Phoenix Project

Mars Mission
Education and Public Outreach Implementation Plan

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Education and Public Outreach Implementation Plan

Prepared by:

_________________________________ _____________________
Doug Lombardi Date
Education and Public Outreach Manager
Phoenix Mars Mission

Approval:

_________________________________ _____________________
Peter Smith Date
Principal Investigator
Phoenix Mars Mission

Concurrence:

_________________________________ _____________________
Karen McBride Date
Mars Scout Program Executive
NASA Headquarters

_________________________________ _____________________
Larry Cooper Date
Acting Director, Education and Public Outreach
Science Mission Directorate, NASA Headquarters

This plan will be reviewed and updated annually to remain consistent with the changes in the Phoenix Mars Scout Mission, the Science Mission Directorate Strategic Plan, and the Mars Public Engagement Plan, as well as to take advantage of new opportunities and alliances for education and public outreach. The E/PO Manager for the Phoenix Mars Scout Mission is responsible for the maintenance of this document.

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1. Overview

The Phoenix Mars Mission, scheduled for launch in August 2007, is the first in NASA's "Scout Program." Scouts are designed to be highly innovative and relatively low-cost complements to major missions being planned as part of the agency's Mars Exploration Program. Phoenix is specifically designed to measure volatile (especially water) and complex organic molecules in the arctic plains of Mars, where the Mars Odyssey orbiter has discovered evidence of ice-rich soil very near the surface.

An integral component of the Phoenix Mission is its Education and Public Outreach (E/PO) program. Just as the mission will further our scientific and technological understanding by exploring the martian artic, the Phoenix E/PO program will inspire, excite, encourage, and nurture the exploration of questions from students and the public about Mars, the Solar System, and space exploration. In doing so, the Phoenix Mission will benefit our society by its commitment to improving our nation's excellence in science, technology, engineering, and mathematics.

Similar to its namesake, Phoenix "raises from the ashes" a spacecraft and instruments from two previous unsuccessful attempts to explore Mars. The 2001 lander, administratively mothballed in 2000, is being resurrected for the Phoenix Mission. Similarly, many of the mission's scientific instruments have already been built, requiring little or no modification for flight to Mars. Unlike the Mars Exploration Rovers, Phoenix is a fixed lander. This is more than sufficient for exploring the northern plains because it appears that the martian permafrost soils are widespread and relatively homogenous in the planet's arctic environment.

With a robust robotic arm, Phoenix will dig trenches up to 1 meter deep, scoop up the icy soil, and bring samples to the lander platform for detailed geological and chemical testing. The scientific instruments will examine the samples for clues about the landing site's history of water in all its forms (ice, liquid, and vapor) and the soil environment's habitability potential for single-celled organisms. Phoenix will specifically probe the soil at the interface of the water ice layer, looking to see if the soil is salty, alkaline, and/or oxidizing, as well as potentially replete with complex organic molecules necessary for life.

Phoenix also incorporates a suite of cameras to take an unprecedented look at the arctic plains of Mars. A descent imaging camera will take detailed pictures of the landing site as the spacecraft enters and descends through the martian atmosphere. Once on the planet's surface, a stereoscopic camera will be extended above the lander platform on a mast to take simultaneous three-dimensional and color panoramic images. The robotic arm will also have a camera on its wrist to image the trenching tool and provide up-close looks at the surface. Even greater detail will be shown by a microscopic camera that will look at individual sand grains down to the nanometer scale.

1.1 Purpose and Goals of the E/PO Program

The purpose of the Phoenix E/PO program is to make a valuable contribution to education and outreach by strengthening public understanding of and participation in the science and technology that characterize our exploration of Mars. In this way, the Phoenix E/PO program is designed to augment the overall mission, where the goals of the E/PO program directly flow from the mission objectives (Table 1). Such linkage is in accordance with guidance from NASA's Science Mission Directorate (formerly NASA's Office of Space Science).[1]

These E/PO goals are designed to (1) pioneer innovative and/or (2) enhance existing outstanding educational and outreach materials. By doing so, the Phoenix E/PO program provides a high-value contribution to NASA's educational program (see Section 1.2.1), the Science Mission Directorate's education and public outreach efforts (see Section 1.2.1), and the Mars Public Engagement Plan (see Section 1.2.2). Also, in order to provide continuity between the various formal, informal and public outreach activities,[2] the thematic educational strands listed in Table 1 provide a succinct categorization of the program goals.

Table 1. Relationship of Mission and E/PO Goals to Educational Strands

Phoenix Mission Objective	Phoenix E/PO Goal	Thematic Strand
Study the history of water in the martian arctic.	Facilitate understanding of the properties of water that are essential for life.	*Water and Life*
Search for habitable zones in the martian permafrost.	Develop awareness of the role of matter-energy interactions in living organisms and their environment.	*Soil Habitability*
Develop a robotic system to successfully explore the environment near Mars' north pole.	Simulate challenges that provide authentic learning environments for appreciating the role of robotics and technology in space exploration.	*Robotics*

[1]Intrinsic Merit Criteria 1 in the *Explanatory Guide to the NASA Office of Space Science Education & Public Outreach Criteria*, Version 3.0, March 2004, page 8, available at http://ssibroker.colorado.edu/Broker/Eval_criteria/.

[2]According to the explanatory guide referenced footnote 1, "there are no rigorous definitions to differentiate between [formal and informal] education, and public outreach…[Formal] education refers to products or sustained services associated with formal classroom learning such as curriculum development, professional development of teachers, or support for systemic [K-12] reform efforts…Informal education engages students, educators, and the general public in settings away from the classroom (e.g. school field trips to science centers)…"Public Outreach" may be thought of as referring to products or services that involve one-time or short-duration contact with the public…that informs, excites interest, and arouses curiosity." Although not "rigorous" definition in this document, these will be used as the operational definitions for the primary E/PO venues.

As listed below, each strand has a specific objective that details how the E/PO goals are to be met, providing a framework to ensure that each activity is aligned with the overall mission goals.

Water and Life. *The objective of this strand is to address a current void present in science education by promoting the exploration and understanding of the physical, chemical, and thermodynamic properties of water that make it an essential ingredient for life.*

Soil Habitability. *The objective of this strand is to promote and enable students and the public to utilize authentic scientific data and images to analyze the chemical properties of Mars' soil to infer potential habitability.*

Robotics. *The objective of this strand is to use exhibits and project-based learning activities in order to foster appreciation and understanding by students and the public about the role of robotics in space exploration and scientific data collection.*

1.2 E/PO Program Alignment

As part of NASA's education efforts, the Phoenix E/PO program is designed to be aligned with policies from NASA Headquarters[3] and with the agency's Mars Public Engagement Plan (a management organization centered at the Jet Propulsion Laboratory and coordinated by the Mars Exploration Program). The Phoenix E/PO program also endeavors to make a contribution to America's scientific and technical literacy, and is therefore aligned with national education reform efforts. These alignments are discussed in more detail in the following three sections.

1.2.1 Alignment with NASA Headquarters

The strategy of the NASA's Education Office[4] is to support the agency's mission by inspiring and motivating "students at all levels to pursue careers in the fields of science, technology, engineering, and mathematics (STEM)" with a particular attention focused on underserved and underrepresented communities. The NASA Education Office also has a "strong supporting role in achieving the agency's goal to engage the public in shaping and sharing the experience of exploration and discovery." To implement this strategy, the Education Office has developed a "pipeline" concept, whereby students are encouraged to pursue an ongoing affiliation with NASA throughout their education, and ultimately, to seek STEM careers. According to NASA, "this will contribute to the

[3]Note that for the purpose of this report, NASA Headquarters includes both the Science Mission Directorate's E/PO policies and NASA's Office of Education. The policies of these two organizations are virtually identical and therefore, to avoid redundancy, one section is used to show alignment with the both entities.
[4]*National Aeronautics and Space Administration Education Enterprise Strategy,* October 1, 2003, Office of Education, NASA Headquarters, Washington, DC, available at http://education.nasa.gov.

continued availability of trained scientists, technologists, engineers, and educators to meet our nation's workforce needs of the 21st Century."

In support of NASA's STEM pipeline, the Phoenix E/PO program provides a comprehensive suite of K-12 formal education, as well as informal education and public outreach activities.

As shown in Figure 1, Phoenix E/PO activities follow a "pyramid structure," with those at the pinnacle directly supporting both NASA's and the nation's need to expand the pool of human capital that is scientifically and technically adept. Such programs that encourage pursuit of STEM careers include the Phoenix Students Intern and Arizona Space Grant Consortium BalloonSat Programs (See Sections 3.1.3 and 3.1.4, respectively). Both of these programs provide high-quality, one-on-one educational and research experiences, where underserved students interface directly with Phoenix science and engineering team members serving as mentors. At the base of this pyramid, are activities such as the "Big Dig" *MarsQuest* exhibit (see Section 3.2.1), which will reach millions of people and provide fundamental and general content about the Phoenix Mission. **Most importantly, Phoenix E/PO is designed to use Mars exploration as a vehicle to deepen understanding of key educational (in the formal setting) and literacy (in the informal and outreach setting) standards.**

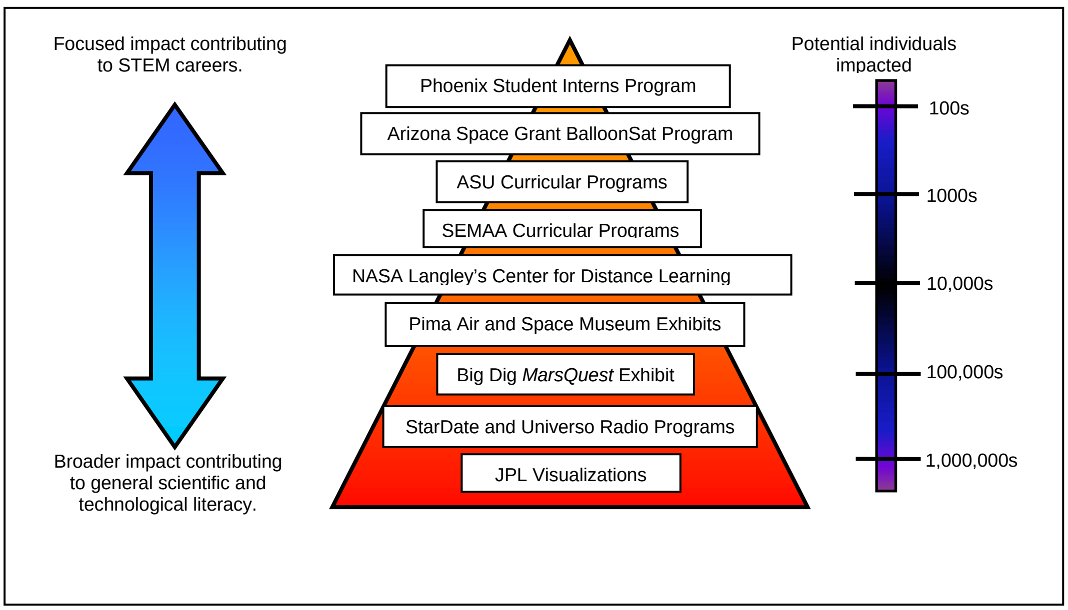

Figure 1. Schematic of pyramid structure of Phoenix E/PO activities.

1.2.2 Alignment with the Mars Public Engagement Plan

The goals of the Phoenix E/PO program interface directly with the long-term goals and supporting objectives of the Mars Exploration Program's Public Engagement Plan[5]. **In this way, Phoenix will "take advantage of the pre-existing infrastructure for cost-sharing and cost-saving, as well as bring new and creative ideas to the program"** (as stated in the Mars Public Engagement Plan).

The activities supported by the Mars Public Engagement Plan fall into the four broad categories listed in Table 2. Each of these broad categories contains a number of "threads," specific focus areas providing clarity and structure to the program. The integration of Phoenix E/PO with these threads is highlighted in Table 2, and when warranted, discussed in more detail later in the report.

