

THE NASA OFFICE OF SPACE SCIENCE EDUCATION AND PUBLIC OUTREACH PROGRAM

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ABSTRACT

Over the past six years, NASA's Office of Space Science has implemented what may well be the largest single program in astronomy and space science education ever undertaken. The program goals include the public sharing of the excitement of space science discoveries, enhancement of the quality of science, mathematics and technology education, particularly at the precollege level, and supporting the creation of our 21st century scientific and technical workforce. This paper provides an overview of the program origins, policies and philosophies, and describes the development and growth of the program. Program accomplishments and the challenges that remain are discussed along with potential opportunities for international collaboration.

INTRODUCTION

Education and contributing to the public understanding of science have long been important components of NASA's mission dating to the 1958 Space ACT which created NASA. The current NASA Office of Space Science (OSS) education and public outreach (E/PO) program really began with work done by the Space Telescope Science Institute in the early 1990's to share the wonder of the Hubble Space Telescope scientific discoveries. More recently, education at NASA has gained significant additional prominence with its elevation to the level of an Agency Core Mission as expressed in the 2002 NASA Mission Statement.

- To understand and protect our home planet;
- To explore the Universe and search for life
- To inspire the next generation of explorers
...as only NASA can.

The mission "To Inspire the Next Generation of Explorers" encompasses all of NASA's education activities to 1) inspire and motivate students to pursue careers in science, technology, engineering, and mathematics and 2) engage the public in shaping and sharing the experience of exploration and discovery. The OSS E/PO program is well aligned with these new Agency goals and expects to make major contributions toward achieving them.

The quality of the U.S. educational system has also long been an area of public policy debate. In recent years concerns over the interplay of education and our country's future economic and national security has received considerable attention. Excerpts from *Road Map for National Security: Imperative for Change* [The United States Commission on National Security/21st Century, 2001] indicate:

- The capacity of America's education system to create a 21st century workforce second to none in the world is a national security issue of the first order. As things stand, this country is forfeiting that capacity.
- Education is the foundation of America's future.... Education in science, mathematics, and engineering has special relevance for the future of U.S. national security, for America's ability to lead depends particularly on the depth and breadth of its scientific and technical communities.
- The health of the U.S. economy, therefore, will depend not only on professionals who can produce and direct

innovation in a few key areas, but also on a populace that can effectively assimilate a wide range of new tools and new technologies.

- The American educational system does not appear ready for such challenges...

NASA recognizes its broader responsibilities to education and the unique contributions that it can make. *Science in Air and Space: NASA Science Policy Guide* [NASA, 1996a] states –

“Both the public and the political system expect benefits broader than purely scientific ones to be derived from NASA research programs and missions...There are two particular areas in which NASA and the NASA-supported research community can make especially significant contributions:

- Education and raising the general level of public understanding and appreciation of science and technology;
- Developing advanced technology in support of NASA’s science missions and research programs which also has uses beyond the space program, thereby contributing to the country’s technological base and its long-term economic competitiveness.”

With respect to education the document then goes on to say:

“It is NASA policy to use its space research missions and research programs and the talents and resources of its research and development communities to make significant and measurable contributions to meeting national goals in the reform of science, mathematics, and technology education, particularly at the precollege level, and the general elevation of scientific and technological literacy throughout the country. NASA will implement this policy by formally making education and public outreach integral components of ground-based and space flight research conducted by NASA and NASA-supported scientists throughout the country.”

“The economic vitality of our nation depends increasingly on new scientific knowledge and its application. For NASA, this means ensuring that the ideas and capabilities of the widest possible talent pool are brought to bear on its missions.”

“The responsibilities of scientists must include explaining scientific results to the public and communicating the role and importance of science and technology in contemporary society.”

