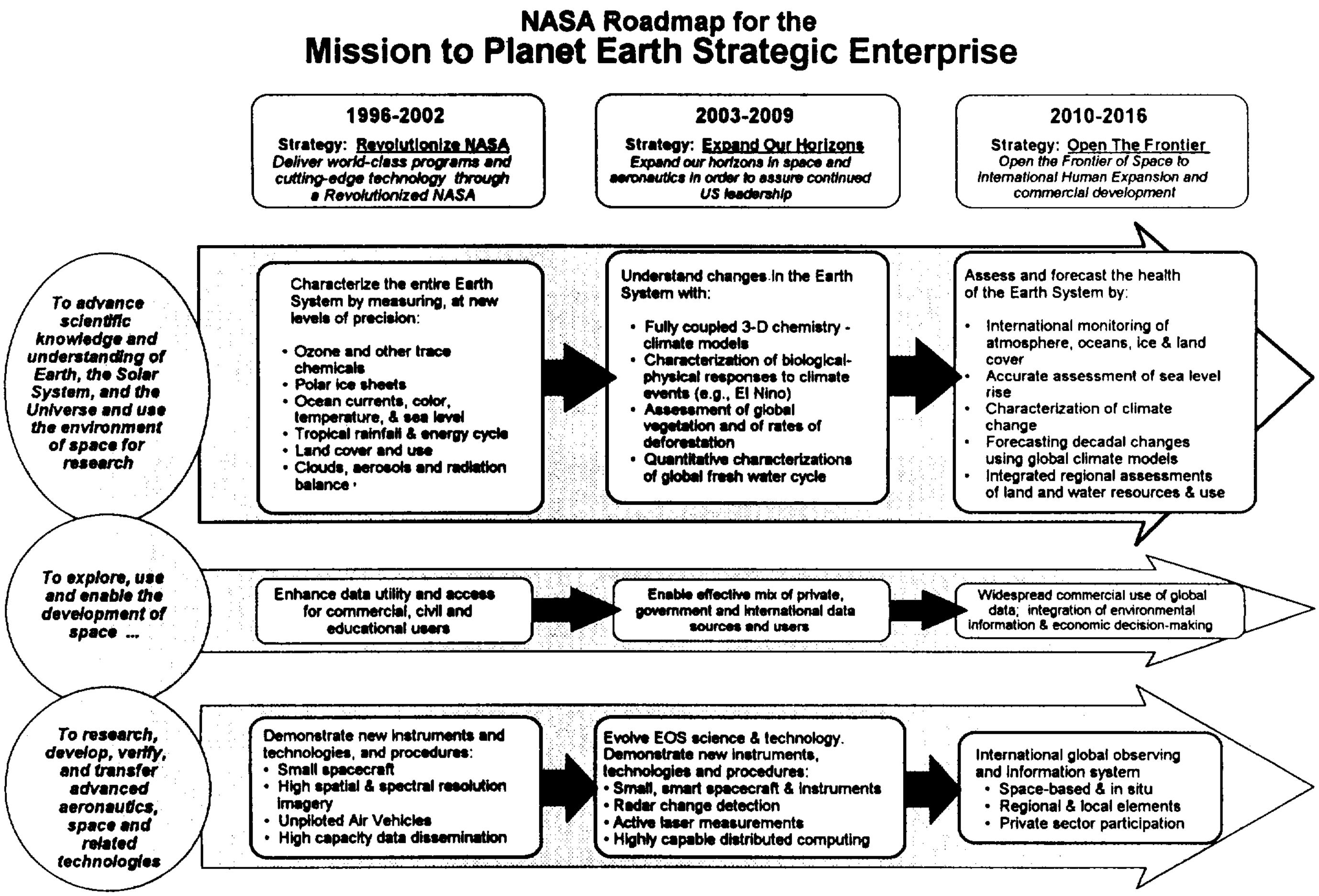


Figure 11. MTPE Enterprise Roadmap.

4. Space Science

by Mary Kicza

Mary Kicza, Assistant Associate Administrator of Technology for the Office of Space Science, addressed the 1995 PMSP Conference to raise fundamental questions about the origin and evolution of planetary systems. OSS strives to serve the science community with understanding and inspiration, the education community with imagination and stimulation, and the aerospace industry with the transfer of technology. She noted that 4.2 million requests came in for a World Wide Web page on the Astro-2 mission. Contrary to predictions of the 1990 Augustine Commission, she said the 10-year duration flagship missions are giving way to 3-year Discovery and small Explorer missions. After the year 2000, many more lighter missions of even shorter duration will be launched to explore the universe.

Capable Microspacecraft

Trends in Spacecraft Size

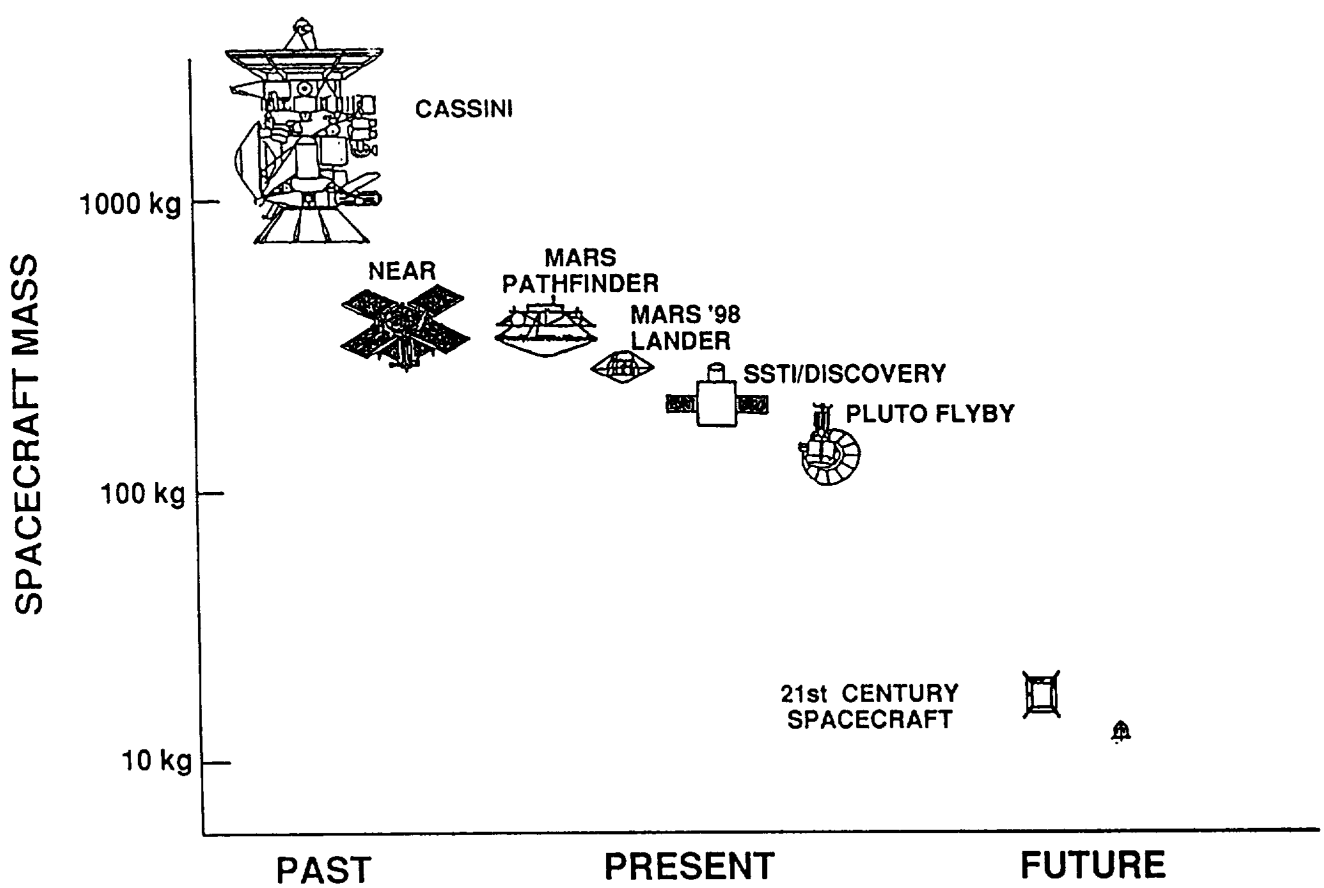


Figure 12. Trends in Spacecraft Size.