Table 2. Integration of Phoenix E/PO with the Mars Public Engagement Plan

Activity	Thread	Phoenix E/PO Integration
Crosscutting	Manage-ment	**As an integral part of the Phoenix Mission, the E/PO program participates in all critical event reviews, in which the Mars Public Engagement Plan Manager is a primary participant**. Progress towards Phoenix E/PO goals will also be reported to Mars Public Engagement on a quarterly basis. The Mars Public Engagement Plan will act as the conduit for Phoenix mission's numerical input to NASA's E/PO tracking and reporting system.
	Community Input	The Mars Public Engagement Plan will participate in the Phoenix Science Team meetings. Feedback from the team members will be used to guide and revise Phoenix E/PO activities, as well as Mars Public Engagement Plan efforts.
	Visuali-zations	Science and E/PO visualizations created for the Phoenix Mission will be provided to the Mars Public Engagement Plan for their use and dissemination. The visualizations will be critical for public understanding of the *Water and Life, Soil Habitability,* and *Robotics* thematic strands.
	Speaker Support	With the aid of the Mars Public Engagement Plan, Phoenix E/PO will create speaker materials in electronic format detailing the science and engineering behind the mission. These materials will be public friendly and technically accurate. **Phoenix Mission scientists and engineers will provide a dynamic cadre of speakers for the Mars Public Engagement Plan, allowing for direct interactions with the students and the public**. The Mars Public Engagement Plan will selectively support travel of team members to support activities at museums and other centers of learning.

[5]The Mars Public Engagement Plan is both a report and a management organization, with a manager and support staff located at JPL. In this report, the Mars Public Engagement Plan almost always refers to the management organization.

Table 2. Integration of Phoenix E/PO with the Mars Public Engagement Plan

Activity	Thread	Phoenix E/PO Integration
Formal Education	Student Imaging and Analysis	The ASU's Mars Education Program is responsible for implementing this thread of the Mars Public Engagement Plan. Phoenix E/PO will support this partnership by working directly with the Mars Education Program to create classroom activities using authentic data obtained from the mission's payload and interoperability test bed and from the lander itself (see Section 3.1.1). The activities developed with ASU will provide the fundamental base for Phoenix E/PO's *Soil and Habitability* thematic stand.
	Robotics Education	Phoenix E/PO activities contained in its *Robotics* thematic strand will support and enhance the efforts of the Mars Public Engagement Plan. The Phoenix Student Intern Program will be a continuation of the Athena Student Interns Program developed for the 2004 rover missions, and will provide high-quality internships for high school students. Also, Phoenix E/PO will also work to develop a long-term partnership with NASA's SEMAA Program to enhance the existing Mars Public Engagement Plan robotics activities.
	Arts, Letters, and Humanities	In collaboration with NASA's SEMAA program, Phoenix E/PO will develop an integrated robotics education and reading literacy module for grades K-3. This will support the Mars Public Engagement Plan in disseminating information about Mars science and engineering activities through reading, while also being relevant to the curricular needs of early elementary students.
	Nationwide Workshops	Keeping with the philosophy of the Mars Education Plan that to be effective in reaching students teachers must be trained in content that is both scientifically and pedagogically sound, Phoenix E/PO will conduct a suite of workshops. Teaming with high-quality educational outreach programs (e.g., ASU's Mars Education Program, Space Science Institute, and the Arizona Space Grant Consortium), Phoenix personnel and material will be used as resources to provide teacher workshops across the country. Additionally, the Mars Public Engagement Plan will use educational material developed by the Phoenix Mission at the workshops they support.
Informal Education	Networks and Alliances	Educational and outreach materials developed by the Phoenix Mission will be distributed to museums, science centers, and planetaria through the Mars Museum Alliance, a program supported by the Mars Public Engagement Plan. The Mars Public Engagement Plan will coordinate with Phoenix E/PO on the distribution and use of education and public outreach resources to JPL's Solar System Ambassadors and Educators Programs.
	Models and Exhibits	The Phoenix Mission will provide model drawings and diagrams so that the Mars Public Engagement Plan can facilitate the development of Phoenix lander models throughout the country. Similarly, the Mars Public Engagement Plan will coordinate with the Phoenix Mission to receive scientific content and visualizations needed to create informal exhibits about the mission. The Mars Public Engagement Plan may supplement models developed by Phoenix E/PO for greater reach and these models would be made available through the Mars Museum Alliance.
	Docent and Curator Training	The Mars Public Engagement Plan will coordinate with Phoenix E/PO to obtain mission scientists and engineers to participate in telecons with the Mars Museum Alliance and other informal education venues.

Table 2. Integration of Phoenix E/PO with the Mars Public Engagement Plan

Activity	Thread	Phoenix E/PO Integration
Public Information and Outreach	Internet Initiatives	**To provide maximum efficiency of Web resources, the Phoenix Web site will be constructed with a format that is parallel to the Mars Mission Program sites.** By doing so, the Mars Mission program will be able to link directly to the Phoenix Web site and not create an additional site for the mission residing on the JPL Web server. This will prevent discontinuity in information that could exist with two mission sites. The Phoenix mission will coordinate with the Mars Public Engagement Plan to ensure the scientific data from the mission are provided to the public as soon as reasonable (see Section 6.4 for more information on public release of scientific data).
	Media Support Initiatives	The Mars Public Engagement Plan will provide resources to the Phoenix Mission to develop documentary footage that may be used for public outreach purposes. Additionally, the Mars Public Engagement Plan supports links of education and public outreach activities with public affairs. Note: a Phoenix Mission Public Affairs Plan will be developed separately from this plan, and will be coordinated with JPL and NASA Headquarters Public Affairs offices.
	Community -building Initiatives	The Mars Public Engagement Plan conducts periodic nationwide presentations and activities to facilitate public understanding of Mars exploration. The Mars Public Engagement plan will coordinate with Phoenix E/PO to obtain the necessary content and materials to support these activities.
	Commercil-ization	Commercialization of any Phoenix-related material will be coordinated with the Mars Public Engagement Plan.

1.2.3 Alignment with Educational Reform Efforts

To ensure value to the educational community and a significant contribution to the nation's scientific and technological literacy, **Phoenix E/PO's goals have a substantive link to educational standards**. Activities and programs developed by Phoenix E/PO will be used nationwide, and therefore the standards addressed by the program represent educational reform efforts promoted by national and international organizations, including the National Research Council's *National Science Education Standards*[6], the American Association for the Advancement of Science's *Benchmarks for Science Literacy*[7], the International Society for Technology in Education's *Technology Standards for All Students*[8], and the National Council of Teachers of Mathematics' *Principles and Standards for School Mathematics*[9]. These standards encourage optimal learning by

[6]The *National Science Education Standards* were developed by the National Academy of Sciences in 1996. The standards can be accessed via the Internet at http://www.nap.edu/catalog/4962.html.
[7]The *Benchmarks for Science Literacy* were developed by the American Association for the Advancement of Science in 1993. The benchmarks can be accessed via the Internet at http://www.project2061.org/tools/benchol/bolintro.htm.
[8]The *Technology Standards for All Students* were developed by the International Society for Technology in Education in 2000. These standards can be accessed via the Internet at http://cnets.iste.org/students/s_stands.html.
[9]The *Principles and Standards for School Mathematics* were developed by the National Council of Teachers of Mathematics in 2000. These standards can be accessed via the Internet at

listing the content, skills, and methods needed to achieve their goals of scientific, mathematical, and technological literacy.

Program goals and activity objectives will be aligned with national content, skill, and professional development standards.

The Phoenix E/PO goals are specifically designed to address the science and technology content standards. For example, the goal of the *Water and Life* strand–to facilitate understanding of the properties that are essential for life–encapsulates several of the physical and life science content strands from the *National Science Education Standards*. Similarly, the goal of the *Soil Habitability* Strand–to develop awareness of the role of matter-energy interactions in living organisms–is a direct distillation of “Flow of Matter and Energy in Living Systems” *Benchmark for Science Literacy*. Finally, the goal of the *Robotics* strand–to simulate challenges that provide authentic learning environments for appreciating the role of robotics and technology in space exploration–is derived from *National Educational Technology Standards* that promote learning about the nature and operation of technology to increase productivity, promote creativity, and solve problems.

In addition to content, standards that address skills will be addressed by the Phoenix E/PO program. One such skill, included in the *National Science Education Standards,* is the ability to do scientific inquiry. Another skill, part of the *Principles and Standards for School Mathematics*, is to collect, organize, graph, and analyze data in order to make inferences and conclusions. Both of these skills will be inherent in activities and programs developed by Phoenix E/PO, providing the students and the general public to use actual and simulated mission data.

The Phoenix E/PO program will also support standards for the professional development of educators. As scientific and technological advances occur, teachers’ understanding of those advances must maintain pace in order to effectively facilitate student learning. Because the Phoenix Mission is at the forefront of understanding the nature of the martian environment’s ability to support life, teachers will have excellent opportunities to increase their understanding of fundamental scientific and technological concepts through workshops and the ability to participate in mission science operations with the Phoenix Student Internship Program.

School curricula must be aligned, not with these national standards, but with their respective state standards. Although the standards associated with the national reform efforts discussed above have influenced the formation of state education standards, these state standards vary appreciably and are most often much more specific than their national counterparts. This variability provides a significant challenge for the Phoenix E/PO program, which is national in scope.

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http://standards.nctm.org/ (note: standards may be accessed free for 90 days, and after that, a subscription is required).

To avoid spending an unreasonable amount of time aligning with each state's standards, Phoenix E/PO activities and programs will be aligned with national standards to a high degree of specificity making the teacher's task of aligning our activities to their particular state's standards much easier.

Tables 3, 4, and 5 show the alignment of the E/PO educational strands with *the National Science Education Standards*, the *Principles and Standards for School Mathematics*, and *the National Educational Technology Standards*, respectively. Because the *National Science Education Standards* are strongly based on the *Benchmarks for Science Literacy*, a separate table showing alignment with the benchmarks is not included in this report.

Table 3. National Science Education Standards Addressed by Each of the Educational Strands.

		Water and Life	***Soil Habitability***	***Robotics***
Grades K-4				
Content Standard A: Science as Inquiry				
	Students should develop abilities to do scientific inquiry.	√		√
	Students should deepen understanding of scientific inquiry.	√		√
Content Standard B: Physical Science				
	Students should develop an understanding of properties of objects and materials.	√		
	Students should develop an understanding of position and motion of objects.	√		√
Content Standard C: Life Science				
	Students should develop understanding of the characteristics of organisms.	√		
Content Standard D: Earth and Space Science				
	Using Mars as an analog, students should develop an understanding of properties of earth materials.	√		
	Students should develop understanding of objects in the sky			√
	Using Mars as an analog, students should develop understanding of changes in the Earth and sky.	√	√	√
Content Standard E: Science and Technology				
	Students should develop abilities of technological design.			√
	Students should develop understanding about science and technology.			√
Content Standard F: Science in Personal and Social Perspectives				
	Students should develop understanding of science and technology in local challenges.			√
Content Standard G: History and Nature of Science				
	Students should develop understanding of science as a human endeavor	√		√

Table 3. National Science Education Standards Addressed by Each of the Educational Strands.

	Water and Life	Soil Habitability	Robotics
Grades 5-8			
Content Standard A: Science as Inquiry			
Students should develop abilities to do scientific inquiry.	√	√	√
Students should deepen understanding of scientific inquiry.	√	√	√
Content Standard B: Physical Science			
Students should deepen understanding of properties and changes of properties in matter.	√	√	
Students should deepen understanding of motions and forces.			√
Students should deepen understanding of transfer of energy.		√	
Content Standard C: Life Science			
Students should deepen understanding of structure and function in living systems.	√		
Students should deepen understanding of populations and ecosystems.	√	√	
Students should deepen understanding of diversity and adaptations of organisms.		√	
Content Standard D: Earth and Space Science			
Using Mars as an analog, students should deepen understanding of the structure of the Earth system.	√		
Students should deepen understanding of Earth in the Solar System.	√	√	√
Content Standard E: Science and Technology			
Students should develop abilities of technological design.		√	√
Students should develop understanding about science and technology.		√	√
Content Standard F: Science in Personal and Social Perspectives			
Students should develop understanding of science and technology in society.	√	√	√
Content Standard G: History and Nature of Science			
Students should deepen understanding of science as a human endeavor.	√	√	√
Students should develop understanding of the nature and history of science.	√	√	√
Grades 9-12			
Content Standard A: Science as Inquiry			
Students should develop abilities to do scientific inquiry.	√	√	√
Students should deepen understanding of scientific inquiry.	√	√	√
Content Standard B: Physical Science			
Students should deepen understanding of the structure and properties of matter.	√	√	
Students should deepen understanding of chemical reactions.	√	√	
Students should deepen understanding of motions and forces.			√
Students should deepen understanding of interactions of energy and matter.	√	√	

Table 3. National Science Education Standards Addressed by Each of the Educational Strands.