As noted earlier, the NASA OSS Education and Public Outreach program is part of a larger NASA effort in education. As expressed in the FY 2000 OSS Strategic Plan [NASA, 2000], OSS has sought to support the Agency through specific programs designed to use space science and the space science research community to share the excitement of space science discoveries with the public, enhance the quality of science, mathematics and technology education, particularly at the precollege level and help create our 21st century scientific and technical workforce. The program is designed around the unique contributions that OSS and NASA can bring to education – the science and the scientists.

The body of this paper provides background and details on the approach used in creating the OSS Education and Outreach program – an effort that is now believed to be the single largest program in astronomy and space science education ever undertaken.

BACKGROUND

Development of OSS E/PO Policy, Strategy and Implementation Principles

The first critical steps in creating a formal OSS E/PO program were taken beginning in late 1993. Drawing upon a diverse cross section of national leaders representing scientists and science educators, science centers and planetariums, state education departments, universities, and NASA Centers, an education and public outreach strategy and set of implementation principles were collaboratively developed over the next two years. Guiding the entire planning effort were a number of observations about NASA OSS, the educational community it desired to impact, and the space science community it desired to engage that were fundamental to shaping the subsequent program. These basic operational principals, included the need for the OSS program to:

- Coordinate with NASA’s overall effort to support the national education agenda;
- Support current national and state efforts of systemic education reform and the establishment of national standards and benchmarks;
- Emphasize, wherever possible, active, experiential involvement in NASA research programs and missions for both teachers and students;
- Use outside advice from the scientific, educational, and minority communities in the planning, development, implementation, and assessment of all our education and outreach activities;

- Tie into existing programs for women and minorities and, in doing so, contribute to the education and training of groups currently underrepresented in technical disciplines;
- Conduct regular tests and assessments of impact and effectiveness;
- Make educational materials and the results of our education and public outreach programs as widely available as possible using both existing dissemination mechanisms and new information technologies;
- Maintain a focus on excellence as the standard for performance in all education and public outreach activities that are undertaken;
- Base all of OSS's E/PO efforts on collaborations between the scientific and education communities thereby drawing upon and marrying the appropriate expertise of the two communities.

The governing strategy [NASA, 1995] and implementation plan [NASA, 1996b] placed major emphasis on: helping scientists become involved in education/outreach through several actions:

- creating a network of brokers/facilitators (to be described later),
- providing opportunities for appropriate training, and
- removing contractual and other impediments to participation.

Attention was also given to the need to enhance the breadth and effectiveness of partnerships among scientists, educators, contractors, and professional organizations as the basis for education and outreach activities by:

- focusing on high leverage opportunities,
- building on existing programs, institutions, and infrastructure,
- emphasizing collaborations with planetariums and science museums,
- coordinating with other ongoing education and outreach efforts inside NASA and with other government agencies,
- involving the contractors in OSS's education/outreach programs,
- making materials widely available and easily accessible, using modern information and communication technologies where appropriate, and
- providing meaningful opportunities for underserved/underutilized groups.

Finally, evaluation for overall quality, impact, and effectiveness was highlighted as a crucial component of the overall strategy.

What is Different About the OSS Approach?

The NASA OSS approach to E/PO specifically recognized that the number of space scientists available to participate in E/PO would be completely inadequate to impact the national educational system. [There are only about 10,000 space scientists and over 100,000 schools across the country. Also the geographic distribution of space scientists is very nonuniform.] A departure from the traditional linear approach was needed. In the traditional approach the collective programmatic impact is simply the sum of a set of individual disconnected efforts. The approach OSS embarked on was to create a decentralized, highly networked system in which the impact of individual efforts could be greatly amplified. Amplification would be achieved through finding the key entry points into the education system and through archiving and disseminating nationally the best products and programs. A key to achieving these goals was to establish a Support Network of Broker/Facilitators and Educational Forums.

