KEYNOTE SPEECH

STRATEGIES IN TRANSITION

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I'm very pleased to be here. As experts from around the world in mission operations and systems, the task facing you here at the Second International Symposium — to exchange information and ideas, share technology advancements, and discuss ways to increase efficiency — has never been more important. One reason is that this year has been the most vigorous for space science in decades, with more missions launched than at any time in over 20 years, and many with great international cooperation. A second reason is that a new vision has emerged within the Office of Space Science and Applications (OSSA), and within the agency as a whole, for how to design missions to be responsive to the changing budget environment of the 1990s. I thought that it would be helpful to open this symposium by giving you a context for your discussions, some sense of why and how the vision has changed, and what strategy OSSA is implementing to achieve these new objectives.

Let me begin by providing some sense of how the environment in which we do business has changed. For most of the 1980s, the National Aeronautics and Space Administration (NASA) enjoyed very healthy budget growth. Between 1983 and 1992, NASA's budget doubled — from $7 to $14 billion. Over the last few years, however, we began to feel the squeeze of competition for constrained Federal resources as a bad Federal funding environment worsened. The 1991 budget agreement — which established walls between domestic discretionary, defense discretionary, and foreign assistance accounts — effectively prohibited NASA from sharing in any peace dividend. It also placed NASA in direct competition with other domestic programs — such as aid to American veterans or housing programs — for very limited resources. Fiscal years 1992 and 1993 were very difficult budget years. Even Mission Operations and Data Analysis (MO&DA), which is a budget category on the rise with all the missions we are flying, suffered as part of the exercise of balancing the books. Nineteen ninety-four and 1995 will clearly bring more of the same, and in MO&DA, as well as in program development, there is a need for finding efficiencies in the near-term and making investments for more cost-effective operations in the long term.

Prior to this new environment, OSSA's strategic planning activities assumed budget growth of more than 10 percent each year. As our Congressional committees made it clear that the rate of growth that nearly doubled OSSA's budget in five years would not continue, the Space Science and Applications Advisory Committee (SSAAC), as part of its activity of reviewing OSSA's strategic plan in summer 1991, evaluated what changes would be required to keep expected growth in line with reality. Table 1 provides an overview of OSSA's 1991 strategic plan core science program.

While SSAAC reaffirmed the importance of most missions already in development, such as Comet Rendezvous Asteroid Flyby (CRAF), Cassini, the Advanced X-Ray Astrophysics Facility (AXAF), and the Earth Observing System (EOS), the committee made the far-reaching recommendation to emphasize smaller missions, with more frequent access to space and a greater role for the research community external to NASA. The Orbiting Solar Laboratory and Space Infrared Telescope Facility were deferred. SSAAC created the intermediate category of missions to characterize the new leaner and more focused class of science missions. It also established two mission queues — one for intermediate and flagship missions and one for small missions — to further insulate the small missions from the effects of shortfalls in funding.

Table 1. Core Science Program: 1991 OSSA Strategic Plan.

Year	Ongoing Program	Major and Moderate Missions	Small Missions	Space Station Freedom Utilization	Research Base Enhancements
1989	Research and analysis	Advanced X-Ray Astrophysics Facility	Scout-class Explorers	Microgravity facilities 1.8-m centrifuge Attached payloads Earth Observing System payload definition	SETI Microwave Observing Project CRAF/Cassini advanced technology development Supernova 1987A suborbital observation ER-2 purchase
1990	Mission operations and data analysis	CRAF/Cassini	Total Ozone Mapping Spectrometer	Space Biology Initiative definition Earth Observing System payload definition	Research and analysis; missions operations and data analysis corrections
1991	Aerospace medicine Flight projects	Earth Observing System	Earth Probes	Space Biology Initiative Biomedical monitoring and countermeasures	
1992	Spacelabs and other carriers		Earth Probes augmentation		Resources to augment research community Data Revitalization Initiative Studies of mesosphere and lower thermosphere
1993 through 1997		Orbiting Solar Laboratory Space Infrared Telescope Facility Lunar Observer Gravity Probe-B Solar Probe	Microgravity fundamental science	Small and rapid-response payloads	Stratospheric Observatory for Infrared Astronomy Focused research and analysis; suborbital, advanced technology development; data systems enhancements

Even as SSAAC and OSSA tried in late 1991 to flesh out a new strategy, the budget environment worsened, leading to a period of further retrenchment. The environment of constraint led to a number of very difficult decisions for OSSA as well as major restructuring of a few key programs in development. As you know, NASA was forced to recommend the termination of the CRAF mission. The decision was based on the savings that would be attained over the life of the program, particularly in the peak years of 1994, 1995, and in the outyears. The termination of the Magellan mission at the end of 1993 was another difficult decision imposed on OSSA by the environment of constraint.