5. Space Technology

by Earl Van Landingham

Earl Van Landingham of the Space Transportation Division of the Office of Space Access and Technology outlined the goals of NASA's Space Technology Enterprise (STE). The first goal is to reduce the cost of access to space through cheaper launch vehicles and in-space transportation. Secondly, STE aims to provide innovative technologies (systems, instruments, operations) for ambitious future space missions. Third, meet customer user needs by focusing on communications, remote sensing and space processing. Finally, share the discoveries through technology transfer and the "Agenda for Change," NASA's new way of doing business. "Commercialization of space is essential to NASA," he said, "and is everyone's job."

The matrix chart below shows the development of technology in the STE in cooperation with and responsive to user requirements.

MANAGEMENT MATRIX FOR SPACE TECHNOLOGY DEVELOPMENT

DRAFT 1/5/95

ACTIVITY	PLAN	PLAN REVIEW/ CONCUR.	BUDGET	EXECUTION	PROJECT REVIEW
Advanced Development System demonstration for a specific mission. Example: **Prototype** of a power system, to meet mission specific power levels, power to wt. ratio and life for use on a **planned mission** in the Van Allen belt.	**USER** Developed by the Enterprise with assistance from Space Technology Enterprise Office (2)	**STE** Plan developed by Enterprise Office, reviewed by STE Office	**USER** Planned, advocated and reported in the Enterprise Office's budget	**USER** Performed by the agent of the Enterprise Office with assistance from STE Office	**USER** Enterprise Office with assistance from STE Office
Focused Technology Technology development and demonstration in a relevant environment (may include space experiments) to address a **range of applications.** Example: Demonstration in the SSTI of a light weight, high eff.., long life, radiation hardened power system	**STE** Developed by STE Office based on collective inputs from the Enterprise Offices & Industry	**USER** Enterprise Offices concur on and industry reviews plan developed by STE Office	**STE** Planned, advocated and reported in the Space Technology Enterprise (STE) Office's budget	**STE** Performed by the agent of the Space Technology Enterprise Office (STE)	**STE** STE Office with participation by Enterprise Office and industry
Exploratory Development **Experimental evaluation**, in laboratory of **innovative** power system **technologies**. Example: Multi-junction PV cells, common pressure vessel batteries and adaptive, high efficiency power management.	**STE** Developed by STE Office based on known or projected mission limiting technology issues	**STE** Enterprise Offices and industry review plan developed by STE Office	**STE** Planned, advocated and reported in the Space Technology Enterprise Office's budget	**STE** Performed by the agent of the STE Office	**STE** STE Office with participation by Enterprise Offices and industry, as desired

Corporate NASA R&D

Figure 13. Management Matrix for Space Technology Development.

Innovations in Managing Complexity

The second major theme of the four-day PPMI/PMSEP focused on innovations in the management of complex programs and projects. The first theme, NASA's strategic planning, ended with a series of parallel breakout sessions on each of the five Enterprise strategic plans.

After a short break, the second theme opened up as the first closed down, with a set of parallel breakout sessions on complex programs inside and out of NASA. There were six such sessions, the first two dealing with integrated product teams in two different programs.

1. Integrated Product Teams: High Speed Aircraft

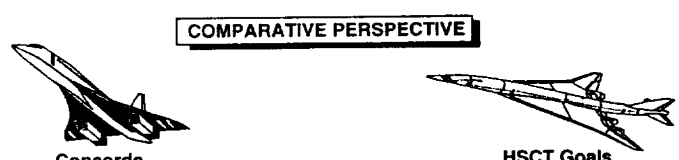
by Wallace C. Sawyer

Wallace C. Sawyer, director of the High-Speed Research project office at NASA's Langley Research Center (LaRC), leads the development of aerodynamics, airframe materials and structure, flight deck and propulsion technologies, and system integration of the High-Speed Civil Transport—an economically viable and environmentally acceptable 300-passenger, 5,000 M. mi., Mach 2.4 aircraft. In less than a decade, the program could mean a $200 billion swing in U.S. aircraft sales and 140,000 new jobs.

Integrated Technology Development (ITD) teams have provided technical focus and visibility to all involved, including five NASA Centers, two Enterprise Offices at Headquarters, five major aerospace contractors and more than 40 subcontractors and major suppliers.

NASA team members include the Office of Aeronautics, Office of Mission to Planet Earth, LaRC, LeRC, Ames, JPL and the Dryden Flight Research Center. Industry team members include Boeing, McDonnell Douglas, GE Aircraft Engines, Pratt & Whitney and Honeywell.

"HSCT economic impact is enormous," said Sawyer. The ITD team approach is expected to discover and resolve problems early, account better for customer requirements, identify and reduce risk quicker, and place decision authority with the most knowledgeable sources.



Concorde		HSCT Goals
North Atlantic	Market	Atlantic & Pacific
1976	Entry into Service year	2005
2.0	Speed (Mach No.)	2.4
3000	Range (nautical mi.)	5000-6500
100	Payload (passengers)	250-300
400,000	Takeoff Gross Weight (lb.)	700,000
87	Required Revenue (¢/RPM)	10
Premium	Fare Levels	Standard
Exempt	Community Noise Standard	FAR 36 - Stage 3
75	Noise footprint (sq. mi.)	5
20	Emissions Index (gm/Kg fuel)	5

Figure 14. The Concorde and the High Speed Civil Transport.

2. Integrated Product Teams: International Space Station

by Lyn Gordon-Winkler

Lyn Gordon-Winkler, assistant manager of the Business Management Office and strategic planning advisor to the program manager of the Space Station Program Office, is responsible for managing the process by which Integrated Product Teams are used. She describes the International Space Station program management approach as product-oriented rather than function-oriented.

The Space Station Program is organized into teams which are delegated authority, budget and schedule. These teams are responsible for meeting technical requirements within their resources and schedules. Team metrics are used to maintain accountability and assure program success. The station is described as "the key to NASA's future." Contractors and NASA work together on teams pursuing a common goal.

3. Advanced Concepts: Virtual Research Center

by John Mankins

John C. Mankins described a new approach for NASA strategic planning and management—his Advanced Concepts division of the Office of Space Access and Technology. The idea is to create a NASA "Virtual Research Center," an Internet-based interface that stimulates on-line discussion, analysis, simulations, gaming and conceptual prototyping of new concepts.

Linked to NASA's World Wide Web/Mosaic homepage, the "Virtual Research Center" will operate and interact through a unique 3-D graphical user interface (GUI) and publish the results for the Advanced Concepts Team, the broader NASA community and the general public.

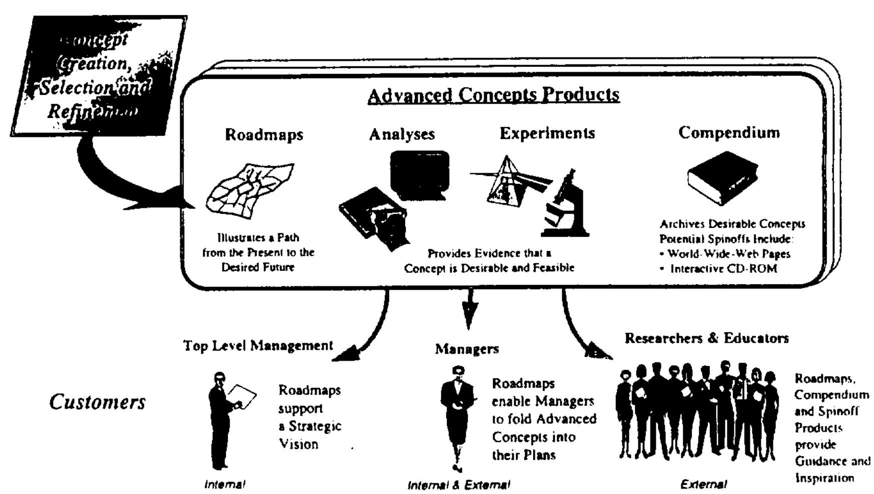


Figure 15. Advanced Concepts Products.

4. Systems Engineering: WES 21

by Dona M. Lee

Dona Lee, PE, is a strategic and program planner at Strategic Insight, Ltd. in Arlington, Virginia, specializing in complex, high technology Federal and commercial programs. She reported on Naval Surface Warfare Center's first "Workshop on the Engineering of Systems in the 21st Century" (WES 21).

After a graphic description of turmoil and rapid change in technology, organizations, corporate environments and the dislocated work force, Lee indicated what she called "Trends du Jour," namely dual use, concurrent engineering, re-engineering/reuse, evolutionary systems and the new affordability. WES 21's approach encourages joint interagency, academic and industry coordination for continuous improvement in the management of complexity.

"WES 21's approach encourages," she noted, "future investments in Systems Engineering research."

