

**Implementing the Office of Space Science
Education/Public Outreach Strategy:
A Critical Evaluation at the Six-Year Mark**

**A Report by the
Space Science Advisory Committee
Education and Public Outreach Task Force**

March 21, 2003

Executive Summary

Over the past 6 years the Office of Space Science (OSS) has used the Plan developed by the 1996 Space Science Advisory Committee (SScAC) Education/Public Outreach (E/PO) Task Force to implement a bold and innovative approach to the planning and execution of its education and public outreach program. The program now underway has enabled the science and education communities to work together to bring scientific research, discoveries in space science, and educational products and activities associated with OSS missions and research programs to students and the public alike. The OSS E/PO program is based on goals most recently expressed in *The Space Science Enterprise Strategic Plan 2000* and has a clear approach to implementation as set forth in the 1996 Report *Implementing the Office of Space Science Education/Public Outreach Strategy*. The Program operates on the premise that achieving genuine success in affecting the quality of science, technology, engineering, and mathematics education in America will not be won through short-term activities with immediate results, but rather through a long-term commitment requiring a sustained effort in education and public outreach.

To assess progress at this stage of implementing the OSS E/PO program, identify issues that need to be addressed in the next stage, and examine possible new directions for program evolution, an E/PO Task Force was set up under the SScAC in 2001. The Task Force has found that the program's numerous accomplishments and successes to date include:

- 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.

It is clear that significant progress has been made to date. The ensemble of activities that are now being undertaken are, by design, highly leveraged and broadly distributed throughout the nation. 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. 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.

To build on this progress, the Task Force has singled out a number of areas for particular attention, areas which the Task Force believes will yield especially rich rewards in taking the OSS E/PO program to even higher levels of maturity, effectiveness and accomplishment. Findings and recommendations have been grouped into eight broad subject areas.

- 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;
- Enhance internal and external communications; and
- Identify and acquire critical resources required for long-term sustainability.

The OSS E/PO program, with its established productive partnership between the space science and education communities and its use of a national network to identify and sustain high-leverage opportunities, has made remarkable progress in a relatively short period of time. Based on its successes to date and the prospects for even greater successes in the future, the approach that has been taken could well serve as a guide for future NASA educational efforts across the Agency.

BACKGROUND

Substantive planning for establishing an Office of Space Science (OSS) Education and Public Outreach (E/PO) Program began in late 1993. Following an extended period of preparation, two key documents were published that have served to guide OSS's work in education. *Partners in Education: A Strategy for Integrating Education and Public Outreach into NASA's Space Science Programs* (published in March 1995) first laid out the principles of embedding E/PO into all aspects of the OSS program and focusing on the creation of partnerships between the space science and education communities. *Implementing the Office of Space Science Education/Public Outreach Strategy* (published in October 1996) laid out the blueprint for operationally realizing the goals stated in the 1995 E/PO Strategy. The Implementation Plan was developed by a Task Force set up under the Space Science Advisory Committee, which carried out its work between June 1995 and September 1996. Actual implementation of the program began in early 1997.

In March 2001, the Office of Space Science asked the Space Science Advisory Committee (SScAC) to set up a new Task Force to carry out an external review of the OSS E/PO Program. At that time OSS felt that, after nearly five years, the time was right to have an outside assessment concerning progress on the program and to see whether any adjustments in the overall approach were needed. SScAC agreed to carry out such a review.

The Charter for the Task Force is contained in Appendix A. Task Force members (see Appendix B) were selected as representatives of a broad cross-section of external stakeholder communities. The detailed schedule of the Task Force's meetings and activities is contained in Appendix C. Information was obtained from the extensive collection of written materials describing the OSS E/PO Program and from numerous discussions with space scientists, educators, OSS mission E/PO leads, members of the OSS E/PO Support Network, OSS Management, and the Program Evaluation and Research Group at Lesley University which has been serving as the External Evaluator for the OSS E/PO Program since November 1998.

This Report summarizes the results of the Task Force's information gathering and deliberations. The Report is organized into an assessment of the current status of the OSS E/PO Program and a series of recommendations intended to strengthen the Program as it moves from an initial start-up phase to the next stage of maturity. Recommendations are primarily directed at OSS Management, although other readers may also benefit from the Task Force's assessment of program progress and recommended areas of future emphasis. The findings and recommendations were presented to and approved by SScAC at its meeting in March 2003.

THE OSS E/PO PROGRAM HAS HAD A VERY SUCCESSFUL BEGINNING

The OSS E/PO Program is based upon an innovative, process-oriented approach developed by the 1996 SScAC E/PO Task Force. The blueprint that has been used by OSS over the past six years has led to the development of a decentralized, distributed system that has yielded a wealth of positive results. Examples of current OSS E/PO activities and products include: award-winning educational web sites; major exhibitions in museums and science centers; partnerships with professional societies of minority scientists; creation of an online directory of products and resources; the development of opportunities for students and teachers to work with scientists on real research projects; creation of a large portfolio of educational materials and products, many of which were developed through partnerships with nationally known science education curriculum developers; and the use of web broadcasts centered on natural events such as solar eclipses to bring space science to a wide variety of audiences. Of special note are an array of activities now underway directed towards individuals with disabilities, Native Americans, and students living in inner cities throughout the nation. It would take too much space in this report to chronicle the vast collection of products and activities that have been developed over the past several years. These have been well documented in a series of OSS Annual E/PO Reports that are available on-line. Statistics collected for fiscal year 2002 are used below to illustrate the progress, current scope, and reach of the program.

1. The E/PO program scope has increased steadily over the past several years. During this past year alone there were:

- 330 separate Enterprise-funded E/PO activities and 70 major new products developed;
- More than 3600 E/PO events held in all 50 states, the District of Columbia, and Puerto Rico;
- More than 350,000 students, teachers, and members of the general public that participated directly in events such as workshops and public lectures;
- 1.7 million visitors to museum programs, exhibitions, planetarium shows and special events;
- An additional 7 million people that participated through web-based activities;
- 200 million people that had access to NASA space science E/PO events through such avenues as newspapers, public television, public radio and exhibits of various types where specific counts of attendance or readership were not made.