In addition to these specific program decisions, we had to look at the overall space science and applications program, restructuring the most expensive and complex projects to bring down costs and ensure their place in the mission queue of the future.

First, after CRAF was canceled, we looked very closely at the Cassini program to see how it could be made more secure for future funding cycles. We were successful in rescoping the program to reduce development costs as well as total project costs, while maintaining a world-class science program. The mission now relies on a simpler, lighter spacecraft with body-fixed instruments. The launch schedule has not changed. In fact, now that spacecraft weight has been reduced, the launch strategy is more resilient.

AXAF is another good example of how we are restructuring the largest missions to be leaner and more focused. While we preserved virtually intact the science mission for AXAF, we reduced mission complexity and restructured the program into two smaller, complementary spacecraft, with comparable imaging science and better observing efficiency than the baseline mission, and with lighter, simpler, and less expensive mirrors to be used for spectroscopy. Lighter, simpler, and less expensive — this is the theme of the new environment. The result will be a mission that will likely fly earlier than the original facility, and excellent science will be returned while funding requirements, particularly for peak years, are reduced.

Restructuring was not limited to the traditional space sciences. EOS is the principal element of NASA's Mission to Planet Earth and NASA's contribution to the U.S. Global Change Research Program. It carried an original price tag of $17 billion through the year 2000 and became another target of restructuring. NASA is going to realize substantial savings by using a common spacecraft design after the first spacecraft, by relying on greater international cooperation, and by pursuing other efficiencies in engineering and analysis. The total development cost has been reduced to $8 billion. The original science objectives and schedule are intact.

In the 1993 budget, OSSA's efforts met with success — EOS and Cassini were fully funded, and AXAF nearly so. Development costs have been reduced substantially in these programs.

Regardless of the savings in some of these programs in development, the challenge of reducing operations costs for all OSSA missions, existing projects as well as new, remains before us. Recently, we appointed a team to study ways of decreasing costs in mission operations by up to 15 percent in five years, an exercise similar to that conducted by the Space Shuttle people to decrease costs by 3 percent, 6 percent, and then 9 percent within three years. The OSSA team looked at individual programs to see how operations management could be made more efficient. Many cost-cutting approaches were identified, and the team, now in the implementation phase, is beginning to put the first of them into effect.

All the hard work in the last year or two to restructure some of OSSA's largest programs in development and to improve efficiency for those in operation is part of OSSA's effort to free funds for more frequent space science missions in the future. Instead of more great observatories, we are looking toward a new vision encompassing a level of great activity through small, frequent missions. What we've learned over the last several budget cycles is that in this new environment, we need a highly flexible program that fits into a continuous, smooth level of effort, without a huge bell curve of funding requirements over peak years. There is excellent science return to be gained by this approach in that it will allow for more rapid development, more frequent flight opportunities, and more focused scientific objectives. It will also allow continued access to deep space, which appeared to be increasingly threatened when large programs met funding constraints.

We are now hard at work on implementing the strategy for attaining this vision. The strategy we developed was to lower costs by reducing size and complexity through new technology, while at the same time making progress in space science. The strategy comprises two interwoven parts: the flight program strategy of each of the science disciplines and OSSA's new-technology strategy.

The flight plan component of the strategy is that every science discipline will have a flexible, low-cost set of missions to carry out its science objectives. This set of quicker, cheaper missions serves several purposes: to increase the flight rate to fill the data gaps between larger missions; to increase university and industry participation in the science programs; to provide opportunities for collaboration with other agencies and with our international partners; and to allow for rapid response to new science opportunities that emerge.

NASA has a long history of success with smaller missions, and in fact, the new strategy builds on many programs already in existence in OSSA. The goal is to expand the small-mission programs already in place and to initiate new ones using those successful models. Table 2 shows OSSA's small-mission programmatic strategy.

The Small-Class Explorers (SMEX) program is an excellent example of a program already in place that fits with the new strategy. SMEX physics and astronomy payloads are modestly sized, modest-capability payloads of up to 500 pounds. They provide the astrophysics and space physics programs with a quick-reaction research capability and frequent launch opportunities, and the relatively short development time for SMEX missions allows for the exploration of new science areas

Table 2. OSSA Small-Mission Programmatic Strategy.