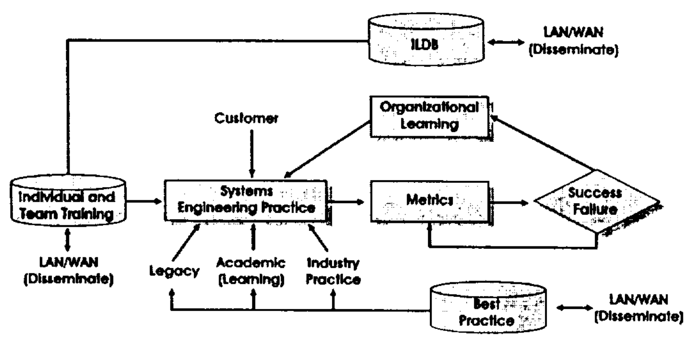


Figure 16. *Continuous Improvement Process Model.*

5. Rapid Prototyping: Single Stage to Orbit

by Bill Gaubatz

Dr. William A. Gaubatz, director of program development in Reusable Launch Vehicle programs at McDonnell Douglas Aerospace, described the rapid prototyping of a totally reusable system, the Delta Clipper experimental spacecraft. The DC-X was the first of the X-flight systems for single-stage-to-orbit technology featuring a seven-day turnaround for the vertical takeoff and landing of a three-person crew.

"Design the team before you design the product," he advises. Integrated Product Teams were responsible for requirements definition, design, assembly, checkout, schedule and budget.

The DC-X rolled out 18 months after authorization to proceed, and the first flight took place in 24 months, on August 18, 1993. It had no solid rocket boosters or external tanks, no fairings or separation devices and very little ordnance but did have reusable engines. Key elements of design included maximal use of off-the-shelf hardware, software, parts and processes, as well as existing embedded facilities.

Program management philosophy called for a single customer program manager empowered to make all decisions and a single contractor program manager empowered to make company decisions.

6. Project Management: Planning NMI 7120

by Ernie Hahne and Susie Mauzy

Ernest Hahne is a private international consultant and Susie Mauzy is with Johnson Space Center's Mission Operations Directorate, which developed a prototype training and project application approach in 1993 using the new NMI and the new Systems Engineering Handbook.

The basic NMI 7120 training focused on the Mission Needs Statement (MNS), the Non-Advocate Review report and the Program/Project Commitment Agreement. It was found that a young team can follow the NMI 7120 process with adequate training, on-the-job training and mentor support, but help is needed in determining what tailoring is appropriate. Also, management has to support the effort. Some false starts will be made, but those are part of the learning process. "War room" data may appear more complex and labor intensive than the "usual" process, but it is not. And, among many other "lessons learned," the process holds people accountable and relies on hard data and metrics to determine if performance is acceptable.

"Understand that 'Business as Usual' cannot continue," they noted. "Take advantage of Lessons Learned."

They add: "Keep things simple at start-up (KISS) and learn by doing." They call this "an evolutionary approach to reengineering."

After a short break, each of the six breakout sessions on "Innovations in Managing Complexity" were repeated, preparing participants for a full day of international, interagency and government/industry collaboration in the management of complexity.

- Three KEY documents:
  - The Mission Needs Statement (MNS)
  - The Non Advocate Review (NAR) Report
  - The Program/Project Commitment Agreement (PCA)

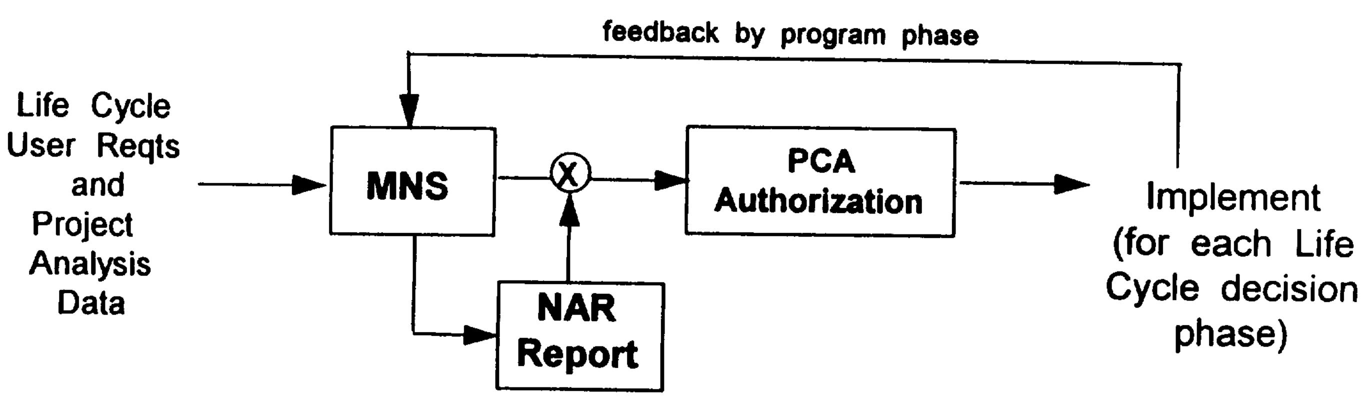


Figure 17. The Basic NMI 7120 Training Scope.

International Partnerships

The Chunnel Project: Challenges and Lessons Learned

by John Noulton and John Neerhout

Day three, Thursday, April 20 began with an examination of the management of complexity. What better project to study than the "Chunnel," a newly opened tunnel under the English Channel from the white cliffs of Dover to the shores of Coquelles, France.

The French first proposed a Channel Tunnel 250 years ago, and in the 1870s work actually started and stopped. In 1975, the two nations agreed to resume the Channel, but "no public funds" were to be spent. A decade later, the private concession was awarded to a consortium of bankers and builders, known as TML. They created Eurotunnel International, and after the inevitable chaos of this triangular project management, Bechtel Corporation was called in for help.

John Noulton represented Eurotunnel and John Neerhout of Bechtel served as Project Chief Executive. Even with streamlined decision making and clearer lines of authority, the project team had to deal with 10 contractors (plus subs), two railway companies (with completely different standards), 220 syndicate banks and 600,000 shareholders, the newly formed European Commission (EC) and two governments that had been at war with each other more than with any other nations. A bureaucratic intergovernmental commission ruled, for example, that pass doors between vehicles had to be widened from 600mm to 700mm—the redesign and refabrication caused a nine-month delay and resulted in a $600 million claim by the supplier.

Nevertheless, the 31-mile tunnels were completed three days ahead of the original 1985 schedule but the cost came in high at $15 billion, and TML made "the claim of the century" against Eurotunnel project management of about $2 billion for cost overruns on mechanical and electrical equipment. With government intervention, the claims were settled in February 1994 and freight service began in the Chunnel in May, followed by gradual tourist service in the summer and autumn of 1994.

John Noulton noted that Eurotunnel had to divide costs and revenues equally between England and France so that the tax "take" or revenue would be equal. Also, French and British workers at opposite ends of the same tunnel worked under different work rules, norms, language, unions and standards. For example, the French could smoke and drink lunch wine, but the British workers wore a breathing apparatus and could not.

John Neerhout said: "When I reflect on the lessons learned from this colossal project, and try to formulate a message to project managers present and future, I think that proper organization, with the right people with clearly defined roles, and a proper contract, are the keys to success."

He added: "You will recall the numerous parties involved. It was essential to have Chunnel instructions and information at the proper level and with the proper detail. Micromanaging on the scale of this project would have resulted in complete chaos. You need experts at every level of responsibility." He concluded: "A lot of people don't know what they don't know."

Noulton agreed and added: "Just decide and be done with it."

Russian-American Cooperation in Space

by Jeffrey Manber
RSC Energia

Following are excerpts from the speech by Jeff Manber, managing director of American operations, Rocket Space Corp., Energia:

My topic this morning is the lessons we can learn from the cooperation and partnership with Russian organizations and cooperation—not just what we learn about space exploration, but equally important, what we learn about ourselves in the process. I want to also talk about a great secret: what makes the Russians continue their own space program at great costs and sacrifice.

...The Russians continue to adopt free-market principles for their space program. The organization that I worked with last time I was here, NPO Energia, is today RSC Energia, a privatized Russian corporation that controls many of the operations of the Russian manned space program. Russian workers own shares in the corporation; it is a commercial entity and soon we will be undertaking even more International, private-sector activities. This is space commercialization on a scale bigger than even the most ardent supporter of commercialization ever thought possible.