2. E/PO has been successfully embedded in space science missions and research programs, and significant portions of the space science community are now actively involved in education.

- More than 100 space science missions and research programs now have associated E/PO activities underway.
- In accord with OSS policies adopted in 1997 in response to the previous Task Force recommendations, missions and research programs have now incorporated E/PO into their baseline budgets at the recommended 1 to 2 percent level.
- E/PO efforts have emanated directly from the science missions and research programs and their discoveries. It is the close association with the OSS science and scientists that makes the OSS E/PO Program unique.
- More than 1000 NASA space scientists, technologists, and support staff participated in OSS E/PO work in a wide variety of ways during this past year.
- The enthusiasm and support of space scientists and educators for the OSS E/PO Program is steadily growing. Scientists are increasing their involvement in E/PO, and educators are taking more and more advantage of the opportunities and resources being provided by the OSS Program.

3. Minority scientists, educators and societies are becoming more involved.

- The fifteen minority institutions first funded in FY 2001 under the NASA Minority University Education and Research Partnership Initiative in Space Science to develop space science-related academic and research capabilities on their campuses have continued to make substantial progress.
- In FY 2002, these institutions were engaged in research collaborations with 9 NASA space science missions or sub-orbital projects and were involved in more than 30 working partnerships with major space science research groups.
- OSS has placed a significant emphasis on involving underserved groups in its education programs (with the eventual aim of involving minorities in the mainstream of its research programs). In particular, OSS has broken new ground for NASA through its work with the national professional societies such as the Society of Black Physicists and the National Organization of Black Chemists and Chemical Engineers.

4. The OSS E/PO program is cost-effective and highly leveraged.

- OSS funding has been substantially leveraged through partnerships with scientific, governmental and educational institutions such as planetariums and museums.
- E/PO Programs are currently being developed and delivered through partnerships and collaborations with more than 500 major educational institutions and organizations. More than 1500 additional institutions have participated as well.
- OSS has succeeded in drawing upon substantial resources that have been brought in by collaborators. Over the past several years, external support in the \$40 to \$50 million range has been applied to the program.
- The OSS E/PO program is thus much larger in scope than would be expected just from the direct funding. As was advocated in the previous Task Force Report, OSS has also made strategic decisions as to where to best invest its limited resources. It has looked for high leverage possibilities to maximize the return on investments. This strategic approach has clearly borne fruit, and OSS should be encouraged to continue on this course in the future.

The OSS E/PO has already succeeded in having an impact on a variety of communities. Such effects can be measured in many ways. With regard to the space science community, notable changes have occurred in the positive emphasis given to E/PO activities by astronomers and space scientists and by their professional societies, such as the American Astronomical Society (AAS) and the Astronomical Society of the Pacific (ASP). As noted above, a growing number of scientists have recognized their responsibility not only for training the next generation of researchers but also for enhancing the general public's scientific literacy and are devoting a substantial amount of their time to E/PO activities.

Various reports, including recent National Research Council decadal surveys that recommend priorities in astronomy and space science, have argued that astronomy and space science are subjects that are particularly well suited for encouraging young people to pursue scientific and technical careers. OSS has succeeded in turning such recommendations into a practical and rapidly growing program. One key to the success of the program is the variety of entry points provided for the space science community to become involved in E/PO. Small grants encourage individuals to experiment and learn how they can contribute effectively. Large efforts, like the one at the Space Telescope Science Institute, provide the professional infrastructure to help scientists translate their results into products that can reach a variety of potential audiences, from the elementary school classroom to major media outlets. The OSS E/PO Support Network has also made tangible progress in helping to forge links between professional educators and research scientists.

The effect of OSS initiatives on attitudes of space scientists and the increasing importance accorded to E/PO efforts by the scientific community is clearly demonstrated by: 1) events like the June 2002 NASA OSS E/PO Conference in Chicago, which was well attended by both scientists and educators, and which provided a venue for enhancing and enriching the dialogue between the space science and education communities; 2) the growing number of sessions devoted to education at the meetings of the American Astronomical Society (and other scientific professional societies as well), which, as recently as ten years ago, devoted its annual meetings almost exclusively to research; and 3) the recent launching of an electronic journal, *The Astronomy Education Review* (sponsored by both the AAS and the ASP) created in response to the recognition by these societies of the need to provide a permanent, refereed record of the growing volume of professional work in astronomy and space science education and education research. Such a journal also provides a badly needed professional outlet for scientists (especially younger scientists) involved in education to publish their work and receive appropriate professional recognition for this aspect of their work.

In response to the recommendations of the 1996 Task Force, mechanisms for quality control and evaluation have been built into the design of the OSS E/PO Program. A variety of increasingly mature mechanisms have been put in place to ensure quality, such as peer review of E/PO proposals associated with missions and research programs, a product review process, and a process for reviewing the quality of educational web sites. External groups have been brought in to advise large projects and to recommend changes in direction. An external evaluator -- the Program Evaluation and Research Group (PERG) at Lesley University -- was selected to work with OSS in November 1998 and has submitted several reports to OSS that have resulted in a number of substantial adjustments in the way OSS has been carrying out its E/PO Program. Finally, the 1996 Task Force Report also envisioned periodic reviews by external groups to examine progress. The fact that OSS Management took the lead in asking for this current review attests to OSS's commitment to carrying out a "world-class" education program. Our work has led to the clear conclusion that the OSS E/PO program is based on a solid foundation and is off to an excellent start. It is now ready to move to a new level of maturity and accomplishment.