OSS E/PO Support Network

The first element of the OSS E/PO support network, "Broker/Facilitators" were conceived of as regional agents charged with helping to identify and catalyze high leverage E/PO opportunities at the local and regional level. This was a new concept developed to address a critical issue in realizing the OSS E/PO program. As described in the Education/Public Outreach Implementation Plan Chapter VII: *Help Scientists Become Involved in Education/Outreach*:

"OSS must do more than place a new requirement on the participants in the space science program. OSS must take active steps to help the scientific community become involved in education and public outreach—help in looking for high-leverage opportunities, help in arranging partnerships and alliances with educators, help in understanding what is now happening in education and what sorts of materials are appropriate for the classroom, help in removing impediments that get in the way of scientists participating in education and outreach even if an individual wants to do

so. A number of approaches are possible to providing such help.”

The Task Force viewed the Broker/Facilitator concept “as central to the systems approach being recommended for implementation of the OSS Education/Outreach Strategy. The job is going to be a difficult and demanding one requiring familiarity with the OSS program and scientific community, familiarity with the needs of the education community, links to the education system at many levels, and an aggressive approach to identifying high-leverage opportunities and arranging alliances.”

The other portion of the Support Network was to be comprised of a set of “Education Forums” aligned with the four NASA OSS research themes. The Forums were to provide the necessary sustained effort and long-term continuity required to effectively work with the education system—a continuity that could not be provided by short duration missions or activities undertaken as a part of individual research grants. Forums were to provide a “home base” for smaller missions so that each mission did not have to create its own infrastructure; play the role of national broker/facilitator for missions and research programs associated with particular OSS themes; work with the education community to develop educational programs and products suitable for national distribution; serve as a national archiver/disseminator for education/outreach programs and products; and create and maintain an accessible directory of education/outreach products and materials.

The integration and coordination of the activities of the Support Network and other participants in the OSS E/PO program was addressed through creation of the OSS Education Council. *From the OSS E/PO Implementation Plan:*

“Based on the previous recommendations, it is clear that close coordination of all activities and a strong interaction among the various institutions and organizations participating in the OSS Education/Outreach program must be achieved if the proposed approach is to realize its full potential. To achieve such coordination, the Task Force recommends that an OSS Education/Outreach Council be set up to assure optimized performance across the entire “Ecosystem”. Membership of such a group should include representatives from all of the key groups playing a role in the execution of this Implementation Plan—OSS, the NASA Education Division, the Office of Equal Opportunity Programs, the “Education Forums”, the broker/facilitator groups, and other appropriate participating organizations.”

Work undertaken through this group has addressed a number of critical OSS-wide issues that would not have been address through any individual program or mission. The Space Science Education Resource Directory [<http://teachspacescience.stsci.edu>] which is intended to provide a single place where educators can look for materials is an example of the work being undertaken through the OSS Education Council.

Funding

Adequate resources to conduct an effective national education and public outreach program were viewed as essential. The Space Science Advisory Committee Task Force that produced the OSS E/PO Implementation Plan, recommended that, as a long-term goal, OSS should plan to spend 1-2 % of its total budget on education and the public understanding of science. Elements to be funded would include: 1) education/outreach components of individual flight missions, 2) education/outreach components of individual research grants, 3) an OSS-wide program of small education grants, 4) a small number of major, high-profile education programs and projects, 5) a network of Broker/Facilitators and “Education Forums”, and 6) a program Evaluator. The predominant fraction of available funding was to be used to support individual or mission-oriented education/outreach programs and projects carried out across the country with the direct involvement of the OSS research community. All these recommendations have been implemented.

IMPLEMENTATION

Beginning in 1997, NASA OSS initiated its E/PO program. All new major missions research solicitations included requirements that E/PO programs be developed and funded at 1-2% of the mission cost. The E/PO program was specifically identified as a factor that would be considered in mission selection. In practice E/PO has actually been a deciding factor in a number of mission selections. A small grants program was begun to add supplemental funds for E/PO programs to individual research awards. Evaluation criteria for E/PO proposals were developed and an Explanatory Guide to the Evaluation Criteria [NASA, 2002] was created. Groups were selected as Broker/Facilitators and Forums.