		Water and Life	*Soil Habitability*	*Robotics*
Content Standard C: Life Science				
	Students should deepen understanding of the cell.	√		
	Students should deepen understanding of biological evolution.		√	
	Students should deepen understanding of matter, energy, and organization in living systems.	√	√	
Content Standard D: Earth and Space Science				
	Using Mars as an analog, students should deepen understanding of geochemical cycles.	√	√	
	Students should deepen understanding of the origin and evolution of the Earth system.	√	√	√
Content Standard E: Science and Technology				
	Students should develop abilities of technological design.		√	√
	Students should develop understanding about science and technology.		√	√
Content Standard F: Science in Personal and Social Perspectives				
	Students should develop understanding of science and technology in local, national and global challenges.	√	√	√
Content Standard G: History and Nature of Science				
	Students should deepen understanding of science as a human endeavor.	√	√	√
	Students should develop understanding of the nature of scientific knowledge.	√	√	√
Teachers				
Professional Development Standard A: Professional development of science teachers requires learning essential science content through the perspectives and methods of inquiry.		√	√	√
Professional Development Standard B: Professional development for science teachers requires integrating knowledge of science, learning, pedagogy, and students.		√	√	√
Professional Development Standard C: Professional development of science teachers requires building understanding and abilities of lifelong learning.		√	√	√
Professional Development Standard D: Professional development of science teachers must be coherent and integrated.		√	√	√

Table 4. Principle and Standards for School Mathematics Addressed by Each of the Educational Strands.

		Water and Life	Soil Habitability	Robotics
Grades K-2				
Algebra Standard				
	Students should be able to sort, classify, and order objects by size, number, and other properties.	√		√
	Students should describe quantitative change.	√		√
Geometry Standard				
	Students should describe, name, and interpret relative positions in space and apply ideas about relative positions.			√
	Students should describe, name, and interpret direction and distance in navigating space and apply ideas about direction and distance.			√
	Students should find and name locations with simple relationships such as “near to” and in coordinate systems such as maps.			√
Measurement Standard				
	Students should recognize the attributes of length, volume, weight, area, and time, and compare and order objects according to these attributes.	√		√
	Students should understand how to measure using nonstandard and standard units and select an appropriate tool to measure.	√		√
Data Analysis and Probability Standard				
	Students should gather data and represent those data using concrete objects, pictures, and graphs.	√		√
	Students should describe parts of the data and the set of data as a whole to determine what the data show.	√		√
Grades 3-5				
Algebra Standard				
	Students should be able to model using words, tables, and graphs.	√	√	√
Geometry Standard				
	Describe location and movement using coordinate systems by specifying locations and determining paths.			√
Measurement Standard				
	Students should understand the attributes of length, area, volume, weight and time, and select the appropriate unit to measure these attributes.	√	√	√
	Students should understand that measurements are approximations and understand how differences in units affect precision.	√	√	√
Data Analysis and Probability				
	Students should collect data and represent these data using tables and graphs.	√	√	√
	Students should propose and justify conclusions and predictions that are based on data and design studies to further investigate the conclusions and predictions.	√	√	√

Table 4. Principle and Standards for School Mathematics Addressed by Each of the Educational Strands.

		Water and Life	Soil Habitability	Robotics
Grades 6-8				
Number and Operations Standard				
	Develop an understanding of large numbers and recognize and appropriately use scientific notation.	√	√	√
Algebra Standard				
	Use graphs to analyze the nature of changes in quantities in linear relationships.	√	√	
Measurement Standard				
	Students should understand, select, and use units of appropriate size and type to measure area and volume.	√	√	√
	Students should use common benchmarks to select appropriate methods for estimating measurement and tools to accurately find length, area, and volume.	√	√	√
Data Analysis and Probability				
	Students should formulate questions, design studies, and collect data about a characteristic shared variable or different characteristics within one variable.	√	√	√
	Students should select, create, and use appropriate graphical representations of data.	√	√	√
	Students should make conjectures about possible relationships between two characteristics of a sample on the basis of scatter plots of the data and approximate lines of fit.	√	√	√
Grades 9-12				
Number and Operations Standard				
	Develop a deeper understanding of very large and very small numbers and various representations of them.	√	√	√
Geometry Standard				
	Draw and construct representations of two- and three-dimensional objects using a variety of tools.			√
Measurement Standard				
	Students should make decisions about units and scales that are appropriate for problem solving situations involving measurement.	√	√	√
	Students should analyze precision, accuracy, and approximate error in measurement situations.	√	√	√
Data Analysis and Probability				
	Students should understand the meaning of measurement data and the term variable.	√	√	√
	Students should be able to display a scatter plot, describe its shape, determine regression coefficients, regression equations, and correlation coefficients.	√	√	√

Table 5. National Educational Technology Standards Addressed by Each of the Educational Strands.

		Water and Life	Soil Habitability	Robotics
Social, ethical, and human issues				
	Students understand the ethical, cultural, and societal issues related to technology.			√
	Students develop positive attitudes toward technology uses that support lifelong learning, collaboration, and productivity.			√
Technology productivity tools				
	Students use technology tools to enhance learning, increase productivity, and promote creativity.	√	√	√
	Students use productivity tools to collaborate in constructing technology-enhanced models, prepare publications, and produce other creative works.	√	√	√
Technology communications tools				
	Students use a variety of media and formats to communicate information and ideas effectively to multiple audiences.	√	√	√
Technology research tools				
	Students use technology to locate, evaluate, and collect information from a variety of sources.	√	√	√
	Students use technology tools to process data and report results.	√	√	√
	Students evaluate and select new information resources and technological innovations based on the appropriateness for specific tasks.	√	√	√
Technology problem-solving and decision making tools				
	Students use technology resources for solving problems and making informed decisions.	√	√	√
	Students employ technology in the development of strategies for solving problems in the real world.	√	√	√

2. Program Management

The Phoenix Mission Principal Investigator, Mr. Peter Smith, has full responsibility for guiding the mission, including E/PO activities. **In his 15 years experience in leading aerospace instrument programs, Mr. Smith has demonstrated full commitment to E/PO**. Specifically, Mr. Smith (1) provides leadership, motivation, and direction for the Phoenix E/PO program; (2) ensures that E/PO activities are consistent with the scientific and engineering goals of the mission; and (3) provides oversight to ensure that all E/PO products are scientifically and technically accurate.

The Phoenix E/PO Manager, Mr. Doug Lombardi, oversees the E/PO program under the direct supervision of the Principal Investigator. Mr. Lombardi (1) provides a focused direction for the E/PO program and its partners; (2) coordinates all E/PO activities with all participants, including the mission science and engineering teams, the Mars Public Engagement Plan, the Science Mission Directorate E/PO, and the NASA Office of Education; (3) combines mission science and engineering with innovative learning ideas, and (4) manages the schedule and budget to ensure achievement of the Phoenix E/PO goals.

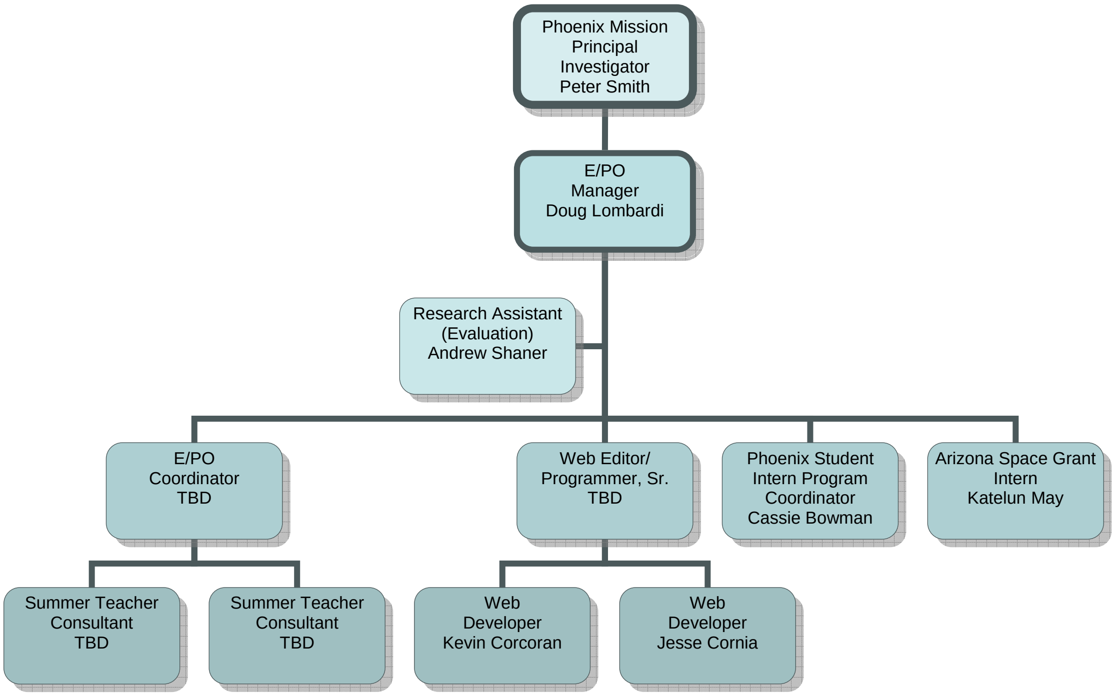

Figure 2. Phoenix E/PO organizational chart.

An E/PO Coordinator will join the team in the summer of 2005 and be responsible for coordinating E/PO programs and activities under the direction of the E/PO Manager. The E/PO Coordinator will also oversee two local area teachers, who will act as program consultants during the summers of 2005-2008 to develop and review E/PO materials. These teachers will assist with conducting E/PO activities held during the summer (e.g., teacher workshops).

A Web Editor/Programmer will join the team in the spring of 2005 to design and maintain a Web site that upholds the Phoenix E/PO goals and provides a dynamic and useful public portal for E/PO materials and content. Two student Web developers, Mr. Kevin Corcoran and Mr. Jesse Cornia, will manage the Phoenix Mission Web site until the Web Editor/Programmer is hired.

Ms. Cassie Bowman, a graduate student at Harvard University, will work part-time to coordinate the Phoenix Student Interns Program, facilitating communications among the science and engineering team mentors and the teacher/student intern teams. Ms. Bowman will work under the supervision of the E/PO Manager and be guided by Dr. Ray Arvidson, Phoenix Mission Co-Investigator (see Section 3.1.3 for more information about the Phoenix Student Interns Program).

The University of Arizona/NASA Space Grant Program will provide an undergraduate research intern, Ms. Katelun May, to work with the Phoenix E/PO program. This intern will assist the E/PO manager in designing and developing E/PO materials.

Independent evaluation of the Phoenix E/PO program will be conducted by the University of Arizona's Conceptual Astronomy and Physics Education Research (CAPER) Team. Mr. Andrew Shaner, a graduate student with the team, is assigned as the evaluation research assistant and will conduct the day-to-day operations of the internal evaluation effort (see Section 4 for more information about the program evaluation).

The E/PO team is integral to the success of the Phoenix Mission and will participate in all mission critical reviews. In support of these reviews and the overall program, the Phoenix E/PO team will develop annual implementation plans, including partnership agreements, scheduling, and budget tracking. Progress toward E/PO milestones and financial accounting will be reported in the monthly Principal Investigator Status Report. (Details on program schedule and financial reporting are found in Sections 6.1 and 6.2, respectively.)

The Phoenix science team is providing a major contribution to the mission's E/PO program by contributing 5% of their time on the project to E/PO activities.

Phoenix science team members are located throughout the country, providing a national network of speaker support to science centers, museums, planetaria, schools, colleges, and universities. In addition to school and public presentations, science team members will create and review E/PO materials. Table 6 lists the science team members and associated E/PO activities in which they are participating.

Table 6. Phoenix Science Team involvement in E/PO Activities.

Science Team Member	Location	E/PO Activities
Ray Arvidson	Washington University, St. Louis, Missouri	Mission Director for the Phoenix Student Interns Program. Local presentations at the St. Louis Science Center, and area schools, colleges, and universities.
Diana Blaney	Jet Propulsion Laboratory, Pasadena, California	Local presentations at the Griffith Observatory, Southern California Science Center, and area schools, colleges, and universities.
William Boynton	University of Arizona, Tucson, Arizona	Local presentations at Flandrau Space Science Center, the Tucson Children's Museum, and local area schools, colleges, and universities.
David Catling	University of Washington, Seattle, Washington	Local presentations at the Pacific Science Center and area schools, colleges, and universities.
Ben Clark	Lockheed Martin, Denver, Colorado	Local presentations at the Denver Museum of Nature and Science and, and area schools, colleges, and universities.
Eric DeJong	Jet Propulsion Laboratory, Pasadena, California	Developer of E/PO visualizations and dissemination of raw images to the public Local presentations at the LA Adventures Club and area schools, colleges, and universities.