The last six years were the start-up phase for the OSS E/PO Program. New institutions were created and became operational, new processes were developed and adjusted where necessary, and a somewhat skeptical scientific community has been increasingly convinced that participating in E/PO is important. A natural transition is now occurring from establishing infrastructure in a start-up phase to a more mature stage of focusing on achieving an even higher standard of quality and measuring impact. The program has been open to feedback from scientists and educators and has made positive changes along the way in response to constructive criticisms from both communities. Its systems approach is working. The Support Network, created as its central element, is a valuable asset and its role is evolving in response to changing needs as the program matures. The Implementation Plan developed by the 1996 SScAC Task Force has served everyone very well and should continue to serve as the program's blueprint in the future.

Despite all this progress, there are important issues that now need to be addressed. The program has created large numbers of products in partnership with other organizations, many of high quality. However, the quality is not sufficiently uniform – there is a need to make certain that all products that are developed reach the same high level of standards that some have attained. Members of the education community also find that the large array of activities and products that have been created are not always easy to get, and it is not always obvious how such activities fit into what they are being asked to do in the classroom. There is a need for coherence of organization and presentation of educational materials to the intended users. Many resource developers (mission teams, individual scientists and E/PO specialists) have insufficient understanding of the end-users, resulting in products that cannot be used effectively because they do not relate well to the needs of classroom teachers. The utility and effectiveness of the OSS E/PO Program can be substantially enhanced through the establishment of a systematic professional development program for the E/PO community that OSS has created.

In summary, the OSS E/PO Program is off to a very good start. In the future the program can benefit from a few well-focused adjustments and enhancements based on the past six years of experience. It is well positioned to evolve in a direction that will result in even greater returns on investments of time and resources as it continues to address the needs of the education community – as only NASA can.

RECOMMENDATIONS: TAKING THE OSS E/PO PROGRAM TO THE NEXT LEVEL OF ACCOMPLISHMENT

To build on the substantial progress that has been made over the past six years, the Task Force has singled out a number of areas for particular attention, areas which the Task Force believes will yield particularly rich rewards in taking the OSS E/PO Program to even higher levels of maturity, effectiveness and accomplishment. Some of these recommendations can be responded to straightforwardly by sharpening the focus of or reorienting efforts that are already underway. Implementing other recommendations will necessarily lead to the establishment of major new activities requiring careful planning and new resources.

1. Make educational products more accessible and organize them in a more coherent way

Many educators aren't certain of how space science topics can be used in their classrooms. To reach the next level of effectiveness, the OSS Education Program should create a Space Science Education Framework to develop a bridge between the science and mathematics of OSS missions and research and the needs of the educational system. This Framework should be aligned with the National Science, Mathematics and Technology Standards. It should provide an appropriate, standards-aligned, sequencing of space science topics throughout the K-12 years, and give overall direction and context for the materials being produced by each mission and research project. The existence of such a Framework will make it easier for educators to use the space science materials in their classrooms. The development of the Framework should be a cooperative effort between NASA and leaders of educational organizations like the American Association for the Advancement of Science, National Science Teachers Association, Lawrence Hall of Science, and TERC. Involvement of such organizations is crucial if the Framework is to have credibility in the education community.

The Framework would provide recommendations for a sequence of content that would help students meet appropriate standards, such as the NRC content standards, that specify what students should have achieved by the end of 4th grade, or 8th grade or 12th grade. OSS could then encourage the development of curriculum sequences and materials that address concepts and topics in the NASA Space Science Framework using coherent and high quality approaches. It could also foster the development of assessment instruments correlated to the concepts in the Framework to enable K-12 teachers to accurately measure student understanding of key space science concepts leading to the increased rigor and effectiveness of space science education nationwide.

Good programs that have already been developed and fit within the Framework

should be sustained. New missions and research projects would then develop additional E/PO programs and materials that fit within this Framework. When new programs are proposed they should identify the science, mathematics and technology education gaps in the Framework and address these in ways appropriate to the mission or research project. This will allow OSS missions and research to avoid duplicating efforts and to focus on developing fewer, better products. Adopting this approach will require greater coordination throughout the Support Network. If the products are logical in flow and connectivity, they will be easier for teachers, students and the general public to locate and use.

The OSS E/PO program must also take actions to make educational materials more accessible. The NASA Space Science Education Resource Directory (SSERD) is a good first step in providing accessibility to some of the products of the E/PO program. It has not yet gone far enough, however, in organizing and evaluating the materials it includes; and the Framework can provide a useful context for this. The Directory could then be expanded to include exemplary materials inspired by NASA science, but developed by other reliable organizations, that also align with the Framework. While having a web-based database of materials is useful, it does not address the wider needs and the larger issues of distribution, particularly for under-served and non-technology oriented groups. Other means of cataloging and distribution should be pursued to better serve these groups.

2. Increase the inclusiveness of the program through reaching out to, involving, and incorporating new audiences, science topics, materials and partnerships

The E/PO program has done a good job in forming partnerships outside of NASA, particularly the involvement of scientists and some scientific and educational institutions in E/PO work. Nevertheless, additional efforts should be made to include other important organizations and audience groups. A more explicit collaboration with the National Science Foundation's educational programs should be established. The OSS E/PO program can by necessity be only a small, but important, part of the nation's educational structure, but to further leverage its impact it should find more ways to partner with educational associations such as NSTA, ASP, NEA, and AFT.

Programs incorporating community colleges, colleges of education and undergraduate students are needed and could produce substantive results. Stronger and continuing partnerships could be developed with the informal education community, especially planetaria and museums, through a peer-reviewed grant program to support key projects aligned with OSS E/PO goals. Initial efforts to work with community groups could be further expanded to include additional amateur astronomers, scouts and youth groups, civic organizations, and especially minority religious and community groups. Partnerships with associations, businesses, and distributors could be pursued to help reproduce and distribute educational materials.

3. Expand and intensify pioneering efforts to attract and better integrate minorities into E/PO projects and into the mainstream of OSS science programs

OSS E/PO has already taken a number of significant steps towards increasing minority engagement in NASA space science research and education programs. The Space Science Minority University Initiative and OSS's work with minority scientific professional societies have broken new ground for NASA and have helped to establish new relationships between OSS and the minority research and education communities. Such activities should continue and be expanded.