Over the next five years the Support Network built important infrastructure for the E/PO program including processes to increase coordination of E/PO activities across missions, providing staffing and other support for education conferences and creating a valuable series of internal and external newsletters. An OSS E/PO Tracking and Reporting System was created to facilitate collection, analysis, and evaluation of E/PO program activities and products and compilation of an E/PO Annual Report [<http://ossim.hq.nasa.gov/ossepo>]. A process was developed and implemented

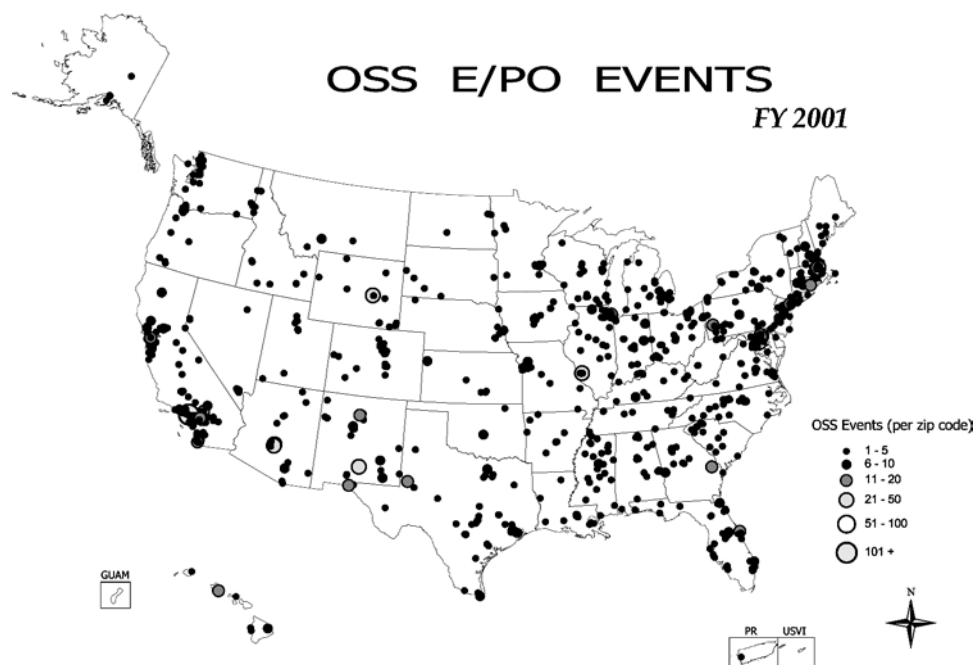
to conduct reviews of OSS E/PO products. Finally, as noted above, an organized approach to product dissemination was formulated which led to creation of an online Space Science Education Resource Directory [<http://teachspacescience.stsci.edu>] and the “Space Science Access” Informal Education Web site [<http://cfa-www.harvard.edu/seuforum/wateringHole/>].

Efforts to increase the involvement of minorities and underserved were initiated. Under the Minority University Initiative, 15 institutions were selected for multi-year funding to enhance their space science curriculum, faculty and outreach efforts. [Sakimoto, 2001]. Dialog with several Minority Professional Societies was begun to explore areas of common interest leading to their involvement in several mission E/PO programs.

CURRENT STATUS

The OSS Education and Public Outreach Annual Report for 2001 [<http://ossim.hq.nasa.gov/ossepo>] details over 400 E/PO activities and new products; nearly 3,000 discrete E/PO events, a presence in all 50 states, the District of Columbia, and Puerto Rico; a presence at 20 national and 36 regional E/PO conferences and more than 50 awards and other forms of public recognition received. The geographic reach of the OSS program is shown in Figure 1. Over 100 OSS missions and programs were involved with nearly 900 OSS-affiliated scientists, technologists, and support staff and nearly 500 institutional partners, including 180 science centers, museums, and planetariums, 40 precollege educational organizations, school districts and boards, and 24 minority colleges/universities. Preliminary analysis of the 2002 data shows substantial continued growth in the number and variety of activities and events being undertaken within the OSS E/PO program.