But I understand how strange all these changes are, in part because the turnaround in exploration is due to many factors, but of chief importance is our working together with the space program of the Russian Federation. That our space exploration future is so entwined with the Russians—whether as commercial competitors or partners—still befuddles some of the experts. It was crystal clear to many that the Russian space program would not, and could not continue to exist, compete with American or contribute to our own program. That it remains operational today, and indeed, that we are learning much from working with the Russians, shows that many did not understand the Russian program, how it works, and what it has to offer to the United States. Judged from an American perspective and American background, it was easy for some to dismiss the program of a former enemy. But history has shown—and I'll talk about this more—that those who oppose the opening of markets and the sharing of expertise and the resultant boom in new products at lower costs, lose in the marketplace...

Many of you in this room are the troops in the trenches for working with the Russians. I know it is challenge enough to learn and understand how things are done on an engineering level. But I challenge and urge you to do more, and to study how the Russians are restructuring their own industry. Because the irony is that what the Japanese taught Detroit was how to go back to Detroit's own roots in manufacturing and corporate structure. What was *new* was how Detroit was making cars in the 1960s and 1970s. What was tried and true was how they did it in the 1930s and 1940s, and the Japanese in the sixties and seventies

So too, I believe, in the Russian Federation. Their space industry reflects our own commercial marketplace, not in space but in manufacturing. Let me cite some examples:

1) Consider the Russian Space Agency headed by Mr. Kptev: it is a small government space agency of no more than three hundred people. It has limited powers, behaving more as a central coordinating office. Of course, they are also incorporating their scientific organizations into a civilian space agency, but the counterpart to NASA in Washington is "lean and mean."

2) Mr. Yuri Semenov is now president of RSC Energia, a commercial corporation that handles operational space programs. We are a corporation that will raise capital, solicit business and work overseas, when appropriate. Energia has negotiated commercial contracts with ESA, with

NASDA, with the Chinese, with European industry and also a *commercial* contract with NASA.

3) There is strong and legitimate competition. We at Energia have competition from Krunichev, to name one example. We also work together with them. They too are moving into the international marketplace. Krunichev, along with Energia, is working with Lockheed to market the Proton. It is not a Russian project, it is not an American project.

4) Russian space industry has a limited use for contractors. The strange and often blurred lines between the public and private sector that exists in our space industry, do not exist in Russia.

5) Clean lines of authority. Everyone knows who is in charge of remote sensing, of materials processing, of manned launches, of the space station, for the Russians. On the American side the lines of authority are unclear and changing every few months . . .

I'll tell you right now what the secret is: it's their determination to continue to explore and the humility of pushing into space. They have a commitment on a society-wide basis, one that survived the breakup of their empire, the collapse of their lives and they will hold it all together and push forward into space.

They are not into space because we are. Space is not a symbol of any one government or federation or nation-state. It is a pride that digs deep into their own history. They can speak of where they will be in space in a hundred years at the same time they smile in embarrassment when questioned about a train schedule for next week.

Working with the Russians, you at NASA will pick up ideas on how to run a space station or launch people in sub-zero weather to spend a year in space. But all that will be for naught if everyone in this room and in our society does not regain our willingness to explore. Otherwise, we are rushing in new programs and new technologies and grafting them onto a system that does not work.

Friends of mine at NASA and in industry tell me that "things will be better with this new program, or with this new budget." I think it takes more than that.

We need to again take risks, to understand and accept that some do die so that others can live in a new frontier. That is what I think it takes to do the business of space exploration. That's what makes our business different than cars of computer chips. It takes courage on a personal and society level to send men and women to orbiting stations and then on to planets.

We in this country cannot have senior administration officials telling us that virtual reality is the same as exploration. "That we can put our minds where our feet can never go." That's not bad news for NASA. That's bad news for us as people, a nation of immigrants and explorers.

So what I've learned from the Russians is that the issue may not be the size of the next launch vehicle program or what percentage of it is reusable, if it isn't going to launch on time. And let's not worry about the size of our space industry; if we continue to graft new technology on old management structures, our programs will fail the test of the marketplace. And I've learned that all of this is secondary to whether we even wish to explore as a nation.

As both the administration and Congress explore how to restructure NASA, you in this room should not sit still. Alfred Sloan, the auto industrial leader, warned in 1963: "For unrivaled leaders, success itself breeds the roots of complacency, myopia and ultimately, decline." It is our fate that from time to time in our commercial history we must re-learn from others—from the Japanese how to build cars like Henry Ford, and perhaps from the Russians how to create a commercial market—for space services.

Industry/Interagency Collaboration

Clementine—A Prototype

by Stewart Nozette

Dr. Stewart Nozette was manager for the Clementine Follow-On in the Space Experiments Directorate for the U.S. Air Force at Phillips Laboratory. Since 1991, when the Clementine effort began, he had been deputy for sensor integration, and had worked for the Space Defense Initiative Organization (SDIO) and Department of Energy.

Interagency collaboration among NASA, the Ballistic Missile Defense Organization (the later SDIO), the Naval Research Lab and the Naval Center for Space Technology plus others resulted in a deep space mission in less than half the development time and less than half the typical costs. Clementine saved so much time and money by adapting available commercial and military technology, using small companies with lower overhead costs, streamlining management controls, and reducing spacecraft size and weight to pursue a focused mission. Clementine's frozen batteries and lightweight solar arrays become spin-offs for the next direct broadcast satellite (DBS) spacecraft. Non-explosive catches and lightweight (300g) cameras for remote sensing can be twice-used technology for the Clementine Follow-On.

Nozette acknowledged that Clementine was not a complete success because of a software glitch and spent fuel, but the team learned that new DoD technology reduced costs considerably and that interagency collaboration requires leadership and support at the "highest levels."

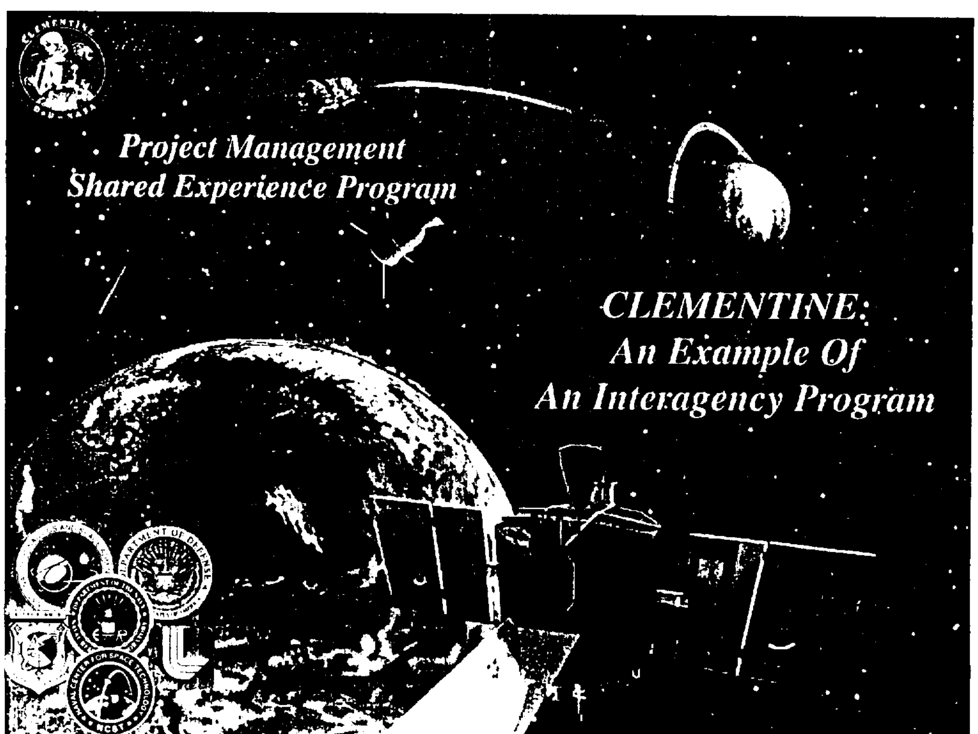


Figure 18. Clementine and Partners.

ARPA's Innovative Awards

by Tim Arnold

R. Timothy Arnold since 1990 has served as director of the contracts management office of the Advanced Research Projects Agency (ARPA), DoD's primary science and technology office. Best known as the developer of ARPA-Net 20 years ago, precursor of the Internet, ARPA has engaged in dual-use technology since 1993.

Arnold focused on Broad Agency Agreements (BAAs) between ARPA and consortia, partnerships or individual high tech companies like Cray, Intel and Hewlett-Packard that normally shun DoD business. The BAA is not subject to much of the red tape and reviews common in other government/industry contracts. Instead, an ARPA BAA begins with "an assessment of a problem we want solved" in high-risk, high-payoff science or technology. The company or consortium submits a five- to ten-page abstract or white paper to ARPA and, only if promising, a full and more expensive bid and proposal. A technical person, not a contracting officer, decides who wins.