The demographics of America are changing in a dramatic way. Currently, about a quarter of the U.S. population consists of minority group members, but during this century, the minority will become the majority. The E/PO participant community (and the research community as well) should reflect these changing national demographics. One of the explicit goals of the OSS E/PO Program is to help create the technical workforce of the future. This goal cannot be achieved without actively reaching out to minorities. The fact that, currently, 55% of the graduate students in physics and 60% in engineering are non-Americans raises a number of important issues. The future technological workforce needs of America cannot be met solely through the non-minority portion of the American population. It is vital that minorities become more involved in science and engineering. So the fundamental unanswered question is not whether the OSS E/PO Program should strive for more inclusion of minorities, rather it is: how is this inclusion to be achieved.

One part of the answer to this question is to make more effective use of the Support Network in working with minorities and minority institutions. Another is to encourage mission E/PO leads to include minorities and minority institutions in the planning of their programs from the beginning. Both groups require help in order to be effective in acting in this role. Our discussions with Forum staff, Broker/Facilitators and E/PO leads revealed a lack of familiarity with minority communities. All of them require additional training on strategies for approaching minority communities and on how to best plan and implement exemplary programs involving minorities.

One fundamental principal of the OSS Education program is the direct involvement of space scientists in E/PO. The implementation of this principle has been responsible for much of the resounding success of the program. However, this principle may need to be considered and applied more broadly as there are too few minority space scientists available to work with OSS to have an impact on a national scale. There are, for example, only about 25 African-American astronomers and astrophysicists in the United States. This means that the OSS E/PO program needs to broaden its sphere of influence to achieve its objectives

vis-à-vis minorities. A good first step in this direction was the Workshop, held at Western Kentucky University in May 2001, which involved the Broker/Facilitators and Forums and the leadership of ten minority professional scientific organizations. The dialogue was valuable, new connections were made, and, subsequently, one of these organizations (the National Organization of Black Chemists and Chemical Engineers) became a major participant in a mission E/PO Program. OSS had not previously thought about working with chemists and chemical engineers. Efforts like this need to be continued and expanded. The Task Force also recommends that such efforts be expanded in the future to include mission E/PO leads.

Because of the long history of exclusion of minorities from science (for instance between 1920 and 1962 only 17 African-Americans obtained a Ph.D. in physics or astronomy) role models and intense interaction of minority scientists with their communities is required to attract more minorities into technical fields. The models for such interaction have yet to be worked out, and the effort required to develop viable models and foster interactions between minority scientists and their communities needs to be increased. The infusion of minority cultural contributions to space science missions in OSS science/space missions will be important.

4. Enhance efforts directed towards quality control and obtaining a better understanding of program impact

As emphasized in this report, the Task Force commends the OSS E/PO for notable successes in engaging astronomers, space scientists, and their professional communities in effective education and public outreach activities. These successes have been documented in the OSS E/PO annual reports in the form of (1) narratives describing individual activities and (2) data showing the numbers of several types of activities carried out each year. During the initial, formative years of the E/PO program, these types of performance measures were understandably the most readily available means of tracking progress. While these descriptions convey the excitement, breadth, and continued potential of the program, more complete measures of the actual impact of the program are needed.

As mentioned earlier in this report, the quality control and evaluation efforts that are built into the program's design have provided useful feedback that is being used to continually improve operations. As the program matures, further assessment of quality and effectiveness of E/PO activities and products is desirable. The Task Force readily acknowledges that indicators of quality and effectiveness are difficult to specify, let alone evaluate; but we nonetheless urge OSS to give them specific attention during the coming years. We recommend increasing efforts to enhance evaluation by continuing to use the standards of good educational practice already employed and by engaging those who know education well. To this end, we suggest

- Longitudinal studies to follow cohorts of students to determine significant influences on their college choices and career paths. Such studies are routinely undertaken by the National Center for Education Statistics (NCES), the Higher Education Research Institute (HERI), and the National Science Foundation (NSF). Examples include the NCES National Education Longitudinal Study (NELS) of students who are tracked from eighth grade through enrollment in undergraduate science and engineering programs; the HERI Freshman Norms Survey of intended majors by first-year students in four-year colleges and universities; and the NSF's Scientists and Engineers Statistical data system (SESTAT) that collects information on the employment, education, and demographic characteristics of individuals with science and engineering degrees in the U.S. The Task Force acknowledges that the complexity and expense of longitudinal studies preclude OSS E/PO from undertaking their own study, but OSS E/PO could explore the possibility of joining ongoing longitudinal studies by adding to them questions related specifically to the role of space science E/PO activities.
- Annual peer-reviews and selection of outstanding individuals for their contribution to E/PO efforts could provide models to help others evaluate their own efforts, and could go far in encouraging effective participation and dynamic innovation in the program.
- Thorough and critical reviews of products for quality and eventually, for alignment to the recommended Space Science Education Framework. OSS could also present awards for meritorious E/PO products. The nomination process might require documentation of the effect/impact of the product, thus lessening the burden on OSS to document success and encouraging the community itself to design and implement impact measures.

5. Increase the effectiveness of the OSS E/PO Support Network by focusing the activities of the Broker/Facilitators on their primary roles

As noted earlier, the Support Network has played a large role in the overall success of the OSS E/PO Program. The Support Network consists of four Education Forums aligned with the OSS themes (Sun-Earth Connection, Solar System Exploration, the Astronomical Search for Origins, and the Structure and Evolution of the Universe) and seven Broker/Facilitators distributed regionally throughout the United States. Our discussions with members of the Support Network suggested that the Forums had a very clear idea of what their role is in the OSS Program and are now operating effectively. However, the role of the Broker/Facilitators is far more ambiguous (even as seen by the participants), and their performance (and effectiveness) has been far more uneven. Core roles for the Broker/Facilitators were clearly spelled out in the 2001 Broker/Facilitator Cooperative Agreement Notice (CAN) and the Task Force believes these core

roles are appropriate. The Broker/Facilitators should spend more of their time on brokering as defined in the CAN (searching out good opportunities and connecting space scientists and educators) and less on developing and implementing their own programs.