Fig. 1. Geographic distribution of OSS E/PO events in 2001.



In 2001, NASA OSS invested nearly \$35,000,000 in its E/PO program. Appropriately, one third went to formal education programs and products which focus on educators and students in the school classroom, one-third to informal education programs such as exhibits and shows provided through science centers and planetariums and one-third on public outreach activities such as public lectures, star parties and Web sites.

OSS's E/PO partners are also investing significant resources. As a consequence, the total scope of the OSS E/PO program is far larger than might be expected from the direct NASA funding amounts. As examples, the Sun-Earth Day 2001 attracted participation from hundreds of institutions around the country - each providing facilities and staff to host events at their locations. OSS missions and science are the focus of major science center exhibits and television programs funded primarily from non-NASA sources. Many scientists and educators are donating their efforts to develop and conduct educator workshops and public events. In general OSS has succeeded in developing products and programs that others want to use and/or participate in because it helps them to do their jobs better and not because

OSS is providing funding.

Some especially significant accomplishments over the past five years have been the creation of a one to 10 billion scale model of the solar system, shown in Figure 2, on the national mall in Washington D.C. [Goldstein, 2002], development of educator guides on the “Reasons for the Seasons” [SECEF, 2001], Astrobiology [Origins Forum, 2001], and the “Invisible Universe” [Cominsky, L. and Plait, P., 2003], creation of several traveling museum exhibits such as MarsQuest, shown in Figure 3, [Space Science Institute, 2001], Hubble Space Telescope - New Views of the Universe [Space Telescope Science Institute, 2001], and Cosmic Questions: Our Place in Space and Time [Dussault, M., 2003], and development of materials for the special needs educators and students such as “Touch the Universe – A NASA Braille Book of Astronomy” [DePaul University/Museum of Science, 2001] and the Multi-sensory Space Science Kit [SERCH, 2001].

Opportunities for foreign participation have primarily come about through international collaboration in the missions. For example the European and Japanese partners on the Cassini mission are translating E/PO materials and planetarium show scripts into their native languages with their own funding. Most NASA E/PO products are now available in electronic format over the Internet, which has significantly increased access by parties outside the United States. We encourage the international community to use these materials and to help in providing translations.

Where are We Now?

A substantial national education and outreach program is now underway and E/PO has strong backing from the top management of OSS. The quality of mission E/PO programs has



Fig. 2. Jeff Goldstein, Voyage project director, visits Uranus with a class of Washington, DC middle school students. Photo credit; Challenger Center for Space Science Education.



Fig. 3. The MarQuest exhibit has been at seven venues across the county since opening in 2000. Photo credit; Space Science Institute.

improved significantly but is still uneven and needs additional attention. With the minimal staff available, emphasis to this point has had to be on large mission E/PO programs.

The Support Network has provided a broad array of services and identified a wide range of educational opportunities. Close connection to the grassroots of the education system has been important. There is increasing integration and coordination with NASA Education Division Programs that will be further enhanced through the new NASA Education Enterprise.

The Minority University Initiative (MUI) has broken new ground for NASA and provided a realistic pathway to move minority institutions into the mainstream of NASA research efforts. Under this initiative, 15 minority institutions are engaged in research collaborations with nine NASA space science missions or suborbital projects and in more than 30 working partnerships with major space science research groups. The start-up of the “systems approach” has been more difficult than expected and we tried to do too many new things simultaneously and ambition has exceeded the resources. We are now starting to take a more strategically focused approach to the definition and implementation of the core programmatic goals, while deliberately allowing for some aspects of the program to evolve and change. Over

the next few years, we will pay critical attention to improving the coherence, quality, and availability of NASA space science educational materials; providing professional development for personnel engaged in OSS E/PO efforts; and more fully understanding the impact of the OSS E/PO program on the audiences it is designed to serve.