The effects on program management of this new way of doing business are many. The award is more like an investment than an obligation, creating a new sense of trust and spirit of cooperation with industry. Tax dollars are leveraged with a strong incentive to commercialize technology. Of course, the new approach is, experimental, but with a clear vision statement up front and review milestones, the initial kickoff meeting represents a new beginning in government/industry collaboration.

Intelligent Highway Systems

by John MacGowan

C. John MacGowan, Chief of the Intelligent Highway Systems division in the Federal Highway Administration, described government/industry collaboration in technology application in terms of an intersection of three streets. Public/private partnership (PPPs) depend upon the convergence of Madison Avenue (the marketplace), Wall Street (investment) and Main Street (the public interest).

Highway congestion, for example, costs about $100 billion a year in lost efficiency and 40,000 lives, by far the major nonmedical killer in America. Yet, public/private partnerships to solve or at least alleviate congestion face three interrelated levels of resistance. The strategic or institutional barriers consist of political differences (Republican and Democrat, for example) as well as basic cultural differences between government and industry. The private sector is far more concerned with investment, competition and profit seeking while government agencies are more concerned with standard procedures, cooperation and the public trust. Programmatic or legal barriers include existing laws, regulations and restrictive practices that inhibit public/private partnerships. Finally, project agreement barriers include the multiple layers of government scrutiny set against private market uncertainty and financial and technological risk-taking.

Removing or lowering such barriers will enable government and industry to share both risks and rewards, especially in highway safety and efficiency. Meanwhile, he noted, the traffic information on the Internet is requested 30,000 times a day in just San Diego and Seattle alone as commuters seek faster ways to get to work and back home safely again.

Rapid Prototyping—SSTO

by Bill Gaubatz

Dr. William A. Gaubatz is director of program development at McDonnell Douglas Aerospace's Reusable Launch Vehicle Program in Huntington Beach, California. He focused on the Delta Clipper Experimental (DC-X) single-stage-to-orbit (SSTO) rapid prototyping as an example of innovative government/industry collaboration.

The DC-X was the first of the "X-flight" systems to demonstrate SSTO technologies and low-cost operations. A three-person crew would be able to take off and land vertically, operate the spacecraft like an aircraft, and be ready to fly again in just seven days turnaround. Rapid prototyping called for a limited budget and a quick schedule, 24 months from start to flight. It first flew on August 18, 1993, with Pete Conrad as the flight manager.

The rapid prototyping system maximized the use of off-the-shelf hardware and software, commercial parts, processes, and existing embedded facilities. Project managers used "work arounds" in lieu of schedule slips and saved an estimated 28% in time over "business as usual." Software savings of 33% in time and 80% in cost were even more spectacular. Among the "hard to quantify" factors for the DC-X success were daily meetings at both the program level and shop floor.

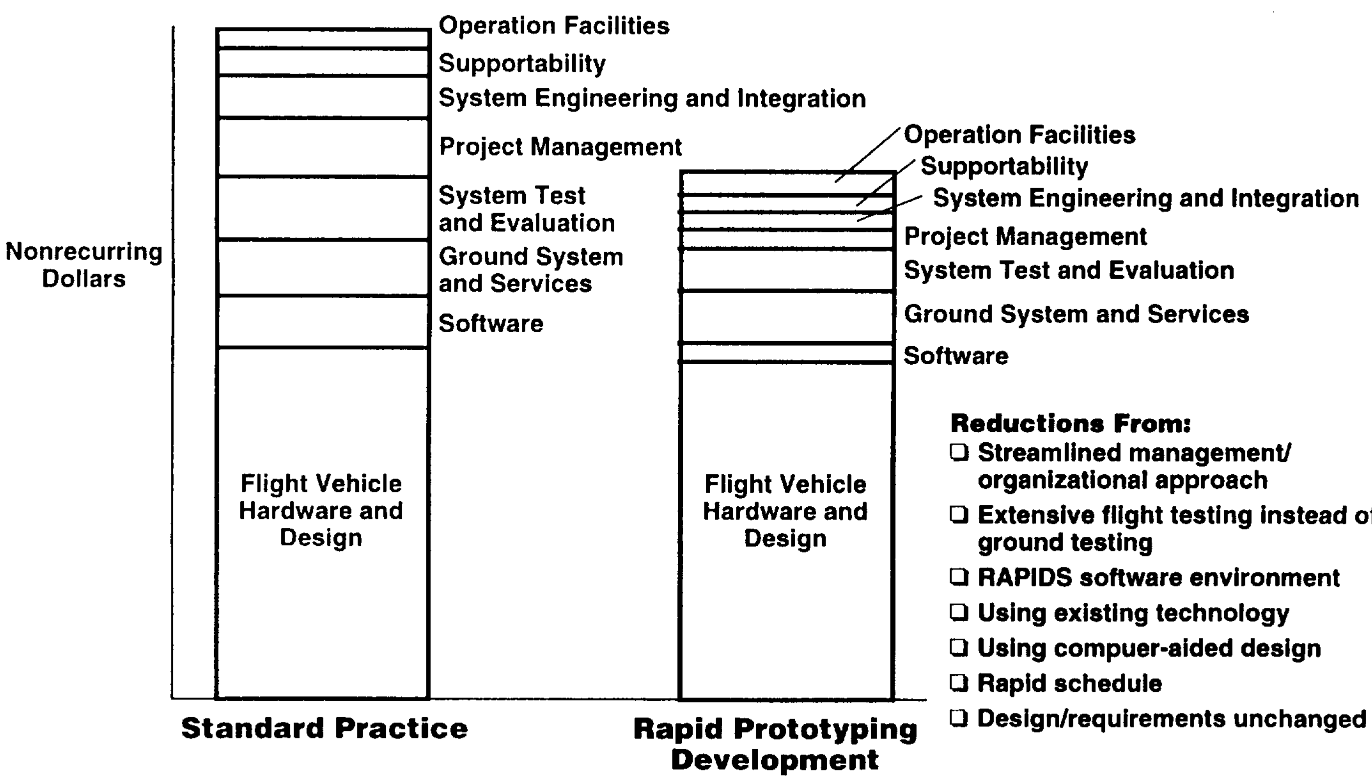


Figure 19. *Cost Reductions Through Rapid Prototyping.*

Air Force Lessons Learned

by Chris Andrews

Chris Andrews is director of the Spacelift Technology Office for the U.S. Air Force at Phillips Laboratory in Northern Virginia, where he is responsible for planning and focus of all USAF technology for launch vehicles and upper stage concepts.

"Future success is based upon new approaches," said Andrews, such as "actively exploiting emerging capabilities," known as "spin-ons." With spin-on technologies and downsizing, Phillips Laboratory, formed in 1992 with 2,600 employees, will be expected to do the same level of work in 1997 with just 1,800 people.

While traditional spacecraft have been heavy, large, complex and expensive, Andrews says the future calls for low mass, low power, small dimensions (100 kg, 100W, 1m3 or less) and highly capable spacecraft with micro-instruments and intelligent flight systems, not to mention more joint USAF/NASA missions. "Our biggest problem today is joint funding," he says. "Who's in charge?"

Ongoing USAF/NASA programs include the DC-X, DC-XA, X-33 and X-34 reusable launch vehicles; solar thermal, electric and LH2/LO2 propulsion; and the Small Spacecraft Technology Initiative (SSTI) and Lewis and Clark spacecraft.

As a result, the USAF and NASA are adopting new ways of doing business.

- Instead of technology to enhance performance, develop technology to enable affordable missions.
- Contracting gives way to partnerships.
- Instead of labor-intensive ground control, develop autonomous spacecraft control.
- Instead of risk avoidance, consider risk management.
- In place of conservative designs, count on spin-ons—the rapid infusion of commercially available new technology.