Broker/Facilitators (and Forum leaders) could also be more proactive in working with research and mission proposers to ensure that there is greater cooperation among scientists and educators in planning and preparing E/PO Proposals right from the beginning. Specific suggestions are given in recommendation 6 for raising awareness and skill levels of Support Network members in educational expertise – a crucial step if the Support Network is going to be more effective in the future. Specific steps are also given in section 3 for raising the skill levels of the Support Network members concerning diversity. Finally, a clear set of metrics needs to be developed for the Broker/Facilitators and Forums against which they can judge their success. While some indicators are already in place, the time has now come for a more rigorous approach to judging the effectiveness of the Support Network.

6. Strengthen and expand professional development efforts for E/PO professionals, scientists, and the education community

OSS has created a new profession—space science education and public outreach specialists—and it is now necessary to establish the standards for the profession and to put into place professional development programs. E/PO specialists include the Broker/Facilitators, Forum Directors, mission E/PO leads and others engaged in the E/PO program. The institutions that manage space science missions and conduct space science research programs employ many of these professionals. These specialists plan and implement the E/PO efforts of the missions and programs. Some are scientists or technologists who have adopted E/PO as a new career, while others have come from the educational community. All need to have a better understanding of the practical aspects of developing E/PO activities and products that are based on the best knowledge and practices of the professional education community.

The creation of the refereed journal the *Astronomy Education Review*, which is endorsed by both the AAS and the ASP and has received start-up funding from NASA, is one step in the direction of developing an archival record of best practices. Professional development opportunities in the form of workshops, short courses, and special sessions at scientific meetings are also needed for current members and new entrants into space science education. The third Lesley University Report (available on-line through the OSS Education homepage) notes that many in the E/PO community are up to the limits of their knowledge of educational practices. There is certainly a lot of talent, enthusiasm and creativity available, but there is a requirement to deepen the OSS E/PO community's understanding of the needs of educational community with special attention paid

to best practices for creating products relevant to the age and learning needs of students.

Professional development is also needed for members of the education community, particularly classroom teachers and developers of curricular materials. Approaches to providing sustained help for educators must be found, not just a single workshop or conversation. As an example, programs that engage teachers in space science research projects over several summers would go a long way towards this goal.

7. Enhance internal and external communications

In a system as diverse and geographically distributed as the OSS E/PO effort has become, clear and efficient communication is essential. We note and applaud steps already taken to maintain communication within the system, and between elements of the system and external communities of space scientists and educators. These include the OSS Education Council, monthly OSS E/PO newsletters, and presentations at professional meetings of astronomers and educators. Given the rapid increase in the size and complexity of the system, however, we find that additional efforts to enhance communications are advisable.

Communications within OSS at Headquarters must be improved. For example OSS E/PO managers are not always informed of successful research grants to which E/PO components may be added, nor are the science program officers within OSS always informed about E/PO awards that have been made. This situation may be a result of too many demands on the time of existing staff, but it is still a problem that must be solved. We have also noted barriers to communication between OSS education programs and other education efforts underway at NASA. We recognize that the new organizational arrangements for education within NASA may help alleviate this situation. However, such coordination efforts will require additional staff time. These gaps in communication both within the Support Network and within NASA Headquarters can, and should, be fairly easily closed.

Another substantial need is for a clear, consistent and sustained dialogue with three external communities: space scientists and astronomers, educators and their professional societies, and the emerging E/PO professional community. We urge increased attention to communication with these three groups, especially with professional societies like the AAS, AGU and NSTA.

Clearer and more efficient communication is also crucial for fostering better cooperation between scientists and members of the formal and informal education communities when they join together to prepare E/PO proposals. The Task Force notes that more effective communication at earlier stages in the preparation of proposals is likely to produce better proposals and more substantive programs.

8. Identify and acquire critical resources required for long-term sustainability

The OSS E/PO Program has made remarkable progress in a relatively short period of time in large part because of the unstinting efforts of a small number of people at NASA Headquarters, and because of the willingness of OSS management to devote substantial financial resources to E/PO. Missions and research programs have allocated 1 to 2 percent of their baseline budgets for E/PO, and OSS has also provided additional resources for the Support Network and for funding a small number of individual E/PO efforts such as the competitively selected IDEAS Program. Such actions are clear indicators of OSS's genuine commitment to E/PO. However, the sheer scale of the program and the level of activity now underway have reached the point where a number of issues must be faced if the program is to be sustained over the long term.

The size of the OSS E/PO staff is presently inadequate to support a program of this scope, while at the same time substantial new demands are being put on the current staff. There simply aren't enough people to do the job well! The scale of the OSS E/PO Program can be expected to continue to grow substantially along with the growth in the overall OSS Program. Large new scientific and technology programs within OSS such as Living with a Star, Beyond Einstein, and Project Prometheus offer exciting prospects for major new E/PO efforts. To realize their potential, such efforts will require strong leadership and careful planning necessitating a major commitment of staff time. Interactions with the new NASA Office of Education are also likely to have a substantial impact on the activities of the current staff, as will the planning of new activities recommended by the Task Force, such as developing the Space Science Education Framework and planning and implementing a comprehensive Professional Development Program.

Taking the OSS E/PO Program to the next level of accomplishment will also require additional resources in a few carefully selected areas. New funding will be needed to develop the Framework, implement the recommended Professional Development Program, and undertake new activities in a few key areas such as programs focused on preservice teachers, expanding successful activities targeted towards minorities, and enhancing efforts to evaluate programs and assess their impact.

OSS must now proceed to analyze its real staffing needs, work to obtain new positions where needed, assess the resources required to carry out critical new activities, and identify how such resources can be acquired. Requirements are likely to be modest, but meeting those requirements will be critical if the OSS E/PO Program is to be sustained and enhanced.