Table 6. Phoenix Science Team involvement in E/PO Activities.

Science Team Member	Location	E/PO Activities
Michael Hecht	Jet Propulsion Laboratory, Pasadena, California	Local presentations at area schools, colleges, and universities.
John Hoffman	University of Texas, Dallas, Texas	Support of local teacher workshops. Local presentation at the Dallas Science Place and area schools, colleges, and universities.
Samuel Kounaves	Tufts University, Medford, Massachusetts	Local presentations at the Boston Museum of Science and area schools, colleges, and universities.
Mark Lemmon	Texas A & M University, College Station, Texas	Local presentations at the Tarleton Science Planetarium and area schools, colleges, and universities.
Mike Malin	Malin Space Science Systems, San Diego, California	Local presentations at the Reuben Fleet Science Center, San Diego Aerospace Museum, and area schools, colleges, and universities.
John Marshall	SETI Institute, Mountain View, California	Local presentations at area schools, colleges, and universities.
Karen McBride	NASA HQ, Washington, D.C.	Local presentations at the National Air and Space Museum, National Geographic Explorers Hall, and area schools, colleges, and universities.
Chris McKay	NASA Ames Research Center, Sunnyvale, California	Local presentations at the Independence Planetarium and area schools, colleges, and universities.
Mike Mellon	University of Colorado, Boulder, Colorado	Local presentations at Fiske Planetarium and area schools, colleges, and universities.
Doug Ming	NASA Johnson Space Center, Houston, Texas	Local presentations at Space Center, Houston and area schools, colleges, and universities.
Richard Morris	NASA Johnson Space Center, Houston, Texas	Local presentations at Space Center, Houston and area schools, colleges, and universities.
Nilton Renno	University of Michigan, Ann Arbor, Michigan	Creation of a Spanish language Phoenix Mission Web site. Local presentation at the Ann Arbor Hands-on Museum and area schools, colleges, and universities.
Peter Smith	University of Arizona, Tucson, Arizona	Oversight of E/PO Program. Scientific review of all E/PO Materials. Local presentations at the Pima Air and Space Museum, Flandrau Science Center, Arizona Science Center, Tucson Children's Museum and area schools, colleges, and universities.
Carol Stoker	NASA Ames Research Center, Sunnyvale, California	Local presentations at the Lawrence Hall of Science and area schools, colleges, and universities.
Leslie Tamppari	Jet Propulsion Laboratory, Pasadena, California	Local presentations at Glendale Community College Planetarium and area schools, colleges, and universities.
Aaron Zent	NASA Ames Research Center, Sunnyvale, California	Local presentations at the Exploratorium Museum and area schools, colleges, and universities.

3. Partnerships and Planned Activities

In order to provide the greatest value for its E/PO funds, the Phoenix E/PO program is designed to partner with existing exemplary NASA education and outreach programs, as well as outstanding programs outside of the NASA community.

Phoenix E/PO's high-quality partner organizations not only create superior educational and outreach materials, they also have well-established and wide-ranging distribution networks that enable Phoenix E/PO materials and activities to reach the largest number of individuals possible.

The Phoenix E/PO partnerships and planned activities are summarized in Table 7 below.

Table 7. Partnerships and Planned Activities at a Quick Glance

Partner	Supported Strand	Formal Education			Informal Education	Public Outreach
		K-4	5-8	9-12		
NASA Langley's Center for Distance Learning	*Water and Life*	×	×	×		×
ASU Mars Education Program	*Soil Habitability*		×	×		
Space Science Institute	*Robotics*				×	×
NASA's SEMAA Program	*Robotics*	×				
Phoenix Student Interns Program	All			×		
Arizona Space Grant Consortium	*Robotics*		×	×		
Mars Public Engagement Plan	All	×	×	×	×	×
JPL Visualizations	All				×	×
Arizona Aerospace Foundation	All				×	
McDonald Observatory	All				×	×
National Optical Astronomy Observatory	All	×	×	×	×	

By teaming with these organizations, Phoenix E/PO aims to enhance existing educational and public outreach efforts and increase the overall effectiveness and impact of their activities. The following subsections provide more information on the activities planned with these partners, including the scheduled major milestones. These subsections are broken down by partner. A more detailed chronological listing of all significant milestones (listed specifically as receivables and deliverables) is included Section 6.1.

3.1 Formal Education

The partners and activities in this section are considered predominately formal education, although significant pieces of these activities may be used for informal education and public outreach.

3.1.1 ASU Mars Education Program

This education program combines the resources of JPL and ASU, offering students nationwide the opportunity to be involved in authentic Mars research. In this program, the already powerful vehicle of Mars exploration to capture the students' imagination is reinforced by incorporating actual planetary data, thereby making the experience more relevant and educationally valuable. Thousands of students and educators use these materials through several venues, including: (1) the ASU Planetary Imaging and Analysis Facility (located on the ASU campus), (2) videoconferencing, (3) the Internet, and (4) ground mail. This variety of curriculum delivery ensures high-tech, low-tech, and no-tech access, enabling all schools and educational groups to participate. Partnership activities between Phoenix E/PO and the ASU Mars Education Program are listed below, with a detailed statement of work in Section 6.8, p. 71.

Activity Code	ASU-1
Activity Description	Martian soil properties curriculum for grades 5-12.
Supported Strand	*Soil Habitability*
Activity Objective	Through comparison, facilitate understanding about the similarities and differences between soil properties on Earth and Mars.
Major Milestones	• Beta-test print-based curriculum module developed by ASU in Adobe® Acrobat® format suitable for printing and posting on both the ASU and mission Web site to Phoenix E/PO—02/01/06 • Beta-test Web-based distance learning module developed by ASU posted on the ASU Web site with a link from the mission Web site—12/01/06 • Final version of print- and Web-based curriculum module—09/01/07

Activity Code	ASU-2
Activity Description	Martian soil habitability curriculum for grades 5-12.
Supported Strand	*Soil Habitability*
Activity Objective	Facilitate understanding about the properties of Earth soil that make habitable for organisms and how martian soil will be explored to determine if it too is habitable or can be made habitable.
Major Milestones	• Print-based curriculum module developed by ASU in Adobe® Acrobat® format suitable for printing and posting on both the ASU and mission Web site to Phoenix E/PO—04/01/06 • Web-based distance learning module developed by ASU, posted on the ASU Web site with a link from the mission Web site—02/01/07 • Final version of print- and Web-based curriculum module—09/01/07

Activity Code	ASU-3
Activity Description	Activities from the two curriculum modules above and other materials developed by Phoenix E/PO in teacher workshops conducted by ASU.
Supported Strand	*Water and Life*, *Soil Habitability*, and *Robotics*
Activity Objective	Use inquiry, reflection, interpretation of research, modeling, and guided practice to increase understanding and skills in science teaching.
Major Milestones	• Phoenix E/PO materials developed by Phoenix E/PO to ASU for presentation at Spring and Fall 2005 ASU Mars Education Workshops—specific dates to be determined • Phoenix E/PO materials developed by Phoenix E/PO and materials developed by ASU presented at Spring and Fall ASU Mars Education Workshops in 2006, 2007, 2008, and 2009—specific dates to be determined

Activity Code	ASU-4
Activity Description	Mars Exploration Student Data Teams (MESDT) for grades 5-12.
Supported Strand	*Soil Habitability*
Activity Objective	Provide authentic inquiry-based learning through use of data collected by the Phoenix Mission to make assessments about potential soil habitability of Mars' arctic plains.
Major Milestones	• The MESDT Web site (residing at ASU and linked from the Phoenix Mission Web site) ready for operation—01/01/08 • Commencement of the MESDT active operations—Phoenix landing, currently scheduled for 06/01/08

3.1.2 NASA's SEMAA Program

NASA's SEMAA program is an innovative national initiative designed specifically to motivate K-12 minority, urban, and/or rural students to seek STEM careers. Students meet during school, after school, or on Saturday mornings to engage in hands-on, interactive learning sessions that are specifically designed for each grade level. SEMAA is located at twenty different sites throughout the United States, including a site headquartered at Central Arizona College (CAC), which serves K-12 students in rural Pinal County, Arizona. In its efforts to enhance the learning of science, mathematics, and engineering, CAC SEMAA collaborates with the Pinal County Gifted Consortium by providing engaging and intensive educational opportunities to rural students. The Pinal County Gifted Consortium and SEMAA have agreed to partner with Phoenix E/PO in a complete cost-sharing basis, meaning that no funds will be exchanged between the three organizations. The following lists the major activities associated with the partnership with detailed letters of agreement in Section 6.8, p. 84.

Activity Code	SEMAA-1
Activity Description	"Mission to Mars" integrated reading, science, mathematics, and technology curriculum for grades 1-4
Supported Strand	*Robotics*
Activity Objective	Students will experience twenty hands-on, minds-on activities to investigate the martian environment and technologies of space exploration, fostering a fundamental inspiration to study reading, science, and mathematics further.
Major Milestone	Field-tested curricula developed by CAC SEMAA available in Adobe® Acrobat® format suitable for printing and posting on the mission Web site to Phoenix E/PO and National SEMAA Office—08/31/05

3.1.3 Phoenix Student Interns Program

The Phoenix Student Intern Program (PSIP) is a direct offshoot of the Athena Student Intern Program—a joint effort between the Mars Public Engagement Plan and the Athena Science Investigation Team, the organization leading the science activities of the Mars Exploration Rovers. As with the Athena Student Intern Program, PSIP is designed to actively engage high school teachers and their students in Mars exploration and scientific inquiry. The idea is to provide outstanding educational opportunities through direct participation on these missions. By closely working with science and engineering team mentors, students become highly motivated to pursue careers in STEM. Co-investigator, Dr. Ray Arvidson will serve as the Mission Director for PSIP providing the oversight of mentors. The following describes the PSIP activities, with a detailed statement of work from the PSIP coordinator, Ms. Cassie Bowman, included in Section 6.8, p. 87.

Activity Code	PSIP-1
Activity Description	Local Arizona team to participate in a PSIP prototype.
Supported Strand	*Water and Life*, *Soil Habitability*, and *Robotics*
Activity Objective	Provide an opportunity for local area students and teachers to participate in the Phoenix Science Operation test-bed providing authentic learning of science and engineering and get Phoenix mission members used to student and teacher involvement
Major Milestones	• Initiate prototype of PSIP at the Phoenix Science Operations Center—08/01/06 • Evaluation report of prototype PSIP developed by PSIP coordinator to Phoenix E/PO—9/30/06

Activity Code	PSIP-2
Activity Description	Prepare and implement PSIP.
Supported Strand	*Water and Life*, *Soil Habitability*, and *Robotics*
Activity Objective	Provide an opportunity for student/teacher teams to participate fully in Phoenix scientific missions and conduct educational outreach activities; thereby increasing the number of students motivated to pursue STEM careers.
Major Milestones	• List of selected PSIP teams from the PSIP coordinator to Phoenix E/PO—11/01/2007 • Orientation information provided by PSIP coordinator and Phoenix E/PO to PSIP student/teacher teams and mentors—11/01/2007 • PSIP preparation of teams and mentors begins, including PSIP information and collaboration on the Phoenix Web site—01/01/2008 • PSIP participation in Phoenix Mission begins—Phoenix landing, currently scheduled for 06/01/08) • Final evaluation report developed by PSIP coordinator to Phoenix E/PO—12/01/2008

3.1.4 Arizona Space Grant Consortium

A primary goal of the Arizona Space Grant Program is to support creative and effective K-12 outreach efforts, particularly with underserved populations within Arizona. Space Grant actively works with schools located on the numerous Native American reservations in the state. One such program that engages Native American schools is Arizona BalloonSat, recently created to provide an accessible vehicle for student payloads to reach near-space. Teams of four students and one teacher collaborate with members of Arizona Near Space Research (ANSR) to build small experiments, launch them on high-altitude balloons, recover them, and analyze the data. In partnering with Phoenix E/PO, the Arizona Space Grant Consortium will endeavor to establish a permanent BalloonSat program at many Arizona schools that could be maintained at minimal costs. The following lists the specific partnership activities between Phoenix E/PO and the Arizona Space Grant Consortium, with a detailed statement of work in Section 6.8, p. 93.