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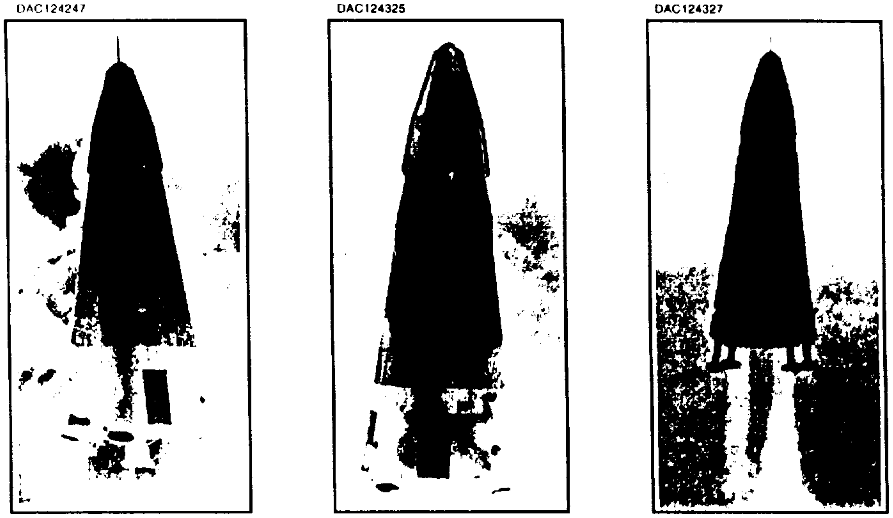

Takeoff **Hover Flight** **Landing**

Figure 20. *Delta Clipper Experimental (DC-X). First flight—August 18, 1993.*

Technology Transfer

Perspectives on Tech Transfer

by Courtney Stadd

Courtney A. Stadd, managing partner of Global Technology Ventures in Maryland and former director of the National Space Institute, offered his perspectives on technology transfer, beginning with an analysis of "the wild and wacky digital-based world" in which we work, and ending with an assessment of the changing political climate. Excerpts of his speech follow:

If the definition of a tech transfer practitioner is someone skilled at leveraging people, assets, capital and ideas, a premium must be placed on constantly getting oneself exposed to the incredible changes shaping the economic landscape . . .

Every one of us in this room faces an average of 300 programmed electronic microcontrollers each day, and my Canon camera has more "intelligence" than an early '80s version of the Apple II . . . The Space Age that gave us the Digital Age is turning the economic world upside down and creating endless entrepreneurial opportunities . . .

Having tried, however feebly, to describe the wacky, bizarre and unpredictable external environment in which tech transfer takes place, I'd like to make some observations on the state of Federally supported tech transfer.

1) I'm tempted to start by saying, "Only in America . . . ." That is, only in this resource rich nation, where our ancestors were pioneers in networking long before they conquered the Wild West (somewhere in Alexis de Toqueville's 19th Century *Democracy in America*, he observes that two Americans getting together guarantees an association), would we go in such a short period from a few lonely tech transfer specialists working the vineyards to the extraordinary proliferation of various organizations at the Federal, state and local levels involved with tech transfer. NASA alone has approximately 130 civil servants and approximately 120 support service contractors and JPL employees whose main job function is technology commercialization. (And these numbers do not include the RTTCs, NTTC employees and any of the other network organizations such as COSMIC.) The good news is that everyone and his uncle seems to be getting in on the act; the bad news is that the whole scene can be pretty confusing for the business sector—especially the small business types that I usually deal with.

2) The successful practitioners of tech transfer are those who appreciate that they are working in a knowledge-based economy and that the fundamental question we all need to be asking ourselves constantly is—Am I adding value to the process? If not, why am I not striving to get additional schooling or training or reaching out to other experts and specialists who can give me the value-added I need? Not surprisingly, this knowledge-based economy is generating a variety in virtual knowledge access—from the various Internet services to the prospect of so-called "software agents" that can be programmed to target and access huge amounts of information while the user is off doing other chores—like saving his or her budget. This virtual, knowledge-based world of ours is a great leveler. At the very least, it tears down the artificial walls separating the public and private sectors. Information is power. But when lots of people have access to the same information stream, the power goes to those most creative in repackaging and adding value to it.

3) There is an inverse relationship between the number of organizations worrying about the problem of tech transfer and their effectiveness in reaching the real engine for economic change—the small business firm. To wit: about 30 states now offer some form of industrial extension assistance. Modeled in part on the successful U.S. Agriculture assistance system, these programs use field agents to diagnose problems in industrial firms and provide one-on-one technological assistance. In some cases, technological demonstration centers have even been formed. In other cases, industrial networks are used in which groups of small firms come together to find solutions to common problems, share information and technologies, and develop new markets. However, their funding, range of services and geographical coverage are still low, with fewer than three percent of U.S. small firms being aided annually.

4) It seems to me that the tech transfer infrastructure, particularly at the Federal level, has grown in a somewhat topsy turvy fashion, and parts of it should at least be reviewed. Centers are waking up to the need to increase their partnering with industry, but they are less than enthusiastic about reporting performance data. (Hopefully, our panelists may address some of these concerns.)

5) This concern is not unique to NASA but applies across the board to people employed in tech transfer in the various organizations referenced earlier. A colleague who has worked in tech transfer for many years—mostly in the university and foundation worlds—believes that there are no more than a dozen effective tech transfer practitioners in the country. That may be a bit harsh. But his point is that an effective practitioner in this field must combine the black arts of effective business experience and skills, interpersonal communications abilities, training in partnership practices, and legal and regulatory frameworks that are fundamental to successful tech transfer....

6) While we're on the topic of bridging, I can't emphasize enough the need for the government tech transfer and private investment worlds to do a better job of intercommunication. For example, about a month ago, I received a call from a certain field center planning to hold a technology fair. I was told that the intent of the fair was to showcase the Center's many technologies and try to encourage the emergence of a regional mini-Silicon Valley-like phenomenon. This person went on to ask me how they could get interest from the investment community—ten days before the fair!! Not exactly advance planning . . .

In that void, the political system, it seems to me, is grappling with no less than a fundamental redefinition of roles and missions. There is no question that the current Congressional leadership brings a set of presumptions to the policy table—a preference for government to focus on basic vs. applied R&D; a preference for creative ways to drastically reduce Federal overhead while leveraging limited resources to produce more robust results; a preference for reviewing government's functions and identifying candidates for privatization or outright termination; a preference to identify ways to relocate resource and administration from Washington and assign those responsibilities to state and local entities.

Beyond these presumptions, I have noticed that some groups with access to the leadership are now pushing a slogan that supports replacement of entire agencies vs. modification. As skeptical as many of you may be about the viability of such radical suggestions, the fact of the matter is that the world has indeed shifted on its

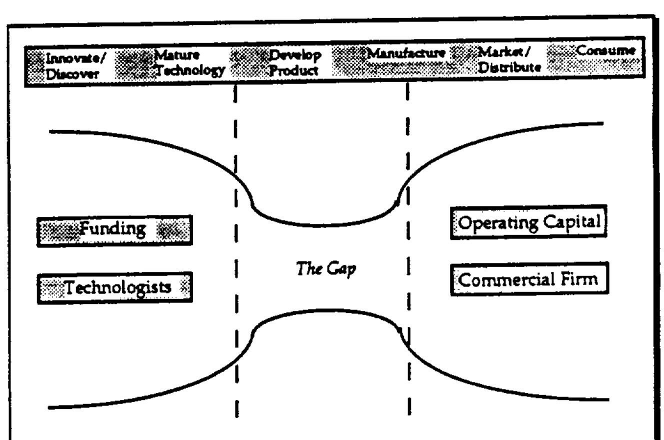

Figure 21. Bridging the Gap of Technology and Commercialization.

axis—and yesterday's rationale that persuaded the political system to support one's program could well be today's rationale for termination. All bets are off.

The same attributes that make for successful entrepreneurship in the marketplace—agility and constant adaptation in the face of daily adversity—will characterize those who succeed in the public sector. No question. It's an Age of High Anxiety. It's been 50 years since the post-WW II generation set this nation's course in technology policy. It is overdue for all of us who worry about this nation's future leadership in technology to join in the larger debate about roles and missions, and lay the groundwork for the next 50 years. The consequences of inaction or sitting in our respective corners and allowing ourselves to be disenfranchised from the debate are simply too serious for our future.

American Competitiveness

by Tom Walters

Dr. Thomas Walters has served as president of the American Competitiveness Enterprise Institute since 1992, specializing in technology commercialization program development. For eight years he has worked at the Jet Propulsion Laboratory in small business innovation research, technology affiliation and technology utilization. In his presentation, Walters showed the strengths and weaknesses of U.S., E.C. and Japanese economic models for developing and marketing high tech products.

In the European Community, especially Germany, "the research community serves corporate interests," but it is moderately difficult for anyone independently to start high tech companies. In Japan also, large corporations can commercialize easily and efficiently through "industrial policy" targeted at specific areas, but there are almost no opportunities for potential entrepreneurs. In the United States, public/private co-funded technology commercialization projects may take a long time to negotiate, coordinate and execute, but creative funding options and minimal government regulation make it comparatively easy to start new companies.

Thus, Walters says the U.S. should not copy Japan or Western Europe in technology transfer. In addition, NASA should focus on what customers want and need, and then arrange management systems that agree with the product or service offered.