CONCLUDING REMARKS

The Task Force study of the OSS E/PO Program clearly shows that its success could only have been accomplished from within OSS. Engaging the missions and the research community required strong commitment from and direct involvement of OSS top management. OSS has built education into all aspects of OSS planning and decision-making, from strategic planning and budget formulation, to mission proposal review and selection, to the production and dissemination of education products and programs. Funding has come largely from incorporating support for E/PO into the baseline budgets of flight missions and research programs. The availability of funding has given investigators strong incentives to develop collaborations with the education community and, through those collaborations, to deliver usable education products that are based both on the needs of the education community and on the unique involvement of the space science community. These steps have led to close and effective partnerships between the science and education communities and have been a necessary condition for the Program's success to date.

With regard to the new NASA Education Enterprise (Code N), the Task Force agrees that it is essential to better coordinate education programs across NASA and to integrate education into the activities of all the Enterprises. The Task Force applauds efforts that more closely couple activities directed towards minorities and minority institutions to the mainstream of NASA's programs. Code N has the potential to create a much more coherent approach to education across NASA and to establish strong partnerships in education across the Enterprises. A central point-of-contact may also be best for forging cooperative links with programs of the professional educational organizations, such as the National Science Teachers Association, and for establishing partnerships with other government agencies, including the National Science Foundation and the Department of Education.

At the same time, however, we are very much concerned that the administrative convenience and efficiency that a centralized Education Enterprise could provide may also have the unintended consequence of disrupting critical relationships (existing and potential) with both the science and education communities. The potential imposition of added layers of bureaucracy could impede the flexibility of the OSS program that has, by design, been highly opportunistic. It has been able to move rapidly in new directions, proceeding quickly and efficiently. This ability has contributed in a major way to the successes of the program to date.

The OSS E/PO Program has made remarkable progress in a relatively short period of time and is now well poised to make even more substantial contributions in the future. The Task Force strongly feels that it should be improved and not disrupted. It effectively utilizes inspirations that come from scientific discoveries. It has invested taxpayers' resources wisely in programs aimed at replenishing the technological workforce. It is highly leveraged and cost effective. Some of the approaches, innovations and accomplishments of the OSS E/PO program could well serve as models for the

overarching education plan of the Agency as a whole. We have earlier expressed our concerns about the potential negative impact of the new NASA Office of Education on the OSS E/PO program and we remain concerned. The Task Force urges SScAC and OSS management to remain vigilant and to take active steps where necessary to maintain the innovation and the integrity of the OSS E/PO Program and its close links to space scientists and missions.

Appendix A: OSS E/PO Task Force Charter

EDUCATION AND PUBLIC OUTREACH TASK FORCE OF THE SPACE SCIENCE ADVISORY COMMITTEE

These terms of reference establish the Education and Public Outreach (E/PO) Task Force of the Space Science Advisory Committee (SScAC), a standing committee of the NASA Advisory Council. The E/PO Task Force is chartered to provide the SScAC with findings and recommendations on the status and conduct of the Office of Space Science (OSS) E/PO program. The Task Force will examine and evaluate how well OSS has done in carrying out its E/PO Implementation Plan, first published in October 1996, and determine whether any significant adjustments in the E/PO approach are needed. The Task Force's findings and recommendations will include the need for change in approach, direction, or content of the OSS E/PO program.

Key overarching questions to be addressed include: How well has OSS done in carrying out the E/PO Implementation Plan developed by the previous SScAC task force? Have there been significant successes? Have there been significant challenges? Is the overall scope, quality, and reach of the OSS E/PO program commensurate with the resources being invested by OSS? Are adjustments in the overall approach needed?

MEMBERSHIP

The E/PO Task Force Chair and members will be appointed by the Associate Administrator for Space Science. The Chair of the Task Force will be selected from the current SScAC membership. Members will be selected from the space science and education communities. They will be chosen so as to broadly represent both the science community that is becoming involved in precollege and public education through the OSS E/PO program and the education community that is the intended beneficiary and user of OSS' efforts. The Task Force will consist of 12 members (plus the Chair) who come from a wide variety of scientific and educational institutions and organizations including academic institutions, science museums and planetariums, state or local Departments of Education, and scientific and educational professional organizations. Term of membership will be for the proposed duration of the Task Force.

MEETINGS

The Task Force will meet three or four times during its proposed lifetime.

REPORTING

The Task Force will report its findings and recommendations to the Space Science Advisory Committee. A final report assessing progress and recommending any changes

needed to improve the effectiveness of the overall OSS E/PO effort will be delivered to SScAC at the completion of the Task Force's activities.

ADMINISTRATIVE PROVISIONS

The OSS Education and Public Outreach Director will serve as the Executive Secretary and will serve as the Designated Federal Official.

OSS will provide staff support and operating funds for the Task Force.

DURATION

The Task Force will operate for no more than 12 months from the date of its first meeting. The Task Force will terminate following submission of its final report to SScAC.

Daniel R. Mulville
Associate Deputy Administrator

Date signed 11/15/01

Appendix B: OSS E/PO Task Force Membership

Paul H. Knappenberger (Chair) - Adler Planetarium and Astronomy Museum

Paul Knappenberger is President of Adler Planetarium & Astronomy Museum in Chicago. He is a member of NASA's Space Science Advisory Committee. He is Chairman of the Museum Partners group of the Chicago Systemic Initiative, part of a nationwide effort focusing on systemic improvement of math and science instruction in schools. He served as Director of the Science Museum of Virginia in Richmond since its founding in 1973 until he left to go to the Adler in 1991. He is a member of the American Astronomical Society and the International Planetarium Society. He has served as President of the Association of Science-Technology Centers and on the Council of the American Association of Museums. His research efforts include work in optical interferometry at the University of Virginia, where he earned his PhD in 1968.