Some tactical considerations we have learned from the first five years include: 1) starting at home and then working outward from within NASA, the Support Network, or your own home town or state, 2) making sure that all the “obvious” connections to potential partners and supporters have really been made, 3) taking advantage of opportunities that have been handed to you, 4) working with the people who want to work with you, 5) focusing on making a modest number of things real, and 6) capitalizing on successes and publicizing them. OSS has discovered that it can not do everything. It has also discovered that the process of making strategic decisions based on well defined operating principles as to what programs should be undertaken is a very powerful approach.

PROGRAM EVALUATION

Since 1998 the Program Evaluation and Research Group (PERG) at Lesley University has been conducting an evaluation of the OSS E/PO program to determine the effectiveness of OSS in carrying out its E/PO Implementation plan. The first two reports are online at <http://spacescience.nasa.gov/education/resources/evaluation/index.htm>. Some of the major findings detailed in the second report [Cohen, S., Gutbezal, J. and Griffith, J., 2002] are:

- OSS E/PO resources have been growing in number and diversity since the implementation of the current E/PO effort. This growth has been documented in the OSS Annual Report, regular newsletters, and through NASA’s EDCATS system (Education Division Computer-Aided Tracking System - a NASA-wide database of education activity).
- The reach of the OSS E/PO effort has expanded to include groups of learners who have not previously benefited from NASA’s educational resources. Resources have been developed to address the needs of audiences of varying ethnicities, of all ages, in all areas of the country, and at various levels of physical and intellectual development.
- OSS has also been building relationships with scientists who are members of Minority Professional Organizations. Minority scientists and researchers reported that their connection to OSS provides them with tools they need to act as role models in their communities and mentors to their students and colleagues.

The report noted that “in general, data from the contacted audience groups are extremely positive. Individuals consistently report that they (and those they are educating) find space science exciting, engaging, and complex; this indicates that OSS is succeeding in its first goal of sharing the excitement of space science”. Report recommendations include:

- OSS should consider systematically including audiences in the creation and assessment of new resources in a variety of ways;
- OSS should provide scientists with increased access to educational expertise;
- OSS should work to improve communications and coordination both within the OSS E/PO program and the users and participants in OSS E/PO programs.

In addition to the Lesley University effort, an E/PO Task Force was set up in 2002, under the NASA Space Science Advisory Committee (SScAC), to assess the progress of implementing the OSS E/PO program, identify issues, and examine possible directions for program evolution. The Task Force conducted a series of program review meetings with a cross section of stakeholders in the OSS E/PO program including scientists, program managers, the Support Network leadership, and E/PO program leads. In addition surveys were made of educators, program participants, and other users. In March 2003, the Task Force presented of its preliminary findings to SScAC [Education and Public Outreach Task Force, 2003]. The Task Force found that the program’s accomplishments and successes to date included:

- Direct engagement of OSS missions and the space science research community in education and in contributing to the public understanding of science;
- A rich harvest of educational programs and materials directed towards many types of audiences in diverse communities across the country;
- Significant steps towards involving minorities in the mainstream of OSS’s scientific, technical, and educational programs and in developing educational materials directed towards audiences that have not previously been served by NASA; and

- Substantial leveraging of resources through collaboration with hundreds of educational institutions and organizations across the country.

The Task Force singled out a number of areas for particular attention, areas which the Task Force believed will yield especially rich rewards in taking the OSS E/PO program to even higher levels of maturity, effectiveness and accomplishment. Major findings and recommendations for OSS include:

- Make educational products more accessible and organize them in a more coherent way;
- Increase the inclusiveness of the program by involving new audiences, science topics, materials and partnerships;
- Expand and intensify pioneering efforts to attract and better integrate minorities into E/PO projects and into the mainstream of OSS science programs;
- Enhance efforts directed towards quality control and obtaining a better understanding of program impact;
- Increase the effectiveness of the OSS E/PO Support Network by focusing the activities of the Broker/Facilitators on their primary roles;
- Strengthen and expand professional development efforts for E/PO professionals, scientists, and the education community; and
- Enhance internal and external communications.