Delivering Accountability

by Molly Macauley

Dr. Molly K. Macauley is a senior fellow at Resources for the Future, a nonprofit and nonpartisan research institute in Washington, and a professor of economics at Johns Hopkins University. Following are her comments on the ways and means of delivering accountability for technology transfers:

Headlines such as "Reinventing Government," "Study Finds Space Support Dwindling," and "NASA Cuts Would Cost 55,000 Jobs" reflect the need for greater accountability of the public sector to its taxpayer constituency. Delivering accountability is problematic for science, technology, and technology transfer activities, however, because of difficulties in specifying and measuring the returns to these investments. Typical approaches have included studies of knowledge diffusion by analysis of the numbers of patents awarded and the geographic and industrial distribution of patent citations; econometric studies relating changes in gross national product to levels of investment in science and technology; and case studies of "spillovers."

These approaches have many shortcomings. For instance, in the case of patent studies, not all activities result in patents; in the case of GNP, spending on space activities is generally too small for its effect on a six trillion dollar economy to be identified through econometric studies; and spillover studies have largely been discredited.

Perhaps a more promising approach is through objective, detailed case studies of the activities themselves. Such a tack is being taken by Stennis Space Center in one of NASA's programs to commercialize remote sensing, the Earth Observations Commercialization Applications Program (EOCAP). In EOCAP, measures of success are agreed upon by Stennis and commercial partners at the very outset of the program; progress towards these goals is measured during program execution and interim results are shared with all participants; and final results are packaged and communicated publicly. The success "metrics" include three measures: (1) net return on government plus industry investment (that is, net commercial profitability); (2) the development of efficiency enhancing, general technologies that improve the health of the spatial information industry (such as widespread adoption of user friendly iconography, commercial practice standards, standardized data formats); and (3) lessons directly learned from EOCAP that contribute to public policy issues (for instance, EOCAP experiences had a direct bearing on some aspects of the 1992 Land Remote Sensing Policy Act). Where possible, these metrics are quantified (calculations have been made of net return and productivity gains enabled by the generic technologies). Documentation about the EOCAP metrics and their measurement is available.

More general observations about how to build an accountable tech transfer program, specifically using government/industry co-funded partnerships, include the following: (1) use private sector business and technical experts, rather than government officials, to select partnerships competitively; (2) define success metrics at the outset, establish quantitative measures of them, periodically measure progress towards these goals, and feed back results to partners and the taxpayer; (3) break large programs into smaller, decentralized profit and loss centers; (4) allocate sufficient resources for program management and metrics definition, collection, analyses, and reporting—including site visits and customer interaction; (5) make public and private managers personally accountable through public recognition; (6) require a business plan; (7) introduce competition among partners to the extent possible; (8) require real co-funding or risk sharing on the part of commercial partners; (9) avoid making awards on the basis of job creation (jobs are a cost, not a benefit); and (10) terminate projects that aren't performing.

NASA's Commercial Technology Program

by Kevin Barquinero

Kevin Barquinero is executive secretary of the NASA Commercial Technology Management Team and a member of the Commercial Technology Division in OAST. "All of us must be involved in technology transfer," he said. "We are a Cold War agency and the Cold War is over. We must push knowledge out of the Agency, and from contractors, to the general public." His prepared remarks follow:

Over the past two years a NASA-wide team, the NASA Commercial Technology Management Team, dedicated itself to reinventing how NASA maximizes its contribution to the nation's economy through technology investments. Last July, Administrator Goldin approved the team's strategic plan titled "NASA Commercial Technology: Agenda for Change." This presentation reviews the team's reinvention process and progress.

The first issue the team addressed was leadership. Successful technology commercialization involves NASA technologists (the knowledge "owners") at field centers interacting with industry technologists (the knowledge "seekers"). Success, therefore, requires that the majority of activity must occur between a field center and a firm. However, NASA's traditional approach was a technology transfer process centered at Headquarters in Washington, with minimal field center participation. The Agenda for Change changed this. It established a field center-led program with increased resources for marketing, business practices, metrics, training, and an electronic network. In addition, it delegated authority and responsibility for creating commercial technology partnerships with industry on each NASA program and technical organization.

These changes are consistent with the National Performance Review's requirement that NASA devote 10 percent to 20 percent of its budget to R&D partnerships with industry. The team recognized two prerequisites to meet the NPR requirement. First, the agency must understand the commercial value embedded in its technology investments. This knowledge will enable managers to actively seek partnerships with industry. Second, we must be able to track these partnerships. Since such a management information system does not exist, the team is creating one. "TechTracS" will integrate existing financial and procurement data and serve as an inventory of all NASA technologies, including those with potential commercial value. It will be a record of commercial technology partnerships and will enable future assessments of the partnerships' contributions to the economy. The most important aspect of this system is that each Associate Administrator will be responsible for assessing and reporting on his or her respective technology investments.

As the team delved deeper, it recognized a fact that has been overlooked in most technology transfer discussions: as measured by budget, 90% of NASA's investment in technology flows through procurement actions, hence 90% of NASA technology knowledge "owners" are not civil servants! The knowledge "owners" are the contractors, grantees, and others working for NASA. They, too, must establish commercial technology partnerships, or commercialize the technology themselves. This recognition places a new obligation on NASA managers to manage their programs such that our contractors and grantees are motivated to develop commercial technology partnerships as part of the technology programs in which NASA is both the customer and sponsor—and do so while accomplishing the mission's goals. This task is not as daunting as it seems. First, the top 25 contractors are responsible for over two-thirds of NASA's total investments. By successfully modifying our working relationships with these companies we will affect the majority of our technologies. Second, by establishing these partnerships at the inception of a project, the manager will increase the likelihood of commercializing technology while maintaining appropriate program control.

Realizing the commercial potential of our technology investments while accomplishing NASA's aeronautics and space missions is a challenge. It requires a new way of doing our business, a new way of managing our programs. Successfully performing the Commercial Technology Mission will demonstrate that the taxpayer's investment in NASA is an investment in the nation's future for aeronautics, space, and U.S. economic competitiveness.

The Future of Technology Policy

by Steve Moran

Steve Moran is with the White House Office of Science and Technology Policy. His wide-ranging topic dealt with "The Future of Technology Policy, Agency Collaboration and the Restructuring of the Federal Laboratory System."

Moran began with an overview of the Administration's science and technology initiatives, including the restructuring of the International Space Station and the Advanced Technology Program. "The space station is restructured but saved," he said, "and it is very important we maintain it." He added: "International cooperation is crucial in the future of lower budgets." With the Russians brought on board as full partners, Moran felt it was also necessary for the Department of Defense, the Department of Energy and NASA to collaborate to meet national needs, such as joint use of facilities and joint efforts.

"Commercial space is becoming a reality," Moran stated, pointing to the once mainly military and now mainly commercial use of the Global Positioning System for ship navigation, air traffic control and mobile communications. "By 2005, this will be a $5 billion-a-year industry," he predicted, noting its potential in direct broadcast television services. He lamented our ground based hybrid of fiber optics, copper and coaxial cable communications. "Emerging nations can leapfrog us" if we do not agree on a National Information Infrastructure.

These and other Administration initiatives were expected to be unveiled in a Presidential Directive slated for January 1996. Besides new directions for a national space policy, building and construction initiatives and advances such as enhancements to the World Wide Web White House Home Page, the directive will focus on transportation infrastructure in a $70 billion research and development proposal. The Advanced Technology Program under ARPA, for example, will be a "high priority" since the U.S. civil aircraft market has lost a 30% share to a company, Airbus, that did not even exist 15 years ago.

"Faster, better, cheaper has a lot of support in the Administration," Moran stated, but the new Republican majority threatens not only new science and technology initiatives, but also existing high tech programs. "The reality is grim for R&D in S&T," he said, noting that "Japan now invests more in R&D than the U.S." while the Congress "erroneously labels it as 'corporate welfare.'"

During open discussion, Moran failed to provide a satisfying answer to the question: "Why the [recently announced] $5 billion cut in NASA's budget?" Another comment suggested we are not in a Cold War but a Technology War instead. Agreement did seem to emerge around the statement that "science may be the engine of economy, but technology is the driver."

Project Management Development Process (PMDP)

by Dr. Edward J. Hoffman

PPMI Program Manager Ed Hoffman outlined the new NASA Project Management Development Process. Two years ago, PPMI sponsored a study of career paths at NASA, interviewing 150 people and groups at system and subsystem levels, asking them: What is required for excellence in project management? The results are charted on the next two pages, under Requirements and Core Training. This led NASA senior management to support the first NASA-wide formal development process for project management.