Sandra Begay-Campbell - Sandia National Laboratories

Sandra Begay-Campbell is a Regent for the University of New Mexico and is the former executive director of the American Indian Science and Engineering Society (AISES), a non-profit organization whose mission is to increase the number of American Indian scientists and engineers. Sandra returned to Sandia National Laboratories where she is a senior member of the technical staff. Currently, Sandra leads Sandia's technical efforts in the Renewable Energy Program to assist tribes with renewable energy development. In 1987, Sandra received a Bachelor of Science - Civil Engineering degree from the University of New Mexico. She worked at Lawrence Livermore National Laboratories before she earned a Master of Science - Structural Engineering degree from Stanford University and she also worked at Los Alamos National Laboratory. Sandra serves on the national Board of Directors for Women in Engineering Programs & Advocates Network (WEPAN). In 2000, Sandra was a recipient of Stanford University 2000 Multicultural Alumni of the Year Award and she was also selected as a recipient of the Governor's Award for Outstanding Women from the New Mexico Commission on the Status of Women.

Andrew Fraknoi - Foothill College

Andrew Fraknoi is Chair of the Astronomy Program at Foothill College and Director of Project ASTRO at the Astronomical Society of the Pacific (ASP). He served as the ASP's Executive Director for 14 years, and edited both its popular-level magazine "Mercury" and its newsletter for teachers. He is the author or co-author of more than 15 books on astronomy and astronomy education. For five years, he was lead author of a syndicated newspaper column on astronomy and appears regularly on local and national radio. With Dennis Schatz, he has edited "The Universe at Your Fingertips" and "More Universe at Your Fingertips", two widely used collections of K-12 astronomy activities and resources. With Sidney Wolff, he is co-editor of the on-line journal "Astronomy Education Review." He serves on the Board of Trustees of the SETI Institute, and on the Astronomy

Education Board of the American Astronomical Society. His awards include The Annenberg Foundation Prize, the Klumpke-Roberts Prize, and the designation of asteroid 4859 by the IAU as Asteroid Fraknoi.

Heidi B. Hammel - Space Science Institute

Heidi Hammel received a B. S. from the Massachusetts Institute of Technology in 1982 and a Ph.D. in physics and astronomy from the University of Hawaii in 1988. After post-doctoral work at the Jet Propulsion Laboratory, she returned to MIT, where she spent nearly nine years as a Principal Research Scientist in the Department of Earth, Atmospheric, and Planetary Sciences. She is now a Senior Research Scientist with the Space Science Institute. Her latest research has focused on imaging and spectroscopy of the outer planets with Hubble Space Telescope and ground-based facilities. She was recently appointed an Interdisciplinary Scientist for HST's successor, the James Webb Space Telescope. She has won numerous awards for her public outreach activities, including the 2002 Sagan Medal for outstanding communication by an active planetary scientist to the general public, the San Francisco Exploratorium's 1998 Public Understanding of Science Award, and the 1996 "Spirit of American Women" National Award for encouraging young women to follow non-traditional career paths.

Shelley A. Lee - Wisconsin Department of Public Instruction

Shelley Lee is the science education consultant for the State of Wisconsin's Department of Public Instruction, where she has recently completed the *Guide for Curriculum Planning in Science* and the *Wisconsin Model Academic Standards for Science*. She has been an active member of the National Science Teachers Association (NSTA) and has served on its Board of Directors in many capacities including Middle Level Division Director and as NSTA President in 1995-96. This year NSTA recognized her contributions to science education by honoring her with the Distinguished Service to Science Education Award. She has also served on numerous task forces and advisory boards for NASA. For 24 years she was a ninth grade science teacher for the Sand Springs Oklahoma Public Schools. In that capacity, she was the recipient of numerous awards including the teacher of the year for her district.

Molly K. Macauley - Resources for the Future

Molly Macauley is a Senior Fellow at and Director of Academic Programs at Resources for the Future. Her research interests include: space economics and policy; the economics of new technologies; recycling and solid waste management; urban transportation policy; and the use of economic incentives in environmental regulation. She has recently been nominated by the National Research Council to serve as a member of the Committee on an Assessment of the National Aeronautics and Space Administration's Space Solar Power Investment Strategy. She has also served as Visiting Professor at Johns Hopkins and Princeton Universities. Dr. Macauley was named by the National Space Society

as one of the top 25 "rising stars" among people doing work related to the U.S. space program. She received her Ph.D. in economics from Johns Hopkins University.

Charles H. McGruder III - Western Kentucky University

Charles McGruder is the William McCormick Professor of Astronomy at Western Kentucky University (WKU). He is the past President of the National Society of Black Physicists and for nine years he was the head of the Department of Physics and Astronomy at WKU. Under his leadership a group of nine astronomers was created at WKU, who employ a 24" telescope in Kentucky and a 50" at Kitt Peak National Observatory to study active galactic nuclei, extrasolar planets, and gamma-ray bursts. His department has been very successful in securing funding that involves undergraduates in faculty-mentored research.

Wendell G. Mohling - National Science Teachers Association

Wendell Mohling is Associate Executive Director for Conventions and Professional Programs for the National Science Teachers Association. He also serves as NSTA's Project Director for the NASA Educational Workshops Program, the Food and Drug Administration (FDA)/NSTA Food Science Program and the NSF/NSTA Webwatcher Program. He was a science teacher from 1964 through 1993 in schools in Nebraska and Kansas. He has served on many professional associations nationally and locally, and has received recognition for his outstanding work from numerous organizations including the 1983 Presidential Award for Excellence in the Teaching of Science. He was a finalist for the NASA Teacher in Space Program.

George D. Nelson - Western Washington University

George "Pinky" Nelson is the Director of Science, Mathematics, and Technology Education at Western Washington University. He previously served as Director of Project 2061 at the American Association for the Advancement of Science, Associate Vice Provost for Research / Associate Professor of Astronomy and Education at the University of Washington in Seattle, and as a NASA astronaut on three space shuttle missions. His research interests include the effective preparation of future science teachers and science education reform.