Activity Code	ASG-1
Activity Description	Annual selection of five new Arizona schools to participate in the BalloonSat program.
Supported Strand	*Robotics*
Activity Objective	Identify and select underserved and underrepresented school teams that would provide maximum benefit to encourage students to pursue STEM careers.
Major Milestone	Teams selected—Spring of 2005, 2006, 2007, and 2008 with specific dates to be determined

Activity Code	ASG-2
Activity Description	Annual teacher training workshops for the BalloonSat Program.
Supported Strand	*Robotics*
Activity Objective	Use inquiry, reflection, interpretation of research, modeling, and guided practice to train teachers in the design, construction, and launch of small robotic payloads.
Major Milestone	Phoenix E/PO materials developed by Phoenix E/PO and BalloonSat training materials developed by Arizona Space Grant presented at the workshops—May or June of 2005, 2006, 2007, and 2008, with specific dates to be determined

Activity Code	ASG-3
Activity Description	Payload designed, constructed, and launched.
Supported Strand	*Robotics*
Activity Objective	In an authentic learning environment, student teams will design, construct, and operate their payloads to measure and image the atmosphere.
Major Milestone	Launches conducted by Arizona Space Grant and ANSR mentors with student and teacher teams—Fall and Spring of 2005, 2006, 2007, and 2008, with specific dates to be determined

3.2 Informal Education

The partners and activities in this section are considered predominately informal education, although significant pieces of these activities may be used for formal education and public outreach.

3.2.1 Space Science Institute

The institute is devoted to collaboration between researchers and educators in order to expand knowledge of space science and communicate this knowledge to the public. In developing major traveling science center and museum exhibits, as well as other educational and outreach materials, the Space Science Institute endeavors to bring the wonders of space exploration to the public. One such program is *MarsQuest*, a 5000 square foot exhibit that has been traveling around the country since 2001, reaching millions of visitors and attaining high-quality educational goals. However, *MarsQuest* is more than a highly successful museum exhibit because it also includes a comprehensive education program for formal and informal educators, as well as an interactive Web site, called *MarsQuest Online*. The following lists the specific partnership activities between Phoenix E/PO and the Space Science Institute, with a detailed statement of work in Section 6.8, p. 78.

Activity Code	SSI-1
Activity Description	The "Big Dig" interactive exhibit component of *MarsQuest* with duplicate exhibits to the Phoenix Science Operations Center.
Supported Strand	*Robotics*
Activity Objective	Foster collaborative learning through simulation of Phoenix Mission engineering and science operations.
Major Milestones	• Interactive mission simulation area, low-tech open-ended inquiry area, and exhibit backdrops developed by SSI deployed with *MarsQuest*—01/01/2006 • Duplicate low-tech open inquiry area and exhibit backdrops developed by SSI to Phoenix E/PO—01/01/2006

Activity Code	SSI-2
Activity Description	"Virtual Robot" exhibit patterned after the "Big Dig."
Supported Strand	*Robotics*
Activity Objective	Foster understanding of how scientists operate a robot on Mars using Web-based learning tools.
Major Milestone	Fully virtual version of the "Big Dig" developed by SSI that will be deployed through the Phoenix Mission and *MarsQuest Online* Web sites—06/01/2006

Activity Code	SSI-3
Activity Description	Upgrading the *Family Guide to Mars* to include Phoenix mission science.
Supported Strands	*Water and Life*, *Soil Habitability*, and *Robotics*
Activity Objective	Provide activities, based on Mars themes that stimulate co-learning between pre- and early-school children and their parents or guardians.
Major Milestone	Updated *Family Guide to Mars* developed by SSI in Adobe® Acrobat® format suitable for printing and posting on both the *MarsQuest Online* and mission Web site to Phoenix E/PO—06/01/06

Activity Code	SSI-4
Activity Description	Phoenix Mission science and educational materials to underserved Native American teachers presented in a summer workshop associated with the 4-Corners Alliance for Space Science
Supported Strands	*Water and Life*, *Soil Habitability*, and *Robotics*
Activity Objective	Use inquiry, reflection, interpretation of research, modeling, and guided practice to increase understanding and skills in science teaching.
Major Milestone	*Family Guide to Mars* and Phoenix E/PO materials developed by Phoenix E/PO presented at the summer 2007 4-Corners Alliance for Space Science Workshop—specific date to be determined

Currently, activities SSI-3 and SSI-4 are not included in Space Science Institute's statement of work. These activities will be included in an amended statement of work that will be developed in March 2005.

3.2.2 Arizona Aerospace Foundation

The Arizona Aerospace Foundation runs the Pima Air and Space Museum, one of the world's largest aerospace museums. In 2003, the museum opened the "Imagine Mars" exhibit in its Space Gallery. More than 100,000 visitors have seen this high-quality exhibit, which was originally developed through cost-sharing between the museum and NASA ROSS E/PO funds with Mr. Peter Smith as the Principal Investigator. The same model will be followed with the Phoenix E/PO program, where Arizona Aerospace Foundation and Phoenix Mission resources will be coordinated to create the broadest opportunity for public access to the educational information about Phoenix Mission science, Mars, and Solar System exploration. The following lists the activities associated with the Arizona Aerospace Foundation, with a detailed statement of work included in Section 6.8, p. 104.

Activity Code	AAF-1
Activity Description	Interpretive exhibit introducing the Phoenix Mars Mission, including the science goals.
Supported Strand	*Water and Life*, *Soil Habitability*, and *Robotics*
Activity Objective	Provide a free choice learning environment that deepens understanding about the fundamental science and engineering behind the Phoenix Mission.
Major Milestones	• Interpretive exhibit, including a model of the spacecraft, deployed at the Pima Air and Space Museum—12/01/05 • Duplicate interpretive exhibit, including a model of the spacecraft, deployed at the Phoenix Science Operations Center—04/01/06

Activity Code	AAF-2
Activity Description	Interpretive exhibit covering the search for water and biological activity elsewhere in our Solar System (i.e., beyond Mars).
Supported Strand	*Water and Life* and *Robotics*
Activity Objective	Inspire the public about the search for life beyond Earth and motivate them to develop a deeper knowledge of Solar System exploration.
Major Milestones	• Interpretive exhibit deployed at the Pima Air and Space Museum—04/01/06 • Duplicate interpretive exhibit deployed at the Phoenix Science Operations Center—04/01/06

Activity Code	AAF-3
Activity Description	Interpretive exhibit providing “behind-the-scenes” workings of a Mars mission.
Supported Strand	*Water and Life*, *Soil Habitability*, and *Robotics*
Activity Objective	Provide authentic stories from mission scientists and engineers that reveal the nature of scientific inquiry to the public.
Major Milestone	Interpretive exhibit deployed at the Pima Air and Space Museum—04/01/07

Activity Code	AAF-4
Activity Description	Interpretive exhibit examining the mechanics of a Mars mission, specifically its launch, flight, and entry-descent-landing profile.
Supported Strand	*Robotics*
Activity Objective	Display current mission information to enhance public involvement in the Phoenix Mission.
Major Milestone	Interpretive exhibit deployed at the Pima Air and Space Museum—08/01/07

3.2.3 NOAO

NOAO’s outreach was established to make the science of the observatory more accessible to the K-12 and college-level communities. To promote public understanding and support of science, NOAO encourages public information and supports science education through an active outreach program, including nationally renowned science teaching workshops. NOAO operates the Kitt Peak Visitor Center and Museum near Tucson, Arizona, allowing the public near-accessibility to the twenty-two optical telescopes and two radio telescopes located on-site. NOAO’s outreach program has agreed to partner with Phoenix E/PO on a complete cost-sharing basis, meaning that no funds will be exchanged between the two organizations. The following lists the major activities associated with the partnership, with a detailed letter of agreement in Section 6.8, p. 107.

Activity Code	NOAO-1
Activity Description	Interpretive exhibit detailing the Phoenix Mars Mission, including the mission's science goals.
Supported Strand	*Water and Life*, *Soil Habitability*, and *Robotics*
Activity Objective	Inspire the public about the Phoenix Mission in order motivate them to develop a deeper knowledge of Solar System exploration.
Major Milestones	• Model of the Phoenix spacecraft from Phoenix E/PO to NOAO—08/01/06 • Phoenix Mission content information from Phoenix E/PO to NOAO—08/01/06 • Interpretive exhibit deployed at the Kitt Peak Visitor Center—04/01/07

Activity Code	NOAO-2
Activity Description	NOAO consultation and participation in teacher workshops held by Phoenix E/PO.
Supported Strand	*Water and Life*
Activity Objective	Use inquiry, reflection, interpretation of research, modeling, and guided practice to increase understanding and skills in science teaching.
Major Milestones	• List of master teachers that have participated in NOAO E/PO programs to Phoenix E/PO—six months prior to the first workshop and annual thereafter • Participation by NOAO outreach staff in Phoenix teacher workshops—specific dates to be determined

3.3 Public Outreach

The partners and activities in this section are considered predominately public outreach, although significant pieces of these activities may be used for formal and informal education.

3.3.1 NASA Langley's Center for Distance Learning

This center creates innovative multimedia educational programs using NASA-related research and subject matter to inspire successful learning. Currently, there are five distance learning programs produced by the center that span a wide audience range, from young children to adults. These programs are made available free of charge to teachers, students, and the public through a wide dissemination network, including broadcast public television, satellite television, Internet video streaming and download, and DVD/VHS copies. The following lists the planned formal education activities between Phoenix E/PO and the NASA Langley's Center for Distance Learning, located at the NASA Langley Research Center (LaRC). A more detailed statement of work from NASA Langley's Center for Distance Learning is included in Section 6.8, p. 59.

Activity Code	LaRC-1
Activity Description	3-minute segment in the elementary level NASA SCI Files™ program *The Case of the Great Space Exploration.*
Supported Strand	*Water and Life*
Activity Objective	Deepen understanding about why Phoenix Mission scientists believe that the search for life beyond Earth is essentially a search for liquid water.
Major Milestones	• Program developed by LaRC airs on PBS—9/22/04 • Program DVD with lesson guide developed by LaRC to Phoenix E/PO—10/31/04

Activity Code	LaRC-2
Activity Description	Two NASA Kids' Science Network™ news breaks (each in both English and Spanish) for elementary students.
Supported Strand	*Water and Life*
Activity Objective	Deepen understanding about how Phoenix Mission scientists will search for water and life's precursors on Mars.
Major Milestones	• First news break developed by LaRC as a streaming video segment to television stations and Phoenix E/PO—11/15/04 • Web-based activity associated with the news breaks posted on Kids' Science Network™ Web site—11/30/04 • Second news break developed by LaRC as a streaming video segment to television stations and Phoenix E/PO—02/15/05 • Web-based activity associated with the news breaks posted on Kids' Science Network™ Web site—02/28/05

Activity Code	LaRC-3
Activity Description	NASA CONNECT™ middle school classroom activity.
Supported Strand	*Water and Life*
Activity Objective	Promote exploration and deepen understanding about the physical, chemical, and thermodynamic properties of water that are important for life.
Major Milestone	DVD developed by LaRC containing an Adobe® Acrobat® file of the activity suitable for printing and posting on both the mission and NASA CONNECT™ Web sites to Phoenix E/PO—07/23/2005

Activity Code	LaRC-4
Activity Description	NASA Destination Tomorrow™ segment for high school students and adults.
Supported Strand	*Water and Life*
Activity Objective	Promote exploration and deepen understanding about the physical, chemical, and thermodynamic properties of water that are important for life.
Major Milestone	Program DVD developed by LaRC delivered to PBS, ITV, cable television stations, and Phoenix E/PO—09/30/05

NASA Langley's Center for Distance Learning and Phoenix E/PO will continue to partner throughout the duration of the mission; however, the volatility in costs and scheduling associated with producing educational television and distance learning programs precludes projections beyond FY 2005. In the middle of FY 2005, the center will revise its statement of work to include additional activities. For example, the NASA CONNECT™ classroom activity (code LaRC-3 above) will be designed to support a 30-minute television program produced in FY 2006.

3.3.2 JPL Visualizations

The Solar System Visualizations (SSV) Project at JPL provides high-quality visualizations for mission science teams, as well as educational and public outreach efforts. These visualizations, which include detailed images and animations, prove to be one of the most sought after and used materials requested by the public. These visualizations serve to inspire the public by placing them in a realistic virtual environment that gives them the sense that they are actually on Mars. Partnership activities between Phoenix E/PO and the SSV Project are listed below, with a detailed statement of work in Section 6.8, p. 99.