Status	Astrophysics	Space Physics	Solar System Exploration	Earth Sciences	Microgravity and Life Sciences
Existing	Explorers SMEX	Explorers SMEX		Earth Probes	Middeck payloads SMIDEX Small and rapid-response payloads
New	UNEX	Space physics smallsats	Discovery program MESUR Outer planet probes	Second-generation Earth Probes	Space Station Freedom EXPRESS

and special-topic investigations. The first of these, the Solar, Anomalous, and Magnetospheric Particle Explorer (SAMPEX), was launched this past July to study cosmic rays. This Explorer was developed within three years at a cost of $35 million. Two other small Explorers are already in development, one for launch in 1994 and one in 1995.

The astrophysics and space physics programs were both using Delta-class explorers before this new strategy was conceived. The Explorer program was designed to target specific science objectives on limited missions. The program as a whole is cost-capped on an annual basis. It has resulted in the launch of almost 70 missions. The Extreme Ultraviolet Explorer launched this year was in development well before SSAAC began articulating its recommendations for emphasizing smaller missions.

The Earth science community also put this concept to work before this year. The Earth Probes program, also Explorer class, is a series of small and moderate-sized missions designed to address highly focused problems in Earth science. This program will provide for the collection of long-term global change data sets prior to the launch of EOS. Each free-flyer instrument has a specific purpose, providing critical measurements of specific phenomena. An example is the Total Ozone Measurement System (TOMS), which will measure total ozone concentrations.

We also created the capability for focused experimentation in the microgravity and life sciences at reduced cost and with greater frequency. The Middeck Payloads program provides accommodations in the middeck of the Space Shuttle for investigations that require limited physical resources. This program takes advantage of the unique capabilities of the Orbiter, including the ability to support late installation or early retrieval of samples or equipment (often particularly important for life sciences and microgravity science experiments). Middeck payloads involve lower costs and shorter lead times; the level of effort is somewhat similar to sounding rocket activities in terms of scope and flight frequency, but with much longer operational periods.

The Spacelab Middeck Experiments (SMIDEX) program is a similar activity. It provides racks inside the Spacelab module that convert to locker accommodations for small experiments. This rack uses a standard interface that is similar to that used on the middeck, which means that experiments can be mounted in either the Spacelab or the middeck, depending on where space is available, without reconfiguring the equipment. SMIDEX offers the same advantages as middecks, such as late access.

Also in place before this year were interdisciplinary research opportunities that are low cost and allow quick response. For example, NASA's sounding rocket program, which I mentioned a moment ago, has logged nearly 2,500 flight missions since 1959 and is an increasingly important means of achieving space science objectives. The sounding rocket program provides about 40 flight opportunities per year to space scientists in Earth science, space physics and astronomy, and microgravity research.

But over the course of the past year, OSSA has redoubled its efforts to embark on a new strategy, and this new strategy is building on those successes. A second generation of Earth Probes is in development, as are numerous missions under the SMEX and Explorer programs. The University-Led Explorer (UNEX) program is modeled after the SMEX program but will provide additional cost savings by incorporating an enhanced role for the academic community in program design and management.

In space physics, we find another excellent example of our new strategy, the Thermosphere–Ionosphere–Mesosphere Energy and Dynamics Mission (TIMED). This mission can be accomplished on two Delta-class spacecraft. However, if the instruments could be flown on five small but common satellites, there would be a substantial increase in robustness and flexibility and a reduction in overall cost. We are evaluating the potential of using a common bus, particularly Lightsat technology, to get up and running quickly (hopefully a 1998 launch) and at less cost. I expect this strategy to be expanded to encompass many, if not all, of the other moderate space physics missions recommended by SSAAC in 1991.

There are several planetary programs in development. The Discovery program is a new initiative for low-cost missions to study the inner planets. Like the other series of Explorer-class missions, the Discovery program minimizes costs by emphasizing a focused science return achieved with the simplest possible spacecraft, science payload, and mission designs. Mars Environmental Survey (MESUR) Pathfinder is a promising candidate for the first in this series; the long-studied Near-Earth Asteroid Rendezvous mission also falls into this category.

A series of missions to the outer planets will also be possible under the new strategy. The Pluto Flyby, for example, will be the lightest weight, lowest power spacecraft possible, to achieve the shortest possible trip time. The development of the Pluto Flyby mission will be one of the first to incorporate the new-technology infusion policy, the second integral piece of OSSA's new strategy, which I will highlight in a few moments.

The MESUR Network is another good example in the planetary program. A series of 16 small landers that will study the atmosphere and soil of Mars will be dispatched through multiple launches over a four-year period. The risk is greatly spread out — no one launch can impact the entire program, and in the case of a failure of a lander, the network will continue to be viable.