During visits to each NASA Center, Hoffman and General Spence "Sam" Armstrong, Associate Administrator for Human Resources and Education, uncovered only one sticking point: that career development for project management should not become a "certification program," neither a barrier nor a guarantee, but rather a professional career opportunity. As a result, the project management development process is designed to be voluntary (not selected into it), non-bureaucratic (with a minimum of paperwork), and fair to all who participate. General John R. Dailey, Acting Deputy Administrator, announced his support for the process shortly after the program.

Armstrong and Hoffman were then featured in a 14-minute video on the "Project Management Development Process." (This tape, as well as indepth handbooks describing the process, is available through all Center training or project offices. In addition, interested individuals can contact Ed Hoffman at (202) 358-2182 to discuss the PMDP.) Four levels, as depicted on the chart, were explained, along with the development system.

Hoffman noted that this is a process, not a program, because it is ongoing, even for senior managers. In a question-answer session, a participant wondered aloud, Why go through this when agencies are downsizing? Hoffman replied that the world may be in continuous change for a long time, and that development opportunities make people more valuable on the outside, too. "In addition, the development process is the right idea at the right time. We have received much interest from within NASA, as well as from industry and other government agencies." He added that both a manager's guide and a participant's guide to the process would be available in a week. "We tried to get fairness in the structure," he noted, "and put down on paper what was identified by members of the project management community."

Requirements (knowledge, skills and abilities, experiences and other characteristics) for effective performance at the four levels of program and project management follow on the next two pages.

Career Development for Project Management

	LEVEL ONE — REQUIREMENTS	LEVEL TWO — REQUIREMENTS
Organizational Knowledge	All of the following: • NMI 7120.4 • Mission operations policies, processes and organizational aspects • NASA Project Life Cycle	• Developing and overseeing Agency or multi-installation mission operations conceptualization, training, testing, review and implementation (O) • Knowledge of NASA's political environment (E)
Technical	• Hands-on hardware/software/operations (R) • Configuration management systems and procedures (R) • Quality assurance (R) Three of the following: • Systems engineering (design, development and integration) • Operations research • Systems performance and testing • Ground system configuration, plans and procedures • Breadboarding • Performance analysis • Construction of facilities process • Engineering fabrication process • Materials selection • Knowledge of logistics	Two of the following: • Designing and developing hardware/software • Testing and reviewing hardware/software • Systems performance and testing • Overseeing the creation, maintenance, and reporting of data/records regarding the verification of hardware and software items
Technical Management	• Reviewing other engineers' work	Two of the following: • Managing contractor technical work • Supervising hardware/software implementation • Integrated Logistics Support (ILS) planning and implementation • Managing people
Project Life-Cycle and Program Control	All of the following: • Knowledge of budget cycle and process • Knowledge of program flow • Work breakdown structure definition • Knowledge of scheduling process and tools	• Budget creation and management (R) All of the following: • Cost estimation and control (balancing costs with schedule and performance, controlling money, measuring earned value, etc.) • Projecting the effects of program/project changes on life cycle costs • Work breakdown structure definition • Scheduling process and tools • Requirements definition and documentation • Program Operating Plan (POP) development
Contract/Acquisition	• Knowledge of contract administration (contract types, role of COTR, procurement law, SOW preparation, etc.) (R)	All of the following: • Contract administration (contract types, role of COTR, federal procurement law, SOW preparation, etc.) • Involvement in evaluating contractor progress in light of project characteristics (schedule, cost, etc.) • Involvement in general management and execution of systems engineering in conjunction with the contractor team • Designing an acquisition management approach, including advance planning and post award contract management
Individual and Team Development	All of the following: • Communication (verbal and written): reports, presentations, listening • Participation in team problem solving activities • Reading to continuously update technical knowledge	All of the following: • Knowledge of human motivation and small group dynamics • Knowledge of NASA personnel system • Participation in team problem-solving activities • Delivering presentations • Writing reports, requirements, SOWs, etc. • Leading teams (setting direction, managing work, motivating workers)
Agency, Business and International Relations	• Knowledge of issues in intra/inter-center relations (R)	All of the following: • Knowledge of business management and its relationship to government • Knowledge of issues in inter-agency and international relations
Risk Management and Safety	One of the following: • Knowledge of probabilistic risk analysis • Safety and risk management processes, strategies and requirements	Two of the following: • Knowledge of probabilistic risk analysis • Knowledge of risk management processes and strategies • Identifying and evaluating risks
	Core Training Task Management (R) Systems Engineering (R) Management of Major System Programs and Projects (R) Crossing Department Lines (O) Installation-level Professional Development Program (O) Program Control Overview (O)	**Core Training** Project Management (R) Program Control Overview (R) Installation Leadership Programs (O) Professional Development Program (O)

KEY

(O) = Optional
(R) = Required
(E) = Encouraged

Career Development for Project Management

	LEVEL THREE	LEVEL FOUR
	REQUIREMENTS	**REQUIREMENTS**
Organizational Knowledge	• Knowledge of NASA's political environment (R) • Strategic Planning (E)	All of the following: • Knowledge of NASA's political environment • Strategic Planning
Technical	Maintain knowledge of technical state-of-the-art concepts and techniques (R)	• Maintain knowledge of technical state-of-the-art concepts and techniques (R)
Technical Management	Four of the following: • Coordinating and overseeing the identification of systems engineering design issues • Oversee total system trade-off and design • Management of designing engineering products and fabrication processes • Managing total contract • ILS planning and implementation • Customer interface and management	• Ensure projects are managed consistent with NMI 7120.4 • Knowledge of program system/requirements • Interface with program office
Project Life-Cycle and Program Control	Three to five of the following: • Assessing affordability and ensuring consistency with Agency requirements • Projecting the effects of program and project changes on life cycle costs • Preparing a Program Operating Plan (POP) • Maintaining fund data • Developing and monitoring master schedules	All of the following: • Budget creation and management • Developing and monitoring project schedules • Project control and oversight – Total project accountability – Lead formulation of project – Advocacy – Ensure mission success – Interfacing with all project implementation organizations and Headquarters
Contract/Acquisition	Three of the following: • Contractor management (establishing realistic procurement plans, proposal review, contract negotiation, etc.) • Acquisition management policies and procedures • Designing an acquisition management approach • Linking acquisition management to control gates of NASA project life cycle • Contractor management • Monitoring contractor progress using contractor-provided financial reports and project execution (performance) information	• Determining award fee (R) • Managing the entire acquisition process (R)
Individual and Team Development	All of the following: • Knowledge of NASA training and career development systems • Knowledge of NASA personnel system • Teamwork (including team selection, rewarding, participation, empowerment and conflict management) • Managing people (including recruiting, developing, coaching and evaluating) • Delegating responsibility and authority • Planning (such as contingency, resources, roles and plans) • Decision making • Creative problem-solving and trouble shooting • Conflict management and resolution	Management of human resource and organization system development to ensure the following: • Knowledge of formal training courses and programs available for employees • Teamwork (including team selection, rewarding, participation, empowerment and conflict management) • Managing people (including recruiting, developing, coaching and evaluating) • Delegating responsibility and authority • Planning (such as contingency, project, strategic, resource and meeting) • Negotiating and compromise (on requirements, resources, roles and plans) • Decision making • Creative problem-solving and trouble shooting • Conflict management and resolution
Agency, Business and International Relations	All of the following: • Business management in government • Working across installation and organizational lines • Public relations strategies	All of the following: • Working across Agency, field installation, and international lines • Handling the press
Risk Management and Safety	One of the following: • Compiling a risk management plan • General oversight of a Safety Management Plan • Safety requirements and related design requirements	• Providing general oversight of risk and safety issues, procedures and programs
	Core Training Advanced Project Management (R) Source Evaluation Board (O) Management Education Program (O) Managing the Influence Process (O) SES Candidate Development Program (O)	**Core Training** Executive Project Management Conference (O) Senior Executive Program (O)

KEY

(O) = Optional
(R) = Required
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The PMDP is based on an extensive study of successful project and program managers in NASA. Indeed, the information from that study is the basis of the guidance and models for individual development that make up the PMDP.

The Process is a systematic one that recommends specific skills for persons at every level of accomplishment. To identify the specific skills one needs, the PMDP provides an assessment process and a set of benchmarks. These involve discussions and assessments with a mentor and one's supervisor, in addition to personal determinations using a model of the desired course of professional advancement.

The PMDP is currently being inaugurated at all NASA centers. If you are interested, contact your center's training office and ask for the officer in charge of the PMDP. Also, you can call Ed Hoffman at (202) 358-2182 for information pertaining to the process.

For an online description of the process and assistance in getting involved and progressing, connect to Headquarters Code FT's homepage at: http://www.hq.nasa.gov/office/HR-Education/training (please note that the address is case sensitive and that the HR-E are the only caps.)