Activity Code	SSV-1
Activity Description	Create a 6-minute HDTV animation displaying a summary of events from the time of the Phoenix launch until its arrival at Mars.
Supported Strand	*Water and Life*, *Soil Habitability*, and *Robotics*
Activity Objective	Inspire and motivate students and the public through realistic visualizations about Mars exploration.
Major Milestones	• Rough cut of simulated entry-decent-landing developed by SSV to Phoenix E/PO—09/30/05 • Rough cut of simulated lander developed by SSV to Phoenix E/PO—09/30/06 • HDTV animation of launch and entry-decent-landing developed by SSV to Phoenix E/PO—09/30/07 • DVD animation of launch and entry-decent-landing developed by SSV to Phoenix E/PO—12/31/07

3.3.3 Mars Public Engagement Plan

As discussed in Section 1.2.2, the Phoenix E/PO program is linked with the Mars Public Engagement Plan in several critical areas. In addition to this direct link, the Mars Public Engagement Plan will also serve as the conduit for delivering Phoenix E/PO materials and resources to JPL's Office of Education, which includes such activities as the Solar System Ambassadors and Educators programs. The following lists specific activities coordinated with the Mars Public Engagement Plan.

Activity Code	MPEP-1
Activity Description	Speaker support materials, including the text describing the mission story, visualizations showing launch, entry, descent, and landing, and information about mission science goals.
Supported Strand	*Water and Life*, *Soil Habitability*, and *Robotics*
Activity Objective	Provide high-quality materials for use by the Mars Museum Alliance, Volunteer Education Program, the JPL Office of Education, and the Mars Exploration and mission Web sites.
Major Milestones	• Mission background, launch, entry-descent-landing and other science goal materials developed by Phoenix E/PO to the Mars Public Engagement Plan and mission Web site—06/01/2006 • Revised mission background, entry-descent-landing, and science goal materials developed by Phoenix E/PO to the Mars Public Engagement Plan and mission Web site—Phoenix launch, currently scheduled for 08/01/07 • Week in review mission updates developed by Phoenix E/PO to the Mars Public Engagement Plan—one month before Phoenix landing , currently scheduled for 06/01/08, and every week thereafter until termination of the mission

Activity Code	MPEP-2
Activity Description	Mars Museum Alliance telecons.
Supported Strand	*Water and Life*, *Soil Habitability*, and *Robotics*
Activity Objective	Provide current and accurate information via telephone conferencing to the Mars Museum Alliance.
Major Milestones	• Technical testing of telecons with Mars Public Engagement Plan—six months prior to Phoenix landing, currently scheduled for 06/01/08 • Content for and participation by Phoenix mission team on weekly telecons to Mars Public Engagement Plan—six weeks before Phoenix landing, currently scheduled for 06/01/08, and every week thereafter for three months • Content for and participation by Phoenix mission team on daily telecons to Mars Public Engagement Plan—every day for the first week after Phoenix landing, currently scheduled for 06/01/08)

Activity Code	MPEP-3
Activity Description	Documentary filming, editing, and archiving of critical mission events
Supported Strands	*Water and Life*, *Soil Habitability*, and *Robotics*
Activity Objective	Provide video and audio documentation of critical mission events for use in educational and public outreach materials.
Major Milestones	• Scheduling and coordination information from Phoenix E/PO to the Mars Public Engagement Plan—when mission scheduling changes • Filming, editing, and archiving by Mars Public Engagement Plan documentary professionals to support Phoenix E/PO—at mission critical events • Local filming support provided by Phoenix E/PO to Mars Public Engagement Plan documentary professionals—at mission events that have both local and national significance

Activity Code	MPEP-4
Activity Description	Model information for use by the Mars Museum Alliance
Supported Strands	*Water and Life*, *Soil Habitability*, and *Robotics*
Activity Objective	Provide information so that participants in the Mars Museum Alliance can create physical models of the Phoenix lander
Major Milestone	Model drawings to the Mars Public Engagement Plan—09/30/05

3.3.4 McDonald Observatory

The University of Texas' McDonald Observatory Public Information Office is responsible for producing the *StarDate* and *Universo* radio programs. *StarDate* is the longest running science series on the radio; and more than two million listeners hear the program daily. *Universo* is the Spanish language version of the program and reaches over 250,000 daily listeners in the United States and over a million daily listeners in Mexico. In addition to radio broadcast, the shows are made available via Internet streaming at the *StarDate Online* Web site. The following are the activities in which Phoenix E/PO and the McDonald Observatory will be collaborating. Because these activities do not begin until 2006, a statement of work has not yet been developed.

Activity Code	MO-1
Activity Description	Series of radio programs in English (*StarDate*) and Spanish (*Universo*) languages that introduce the mission's science and engineering goals.
Supported Strands	*Water and Life*, *Soil Habitability*, and *Robotics*
Activity Objective	Inspire and motivate the public about the Phoenix Mission and Mars exploration using engaging radio programs.
Deliverables	• Seven, two-minute radio programs in English and Spanish annually, broadcast in 2006 and 2007—specific dates to be determined. • Streaming audio and scripts for each program posted on the *StarDate Online* Web site and with links via the mission Web site—specific dates to be determined

The McDonald Observatory and Phoenix E/PO will continue to partner in 2008; however, the production of these programs will be negotiated in 2005.

4. Program Evaluation

Independent evaluation will be a key element of the Phoenix E/PO program to determine whether overall program goals and individual activity objectives are being met. The University of Arizona's Conceptual Astronomy and Physics Education Research (CAPER) Team will conduct the evaluation. The CAPER Team, led by Dr. Timothy Slater, conducts educational research into student understanding, which is used to inform the development and dissemination of instructional interventions and public outreach activities and of authentic assessment strategies in the areas of astronomy, astrobiology, physics, planetary science, and earth and space science. Dr. Slater, who will be responsible for the Phoenix E/PO evaluation, has significant experience in both NASA E/PO efforts and evaluation of educational programs. A graduate research assistant (Mr. Andrew Shaner), a member of the CAPER team, will conduct the day-to-day operations of the internal evaluation effort. Additionally, Dr. Kathy Garvin-Doxas, an experienced E/PO program evaluator from the University of Colorado, will serve to validate the evaluation results obtained by the CAPER Team.

This program evaluation will provide both formative (i.e., immediate evaluation feedback) and summative (i.e., overall evaluation feedback at particular milestones) information to ensure an effective E/PO program. The evaluation team's activities include the following.

- Assisting the E/PO Manager in preparing reports and making presentations about the E/PO program by providing both quantitative and qualitative evaluation data in a readily useful format.
- Actively communicating with each of the E/PO project partners to gather and combine evaluation data from those sites.
- Serving as a confidential, formative feedback team with the goal of improving the E/PO program impacts, effectiveness, dissemination, and efficiency.
- Leading the production of scholarly publications describing lessons learned by the E/PO team.
- Assisting in compiling and gathering data for the final project summative evaluation.

In evaluating the overall effectiveness of the program, Phoenix will rely on existing evaluation efforts operated by their partners if these evaluation efforts are deemed adequate.

Using partners' evaluation infrastructure, if appropriate, Phoenix E/PO will leverage partners' existing resources to provide a complete evaluation product. Adequacy of partner evaluation efforts have been appraised by the evaluation team and reported in the Phoenix E/PO Evaluation Plan, which is found in Section 6.9. The following provides a list of the other scheduled reports will be produced by the evaluation team, with a detailed statement of work in Section 6.8, p. 109.

Activity Code	Activity	Delivery Date
EVAL-1	E/PO Evaluation Plan	Completed (see Section 6.8)
EVAL-2	Annual Evaluation Report I	08/15/05
EVAL-3	Annual Evaluation Report II	08/15/06
EVAL-4	Annual Evaluation Report III	08/15/07
EVAL-5	Final Report	12/15/08

Phoenix E/PO will also actively participate in NASA's E/PO tracking and reporting system (commonly called EdCats) and will submit its statistics to the Mars Public Engagement Plan on a quarterly basis. These data will be maintained and compiled by the Mars Public Engagement Plan, which submits its EdCats data to NASA Headquarters on an annual basis.

5. Summary

The E/PO Manager, Mr. Doug Lombardi is responsible for developing this report. On November 9, 2005 a panel was convened to review the Phoenix E/PO Program, including: (1) Mr. Peter Smith, Phoenix Mission Principal Investigator, (2) Dr. Karen McBride, Mars Scout Program Executive, NASA Headquarters, (3) Dr. Larry Cooper, Science Mission Directorate, NASA Headquarters, (4) Ms. Michelle Viotti, Mars Public Engagement Plan Manager, Jet Propulsion Laboratory, (5) Ms. Rosalyn Pertzborn, Education and Public Outreach Expert, Space Science and Engineering Center, University of Wisconsin, Madison, (6) Ms. Jeane Dughi, Education and Public Outreach Expert, Virginia Beach, Virginia, and (7) Dr. Cherilynn Morrow, Western Region NASA Broker/Facilitator. The panel chairperson, Rosalyn Pertzborn recommended the Phoenix E/PO program be approved for PDR, pending written confirmation that the E/PO team intends to address the recommendations of the panel. The findings and recommendations of the panel, along with the disposition of these findings and recommendations are listed in Section 6.6, p. 58. Finally, this report will be updated and reviewed annually to remain consistent with changes in program guidance and to take advantage of new opportunities and partnerships.

6. Appendices

The following sections contained detailed information about the Phoenix E/PO program, including a schedule breakdown into receivables and deliverables, a detailed budget, discussions of Web site design and performance and public release of mission data, and a list of acronyms used in this report. Copies of statements of work from participating partners are at the end of this section.

6.1 Schedule

Figure 3 shows the high level schedule of the Phoenix E/PO program, including significant events in the mission. In the figure, light blue hatched bars indicate periods of development, review, and/or revision of specific E/PO materials and yellow bars indicate active operations of E/PO activities.

The receivable and deliverable schedule of partner activities is listed chronologically in Table 8. Elements receivable are defined as those items a partner receives from Phoenix E/PO. Elements deliverable are defined as those items a partner delivers to Phoenix E/PO.

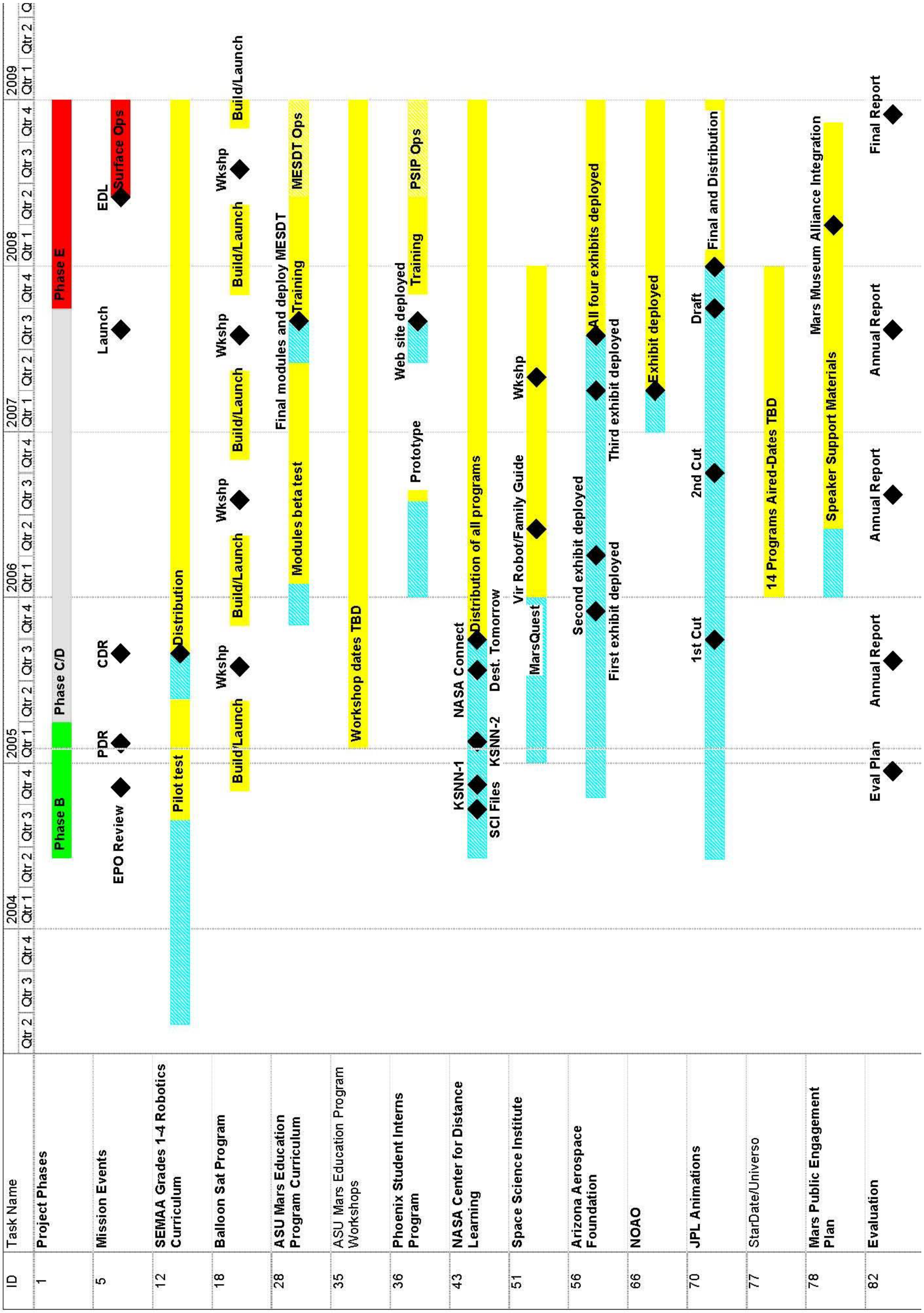

Figure 3. Phoenix E/PO High Level Schedule.