We are also looking at how to conduct high-quality investigations aboard Space Station Freedom in the quickest, most efficient manner. Two components of current planning in microgravity science are good examples. One is the development of standardized drawers or middeck lockers integrated into multiple payload racks, which will greatly reduce the complexity of integrating hardware for specific investigations. Secondly, a study is being conducted on a new type of rack called EXPRESS — Expedite the Processing of Experiments to Space Station. This effort is designed to simplify on-orbit changeout for individual experiment modules. Sub-rack payloads (which now constitute 64 percent of the total) can be integrated with minimal resource and crew training requirements by using precertified hardware and a standard integration process.

Tightly interwoven with these new and existing flight plans will be OSSA's new-technology strategy, the second component of the strategy for implementing our new vision. In the past, to conduct a mission at the least possible cost, off-the-shelf technology (that is, technology developed for other purposes) was applied to the development of new spacecraft and systems. With fewer new technologies being developed by the Department of Defense and other agencies, there is limited, if any, off-the-shelf technology to be used by the space science program. We now have to develop our own new technologies to remain state of the art and achieve our science objectives.

Testbeds are a critical component of our technology strategy for complete laboratory evaluation of spacecraft and instrument system improvement. We will reduce costs by developing generic testbeds at JPL and NASA Goddard Space Flight Center. Currently, testbeds are created on a program-specific basis — for example, testing the Cassini spacecraft. We are now going to develop testbeds that will survive individual programs, becoming permanent facilities, to allow for technological upgrades on an ongoing basis — essentially a product improvement program.

Flight opportunities for technology evaluation are also critical in the new-technology strategy. Flight opportunities will become available aboard spacecraft and also through the use of expendable launch vehicles (ELVs). The MESUR Pathfinder mission is the ultimate spacecraft opportunity — it will serve as a technology and engineering testbed for the MESUR Network program and will hopefully include a newly developed microrover. The ELV technology infusion program is a cooperative effort between NASA, the Air Force, and industry, whereby technologies that reduce cost and increase reliability and operability are funded for development by industry for infusion within one to two years. Secondary payloads aboard ELVs, developed to meet a prelaunch integration schedule of as little as nine months, will provide other opportunities to evaluate new technologies in flight.

The result of this new-technology policy is that each mission will contribute to the advancement of spaceflight technology, to ensure that new technologies continue to become available for use on future OSSA missions. These new technologies will be new designs or techniques applied not only to spacecraft but also potentially to instruments, propulsion systems, launchers, software, and, most importantly to this audience, ground operations. The technologies must significantly improve cost, performance, or reliability and must never have flown before. The strategy is that each new technology will become available to use on future OSSA missions.

The implementation of the flight program and technology strategies that I've outlined for you this morning will result in a launch manifest that reflects a substantially increased flight rate for space science missions. It will lead to focused, well-defined science missions, many of which will close specific gaps in research remaining from the large missions of the past. It will also provide the scientific community in all the space science disciplines with predictable and frequent access to space, including deep space, in spite of the highly constrained fiscal environment. And finally, it will establish NASA's leadership in the emerging technologies of small, capable spacecraft.

One can picture a very robust launch schedule as a result of this new strategy. For example, a successful implementation would yield

- A Small Explorer launch each year.
- A Delta-class Explorer launch every other year.
- A UNEX launch each year.
- A small mission to the inner planets, under the Discovery program, every other year.
- A MESUR launch at every Mars opportunity, or approximately once every other year.
- A Pluto Fast Flyby mission followed by small outer planets missions every other year.
- An Earth Probes launch each year.
- Microgravity and life sciences missions on Spacelab and Space Station Freedom with a frequency equivalent to more than three Space Shuttle missions each year.
- A continuation of the current average of one intermediate or major mission per year.

These launches will represent a very significant level of activity each year in space science, rivaling 1992 with nine to twelve per year. And we will be able to adjust the total launch rate per year very easily as resources allow.

The overall purpose of all OSSA's efforts to date has been to free resources for maximizing the space science program in a tough fiscal environment. It should be clear that what I've said here this morning characterizes an environment in which, in addition to changing the way we design missions and develop new technology, continuous improvement in operating systems will be required. We no longer have the resources to simply multiply our operating cost by the number of spacecraft that we launch. MO&DA is coming under the same budget pressures as are the programs in development — there are growing requirements, but a flat level of resources available, which means that the MO&DA share of the total OSSA program is likely to decrease. This will mean that we must look for and implement approaches for improving efficiency across the board.

The challenge to you, therefore, is to make yourselves and your specialties part of the solution rather than part of the problem. Investments in new operating systems will continue to be difficult to justify without any demonstrable contribution to these goals. But that depends on you. No one knows better than you where improvements can best be made to ensure program viability well into the future.

I hope your efforts at this symposium are productive and rewarding. We at OSSA look forward to seeing the results.

Thank you.