R. Bruce Partridge – Haverford College

Bruce Partridge is Professor of Astronomy at Haverford College, and has served for 5 years as the Education Officer of the American Astronomical Society. His A.B. and D.Phil. degrees in physics are from Princeton University and Oxford University, respectively. He attended the latter as a Rhodes Scholar. He has won teaching awards at his home institution and the American Physical Society Award for Research in an Undergraduate Institution. His research in cosmology, particularly on the cosmic microwave background, has been supported by both the National Science Foundation and NASA. He has held Sloan, Fulbright and Guggenheim Fellowships.

Dennis L. Schatz - Pacific Science Center

Dennis Schatz is Associate Director of the Pacific Science Center in Seattle, Washington. A research solar astronomer prior to his career in science education, he worked at the Lawrence Hall of Science until 1977. He co-directs the Washington State LASER (Leadership and Assistance for Science Education Reform) Program to implement a quality K-8 science program in all 296 school districts in Washington State. He is active in the Association of Science-Technology Centers (ASTC), and received the 1996 Distinguished Informal Science Educator Award from the National Science Teachers Association. He is on the Board of Trustees of the Astronomical Society of the Pacific. He is the author of 12 science books for children, including the popular *Totally* Series of six books (*Totally Dinosaurs* in 2000 to *Totally Sea Creatures* in 2003). He is also co-author/editor of several curriculum resources for teachers, including *Astro-Adventures*, *Universe At Your Fingertips* and *More Universe At Your Fingertips*.

Robert J. Semper – Exploratorium

Rob Semper is Executive Associate Director of the Exploratorium and is responsible for leading the institution's work in developing programs of teaching and learning using exhibits, media and Internet resources. He is the principle investigator on numerous science education, media and research projects including the National Science Foundation sponsored Center for Informal Learning and Schools, a research collaboration between the Exploratorium, U.C. Santa Cruz and King's College, London. He has guided the development of the award winning Exploratorium Website that has explored the role of museums in the online world. He was a Schumann fellow at the Harvard Graduate School of Education and is the recipient of the 1994 NSTA's Informal Educator of the Year award, and the 2000 Association of Science Technology Center's Award for Innovation. He also serves on the George Lucas Educational Foundation National Advisory Board.

Sidney C. Wolff - National Optical Astronomy Observatories

Sidney Wolff received her Ph.D. from the University of California at Berkeley and in 1967 joined the Institute for Astronomy at the University of Hawaii. She was named Director of the Kitt Peak National Observatory in 1984 and served as Director of the National Optical Observatories from 1987 to 2001. She also served as the first Director of the International Gemini Project, which built two state-of-the-art 8-m telescopes, and as President of both the Astronomical Society of the Pacific and the American Astronomical Society. Since stepping down as Director of NOAO, she has been focusing on the initial phases of the conceptual design of a telescope that would survey the whole sky every week or so, and the launch of a new electronic, refereed journal—The Astronomy Education Review.

Jeffrey D. Rosendhal (Designated Federal Officer) - NASA Headquarters

Jeffrey Rosendhal is the Director for Education and Public Outreach in NASA's Office of Space Science (OSS). He is responsible for all OSS activities dealing with education and the public understanding of science. Following service as a faculty member in the Astronomy Departments of the University of Washington, the University of Wisconsin, and the University of Arizona, he joined NASA Headquarters in 1974 where he has held a variety of research and program management, planning, and policy positions. Recognition of his work has included receipt of the NASA Outstanding Leadership Medal, two Presidential Rank Awards of Meritorious Executive, election as a Member of the International Academy of Astronautics, and election as an Associate Fellow of the American Institute of Aeronautics and Astronautics

Appendix C: Schedule of Task Force Activities

Getting Organized

- July 2001 – March 2002 Preparation period
- March 19, 2002 Teleconference

Materials Reviewed

- 1995 OSS E/PO Strategy
- 1996 OSS E/PO Implementation Plan
- 2000 Space Science Strategic Plan
- OSS E/PO Newsletters
- OSS Annual E/PO Reports
- Evaluation Reports by the Program Evaluation and Research Group (PERG) at Lesley University
- Other documents and printed materials collected by individual members

April 18–19, 2002 Discussions in Washington D.C.

- Ed Weiler - the role of education in OSS
- Frank Owens - the NASA Education Program
- Jeff Rosendhal - the OSS Education Program
- Sue Cohen- Lesley University Evaluation effort

June 11-14, 2002 Discussions in Chicago

Panel discussions with Support Network

- Forum Directors
- Broker/Facilitators
 - What Have the Forums & B/Fs Accomplished?
 - What Are the Biggest Challenges?
 - How Do the Forums & B/Fs Do Their Jobs?

June 12-14, 2002 NASA OSS E/PO Conference in Chicago

- Nearly 300 registrants
- 80 scientists
- Growing E/PO Community
- Communications and networking
- Identifying issues and proposing strategies

August 7-9, 2002 Discussions in Washington D.C.

- Panel of Mission E/PO Leads
 - What Are the Goals of Your Mission's E/PO Program?
 - What Was the Process Used to Define and Plan Your E/PO Program?
 - What Have Been the Program's Most Significant Accomplishments to Date?
 - What Are the Biggest Challenges in Planning and Implementing Your Program?

- Panel of OSS Discipline Scientists & Program Executives
 - What Has Your Role Been in the OSS E/PO Program to Date?
 - What Specific Suggestions Do You Have to
 - More Effectively Involve You in the OSS E/PO Effort?
 - Strengthen the Overall OSS E/PO Program?
- Paul Pastorek - The Organization of Education at NASA
- Sue Cohen - First Results from the PERG Phase III Evaluation Study
- Reports From Task Force Members Individual Fact Finding Effort

September 2002 – March 2003 Preparation of Final Report

March 2003 - Presentation to and Approval of the Final Report by SScAC