Table 8. Summary of Receivables and Deliverables

Activity Code	Task	Element Receivable	Element Deliverable	Date	Responsible Party
LaRC-1-A	NASA SCI™ Files 3-minute segment	Draft script comments and revisions		06/17/04	Phoenix E/PO
LaRC-1-B	NASA SCI Files™ 3-minute segment		Script completed	06/25/04	LaRC
LaRC-2-A	NASA KSNN™ Newsbreak	Draft script comments and revisions		07/28/04	Phoenix E/PO
SEMAA-1-A	"Mission to Mars" curriculum		Develop draft grades 1-4 curriculum for pilot test	07/30/04	SEMAA
SEMAA-1-C	"Mission to Mars" curriculum		Conduct initial teacher training workshop	08/19/04	SEMAA
LaRC-2-B	NASA KSNN™ Newsbreak		Script completed	09/15/04	LaRC
LaRC-1-C	NASA SCI Files™ 3-minute segment		Program airs on PBS	09/22/04	LaRC
SSV-1-A	Phoenix Mission HDTV Animation	Scaled colored drawings of Phoenix lander		10/01/04	Phoenix E/PO
LaRC-1D	NASA SCI Files™ 3-minute segment		Program DVD and lesson guide	10/31/04	LaRC
LaRC-2-C	NASA KSNN™ Newsbreak		Streaming video completed	11/15/04	LaRC
EVAL-1-A	E/PO Evaluation Plan	Draft plan comments and revisions		12/01/04	Phoenix E/PO
SSI-1-A	The "Big Dig" interactive exhibit		Design meeting	01/20/05	SSI
SEMAA-1-D	"Mission to Mars" curriculum		Conduct follow-up teacher workshop	12/08/04	SEMAA
EVAL-1-B	E/PO Evaluation Plan		Final plan	12/15/04	Evaluation Team[10]
LaRC-3-A	NASA CONNECT™ classroom activity	Draft activity comments and revisions		12/31/04	Phoenix E/PO

[10]The evaluation team is led by Dr. Timothy Slater of the Conceptual Astronomy and Physics Education Research (CAPER) Team at the University of Arizona.

Table 8. Summary of Receivables and Deliverables

Activity Code	Task	Element Receivable	Element Deliverable	Date	Responsible Party
ASU-3-A	ASU teacher workshops	Phoenix E/PO materials		02/01/05 and every fall and spring through 2008 (specific dates to be determined)	Phoenix E/PO
SSI-1-B	The “Big Dig” interactive exhibit		Draft exhibit preliminary design	02/28/05	SSI
SSI-1-C	The “Big Dig” interactive exhibit	Draft exhibit design comments and revisions		03/15/05	Phoenix E/PO
ASU-3-B	ASU teacher workshops		Teacher workshops	03/01/05 and every fall and spring through 2008 (specific dates to be determined)	ASU
ASG-1-A	Participating Team Selection		Select five school teams to participate in the program	04/01/05 and every spring through 2008 (specific dates to be determined)	ASG
ASG-2-A	BalloonSat teacher training workshops	Phoenix E/PO materials		04/01/05 and every spring through 2008 (specific dates to be determined)	Phoenix E/PO
SEMAA-1-E	“Mission to Mars” curriculum		Conduct student field robotics training sessions	02/01/05 and continue through 04/01/05	SEMAA
ASG-2-B	BalloonSat teacher training workshops		Teacher workshops	05/01/05 and every spring through 2008 (specific dates to be determined)	ASG
SSI-1-D	The “Big Dig” interactive exhibit		Final exhibit design	06/01/05	SSI

Table 8. Summary of Receivables and Deliverables

Activity Code	Task	Element Receivable	Element Deliverable	Date	Responsible Party
LaRC-3-B	NASA CONNECT™ classroom activity		Final activity	07/23/05	LaRC
EVAL-2-A	Annual Evaluation Report I	Draft report comments and revisions		08/01/05	Phoenix E/PO
EVAL-2-B	Annual Evaluation Report I		Final report	08/15/05	Evaluation Team
LaRC-4-A	NASA Destination Tomorrow™ segment	Draft script comments and revisions		08/27/05	Phoenix E/PO
SEMAA-1-F	"Mission to Mars" curriculum		Finalize curriculum for national distribution	08/31/05	SEMAA
AAF-1-A	Phoenix science goals and mission exhibit	Draft exhibit design comments and revisions		09/01/05	Phoenix E/PO
MO-1-A	StarDate and Universo radio program segment	Draft scripts comments and revisions		09/01/2005 and three months prior to airing for all fourteen programs in 2006 and 2007	Phoenix E/PO
LaRC-4-B	NASA Destination Tomorrow™ segment		Script completed	09/15/05	LaRC
LaRC-4-C	NASA Destination Tomorrow™ segment		Program airs on PBS, ITV, and cable TV	09/30/05	LaRC
MPEP-4-A	Model information for the Mars Museum Alliance	Model drawings		09/30/05	Phoenix E/PO
SSV-1-B	Phoenix Mission HDTV Animation		Rough cut of animation	09/30/05	SSV

Table 8. Summary of Receivables and Deliverables

Activity Code	Task	Element Receivable	Element Deliverable	Date	Responsible Party
MO-1-B	*StarDate* and *Universo* radio program segments		Scripts completed	10/01/2005 and two months prior to airing for all fourteen programs in 2006 and 2007 (specific dates to be determined)	MO
AAF-1-B	Phoenix science goals and mission exhibit		Exhibit deployed at Pima Air and Space Museum	12/01/05	AAF
SSI-1-E	The “Big Dig” interactive exhibit		Exhibit deployment to *MarsQuest*	01/01/06	SSI
SSI-1-F	The “Big Dig” interactive exhibit		Duplicate of exhibit backdrop and low-tech piece to Phoenix SOC	01/01/06	SSI
AAF-2-A	Water in the Solar System exhibit	Draft exhibit design comments and revisions		01/01/06	Phoenix E/PO
MO-1-C	StarDate and Universo radio program segments		Programs airs on NPR and other radio stations	01/01/2006 with specific dates to be determined for airing of all fourteen programs in 2006 and 2007	MO
NOAO-2-A	Participation in teacher workshops		List of master teachers	01/01/2006 and every year through 2008	NOAO
ASU-1-A	Martian soil properties curriculum	Beta-test module comments and revisions		01/10/06	Phoenix E/PO
ASU-1-B	Martian soil properties curriculum		Beta-test module in print form	02/01/06	ASU
SSI-3-A	*Family Guide to Mars* upgrade	Draft guide comments and revisions		03/01/06	Phoenix E/PO
ASU-2-A	Martian soil habitability curriculum	Beta-test module comments and revisions		03/13/06	Phoenix E/PO
AAF-1-C	Phoenix science goals and mission exhibit		Exhibit deployed at Phoenix Science Operations Center	04/01/06	AAF

Table 8. Summary of Receivables and Deliverables

Activity Code	Task	Element Receivable	Element Deliverable	Date	Responsible Party
PSIP-1-A	Local Arizona prototype	List of participating Arizona teams		04/01/06	Phoenix E/PO
PSIP-1-B	Local Arizona prototype		List of science and engineering team mentors	04/01/06	PSIP Coordinator
SSI-2-A	Virtual robot	Draft comments and revisions on Web activity		04/01/06	Phoenix E/PO
AAF-2-B	Water in the Solar System exhibit		Exhibit deployed at Pima Air and Space Museum	04/03/06	AAF
AAF-2-C	Water in the Solar System exhibit		Exhibit deployed at Phoenix Science Operations Center	04/03/06	AAF
ASU-2-B	Martian soil habitability curriculum		Beta-test module in print form	04/03/06	ASU
MPEP-1-A	Speaker support materials	Mission background, entry-descent-landing, and science goal information		06/01/06	Phoenix E/PO
NOAO-2-B	Participation in teacher workshops		Presentation of NOAO educational material	06/01/2006 and every year through 2008 (specific dates to be determined)	NOAO
SSI-2-B	Virtual robot		Virtual robot deployed on the Internet	06/01/06	SSI
SSI-3-B	*Family Guide to Mars* upgrade		Final guide update	06/01/06	SSI
EVAL-3-A	Annual Evaluation Report II	Draft report comments and revisions		08/01/06	Phoenix E/PO
NOAO-1-A	Phoenix Mission interpretive exhibit at Kitt Peak Visitor Center	Model of Phoenix lander		08/01/06	Phoenix E/PO
NOAO-1-B	Phoenix Mission interpretive exhibit at Kitt Peak Visitor Center	Phoenix Mission visualization and content information		08/01/06	NOAO
PSIP-1-C	Local Arizona prototype		Conduct local prototype program	08/01/06	PSIP Coordinator
EVAL-3-B	Annual Evaluation Report II		Final report	08/15/06	Evaluation Team

Table 8. Summary of Receivables and Deliverables

Activity Code	Task	Element Receivable	Element Deliverable	Date	Responsible Party
PSIP-1-D	Local Arizona prototype		Report of lessons learned on prototype	09/30/06	PSIP Coordinator
SSV-1-C	Phoenix Mission HDTV Animation		2nd rough cut of animation	09/30/06	SSV
ASU-1-C	Martian soil habitability curriculum		Beta-test Web-based module	12/01/06	ASU
AAF-3-A	Mission “behind-the-scenes” exhibit	Draft exhibit design comments and revisions		01/01/07	Phoenix E/PO
ASU-2-C	Martian soil habitability curriculum		Beta-test Web-based module	02/01/07	ASU
AAF-3-B	Mission “behind-the-scenes” exhibit		Exhibit deployed at Pima Air and Space Museum	04/02/07	AAF
NOAO-1-C	Phoenix Mission interpretive exhibit at Kitt Peak Visitor Center		Deployment of Phoenix exhibit	04/02/07	NOAO
AAF-4-A	Entry-descent-landing exhibit	Draft exhibit design comments and revisions		05/01/07	Phoenix E/PO
PSIP-2-A	Program implementation		Finalize list of science and engineering team mentors	05/01/07	PSIP Coordinator
SSI-4-A	Summer workshop for Native American teachers with the 4-corners Alliance for Space Science	Phoenix E/PO materials		05/01/07	Phoenix E/PO
SSI-4-B	Summer workshop for Native American teachers with the 4-corners Alliance for Space Science		Teacher workshop	05/01/07 (specific dates to be determined)	Phoenix E/PO
ASU-1-D	Martian soil properties curriculum	Final module comments and revisions		07/01/07	Phoenix E/PO
ASU-2-D	Martian soil habitability curriculum	Final module comments and revisions		07/01/07	Phoenix E/PO
AAF-4-B	Entry-descent-landing exhibit		Exhibit deployed at Pima Air and Space Museum	08/01/07	AAF