The Task Force Report noted that 1) the approach that OSS has taken in implementing its E/PO Program provides a model that is unique to NASA, to the government, and to science education in general, 2) based on its successes to date and the prospects for even greater successes in the future, the approach could well serve as a guide for future NASA educational efforts across the Agency, and 3) the program is already a credit both to the OSS and to all of the very talented people who have been involved in its planning and execution. OSS plans to pay close attention to and implement the recommendations received from the Task Force.

CONCLUDING REMARKS

Over the past 7 years, the OSS Education and Public Outreach program has undergone significant development, growth and change. Changes in program scope are summarized in Table 1. The substantial progress of the NASA OSS E/PO program over a relatively short period of time can be attributed to the dedicated work of many individuals and organizations.

The process approach defined in the OSS E/PO Implementation Plan has shown significant adaptability and resilience. Changes have been made in the program on an ongoing basis in response to problems as they been encountered. As we move forward we will continue to focus on increasing the quality of our program activities and products. The program is and will likely remain an ongoing and evolutionary process in keeping with the vision expressed at the program's inception:

“The overall approach described in this Report is an experiment. The focus on process as the centerpiece of this experiment, rather than on the identification of a set of specific programs, represents a deliberate choice ... to depart from the practice of simply creating a collection of stand-alone activities having purely local impact. The proposed process offers the prospect of enormous amplification of OSS's education/outreach efforts. The only way to tell whether the experiment will work is to try it. Flexibility will be required, progress on the experiment will have to be monitored closely, and adjustments made on an ongoing basis.”

“Realistic expectations are important. No single education or outreach program undertaken or sponsored by OSS will, by itself, have a significant, long-term sustainable impact on the American educational system. Rather, it will be the total effect of a broad ensemble of high-leverage activities carried out over a long period of time that can make a difference.”

Excerpts from Chapter XVI, *Concluding Remarks*
OSS E/PO Implementation Plan

Thus far, the experiment appears to be a success. The major challenge now facing the program is how to sustain and build upon that success in the face of an ever-changing political and programmatic environment.

Table 1. Changes in the NASA OSS E/PO program over the past 7 years.

	Then 1995	Now 2002
Status:	A Plan	A Major National Program
Breadth:	Space Telescope Science Institute + a few other things (a handful of activities)	Every mission & research program (hundreds of activities)
Infrastructure:	Mostly focused on Space Telescope Science Institute	Extensive interactions with a national infrastructure involving 13 institutions
OSS \$:	A few million/yr	More than \$ 35 M/yr and growing
Non-OSS \$	None	A significant fraction of the OSS investment
Minority Universities	Occasional Technical Advice to NASA Minority University Research and Education Division	Minority University Initiative (\$ 3M/yr). OSS involvement in oversight and other solicitations
Peer Review:	A small number of proposals	Research grant supplements & Explorer & Discovery Class Mission Downselects
HQ Procurements:	A few \$ 100K/yr	More than \$ 10M/yr
Major HQ Sponsored Projects	None	Support Network, 2 television series, Scale Model Solar System, Training, Product Review, etc.
Coordination:	None	Extensive/OSS Education Council
Oversight:	Little required	Needed for large programs (and there are now many)
Conferences:	Limited – OSS presence only at National Science Teachers Association convention	Significant OSS presence at many science/education conferences
Interaction with Other Groups	Limited interactions with internal NASA education groups	Many interactions with internal NASA education groups, as well as, numerous external groups
Evaluation:	None	Major activity now underway

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