Table 8. Summary of Receivables and Deliverables

Activity Code	Task	Element Receivable	Element Deliverable	Date	Responsible Party
EVAL-4-A	Annual Evaluation Report III	Draft report comments and revisions		08/01/07	Phoenix E/PO
MPEP-1-B	Speaker support materials	Revised mission background, entry-descent-landing, and science goal information		08/01/07	Phoenix E/PO
ASU-4-A	MESDT student data teams	Draft Web site and training materials comments		08/10/07	Phoenix E/PO
EVAL-4-B	Final Evaluation Report		Final report	08/15/07	Evaluation Team
ASU-1-E	Martian soil properties curriculum		Final module in print and Web-based forms	08/31/07	ASU
ASU-2-E	Martian soil habitability curriculum		Final module in print and Web-based forms	08/31/07	ASU
PSIP-2-B	Program implementation	PSIP Web site deployed		09/01/07	Phoenix E/PO
ASU-4-B	MESDT student data teams		MESDT Web site	09/03/07	ASU
ASU-4-C	MESDT student data teams		MESDT training materials	09/03/07	ASU
SSV-1-D	Phoenix Mission HDTV Animation		Draft of animation	09/30/07	SSV
PSIP-2-C	Program implementation		List of participating teams	11/01/07	PSIP Coordinator
SSV-1-E	Phoenix Mission HDTV Animation		Final animation	12/31/07	SSV
MPEP-2-A	Mars Museum Alliance telecons		Technical testing	01/01/08	MPEP
ASU-4-D	MESDT student data teams		MESDT active operations	06/01/08	ASU
PSIP-2-D	Program implementation		Initiate program	06/01/08	PSIP Coordinator
MPEP-2-D	Mars Museum Alliance telecons	Daily mission content information		06/01/08 and every day until 06/08/08	Phoenix E/PO
MPEP-2-E			Daily telecoms	06/01/08 and every day until 06/08/08	MPEP
MPEP-1-C	Speaker support materials	Week-in-review mission updates		05/01/078 and every week until 11/01/08	Phoenix E/PO

Table 8. Summary of Receivables and Deliverables

Activity Code	Task	Element Receivable	Element Deliverable	Date	Responsible Party
MPEP-2-B	Mars Museum Alliance telecons	Weekly mission content information		04/01/08 and every week until 11/01/08	Phoenix E/PO
MPEP-2-C	Mars Museum Alliance telecons		Weekly telecons	04/15/08 and every week until 11/01/08	MPEP
EVAL-5-A	Final Evaluation Report	Draft report comments and revisions		12/01/08	Phoenix E/PO
PSIP-2-E	Program implementation		Final program evaluation report	12/01/08	PSIP Coordinator
EVAL-5-B	Final Evaluation Report		Final report	12/15/08	Evaluation Team

6.2 Budget

The budget is this section reflects the fiscal status of the E/PO program at the time the review panel was convened (November 9, 2004). This budget will be revised to reflect changes in the E/PO program that may be required as the mission budget posture changes prior to and just after the mission preliminary design review, scheduled to be held in the middle of March, 2005.

The total Phoenix E/PO budget through the end of the mission is just under $3.8 million. This represents 2% of the total mission budget minus the launch vehicle and reserve. As shown in Figure 4, the E/PO budget for FY 2004 is just under $220,000 and increases significantly in FY 2005 to just over $720,000 due to initiation of significant subcontractor activity and hiring of additional personnel. (Note in particular that the relatively high subcontractor costs in FY 2005 are associated with the design and construction of the “Big Dig” *MarsQuest* exhibit). The budgets in FYs 2006 and 2007 are virtually the same at just under $820,000 and peaks in FY 2008 at just over $950,000, when the lander is conducting surface operations. The budget tapers off appreciably in FY 2009 to just over $250,000 as the mission ends.

Table 9 summarizes the detailed Phoenix E/PO budget through the end of the mission in FY 2009. Labor salaries were calculated assuming a 2.9% inflation rate. Indirect costs (IDC) were negotiated with the University of Arizona and are 51% through June 30, 2004, 50.5% through June 30, 2006, and 51% through the end of the mission. Subcontractor IDC is applied to the first $25,000 of the contract only. In determining benefits rates for the E/PO Manager, the University of Arizona classifies this position as appointed personnel, the same rate as University of Arizona faculty.

Figure 5, shows a total cost breakdown in each major funding category. As shown in Table 10, cost sharing from the Phoenix E/PO partners that are able to do so increases the effective E/PO funds to be spent by about 9% (i.e., from $3,781,588 to $4,108,088).

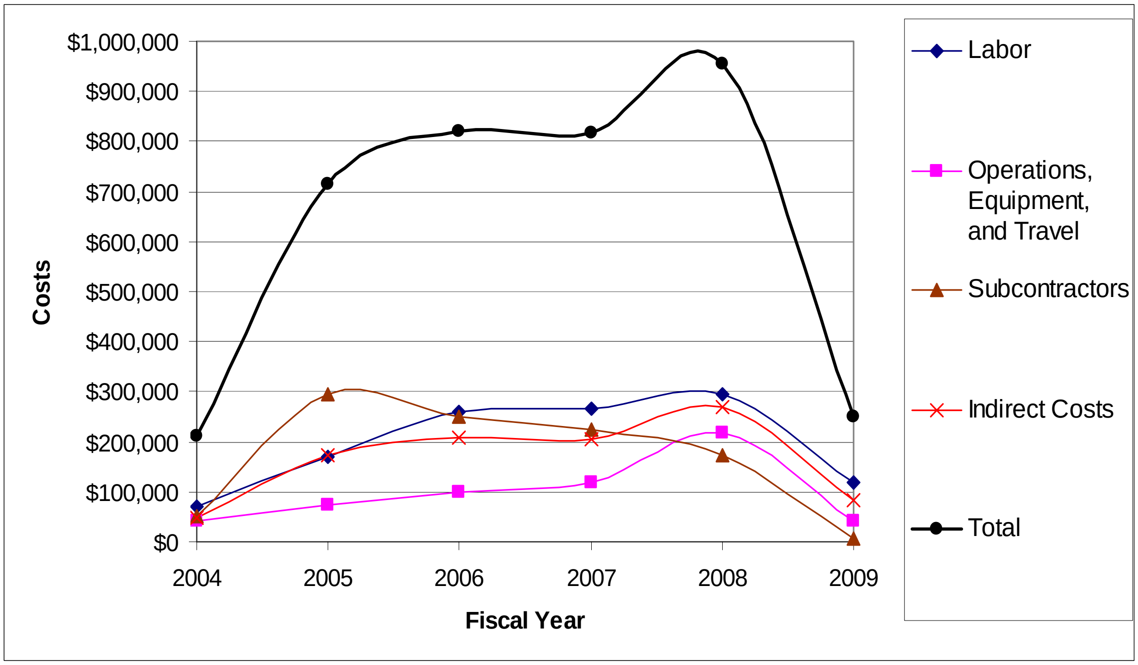

Figure 4. Phoenix E/PO budget breakdown.

Table 9. Phoenix E/PO Budget Summary

	Phase B 06/04-03/05	Phase C/D 03/05-09/07			Phase E 09/07-end of mission		E/PO Total
	FY04	**FY05**	**FY06**	**FY07**	**FY08**	**FY09**	
Labor Budget							
E/PO Manager	$ 47,246	$ 87,704	$ 90,248	$ 92,865	$ 95,558	$ 46,968	**$ 460,590**
Web/Editor Programmer, Sr.	$ -	$ 11,926	$ 46,988	$ 48,351	$ 49,753	$ 24,454	**$ 181,472**
Outreach Coordinator	$ -	$ 11,926	$ 46,988	$ 48,351	$ 49,753	$ 12,994	**$ 170,012**
Web student	$ 7,730	$ 5,792	$ -	$ -	$ -	$ -	**$ 13.522**
Student Intern	$ 300	$ 4,137	$ 4,257	$ 4,380	$ 4,507	$ -	**$ 17,582**
Graduate Student - Evaluation	$ 2,213	$ 15,858	$ 10,326	$ 10,626	$ 25,619	$ 7,074	**$ 71,717**
Labor Totals	**$ 57,489**	**$ 137,343**	**$ 198,807**	**$ 204,573**	**$ 225,190**	**$ 91,491**	**$ 914,895**
Benefit Rates							
Faculty/Appointed Personnel	24.7%	24.7%	26.2%	26.2%	26.2%	26.2%	
Staff	33.6%	33.6%	36.2%	36.2%	36.2%	36.2%	
Students - Undergraduate	3.1%	3.1%	3.1%	3.1%	3.1%	3.1%	
Students - Graduate	23.9%	23.9%	30.8%	30.8%	30.8%	30.8%	
Benefits Budget							
Faculty/Appointed Personnel	$ 10,966	$ 21,663	$ 23,645	$ 24,331	$ 25,036	$ 12,306	**$ 117,946**
Staff	$ -	$ 8,014	$ 34,019	$ 35,006	$ 36,021	$ 13,556	**$ 126,617**
Students - Undergraduate	$ 954	$ 308	$ 132	$ 136	$ 140	$ -	**$ 1,669**
Students - Graduate	$ 529	$ 3,790	$ 3,181	$ 3,273	$ 7,891	$ 2,179	**$ 20,842**
Benefits Total	$ 12,448	$ 33,775	$ 60,977	$ 62,745	$ 69,088	$ 28,041	**$ 267,074**
TOTAL LABOR & BENEFITS	**$ 70,138**	**$ 171,119**	**$ 259,784**	**$ 267,318**	**$ 294,278**	**$ 119,532**	**$ 1,182,169**
Operations Budget							
Supplies & Reproductions	$ 10,000	$ 10,000	$ 10,000	$ 10,000	$ 15,000	$ 2,900	**$ 57,900**
Teachers Summer Stipends	$ -	$ 2,500	$ 5,000	$ 5,000	$ 2,500	$ -	**$ 15,000**
Scholarship Funds	$ -	$ -	$ 5,000	$ 10,000	$ 15,000	$ 2,000	**$ 32,000**
UA Summer Workshops	$ -	$ -	$ 15,000	$ 20,000	$ 25,000	$ -	**$ 60,000**
Phoenix Student Interns Program (PSIP)	$ -	$ -	$ 1,000	$ -	$ 40,000	$ 11,000	**$ 52,000**
Evaluation	$ -	$ 3,950	$ 3,950	$ 3,950	$ 3,950	$ 3,950	**$ 19,750**
Contingencies	$ 2,000	$ 5,000	$ 7,500	$ 25,000	$ 76,000	$ 18,000	**$ 133,500**
TOTAL OPERATIONS	**$ 12,000**	**$ 21,450**	**$ 47,450**	**$ 73,950**	**$ 177,450**	**$ 37,850**	**$ 370,150**
TOTAL TRAVEL	**$ 15,000**	**$ 40,000**	**$ 43,000**	**$ 45,000**	**$ 40,000**	**$ 5,000**	**$ 188,000**
EQUIPMENT WITH IDC	**$ 16,000**	**$ 13,000**	**$ 9,000**	**$ -**	**$ -**	**-**	**$ 38,000**
SUBTOTAL COST	**$ 113,138**	**$ 245,569**	**$ 359,234**	**$ 386,268**	**$ 511,728**	**$ 162,382**	**$ 1,778,319**
INDIRECT COST	**$ 49,329**	**$ 117,447**	**$ 181,937**	**$ 196,997**	**$ 260,981**	**$ 82,815**	**$ 889,505**

Table 9. Phoenix E/PO Budget Summary

	Phase B 06/04-03/05	Phase C/D 03/05-09/07		Phase E 09/07-end of mission		E/PO Total
	FY04	FY05	FY06	FY07	FY08	FY09	
Subcontracts/Partners							
LaRC - (Direct fund thru NASA-No IDC)	$ 30,000	$ 30,000	$ 40,000	$ 40,000	$ 30,000	$ -	**$ 170,000**
SSI	$ -	$ 186,823	$ 67,863	$ 22,298	$ -	$ -	**$ 276,984**
ASU MEP	$ -	$ 5,000	$ 15,000	$ 30,000	$ 20,000	$ -	**$ 70,000**
Az Space Grant	$ -	$ 20,500	$ 28,500	$ 28,500	$ 22,500	$ -	**$ 100,000**
PSIP Coordinator	$ -	$ -	$ 8,000	$ -	$ 40,000	$ -	**$ 48,000**
Visualizations - JPL-(Direct fund thru NASA-No IDC)	$ 20,000	$ 20,000	$ 60,000	$ 70,000	$ 30,000	$ -	**$ 200,000**
Arizona Aerospace Foundation- Models & SOC Exhibit	$ -	$ 25,000	$ 5,000	$ 5,000	$ 5,000	$ -	**$ 40,000**
McDonald Observatory	$ -	$ -	$ 18,000	$ 18,000	$ 12,000	$ -	**$ 48,000**
Documentary	$ -	$ 9,000	$ 9,000	$ 10,000	$ 15,000	$ 5,000	**$ 48,000**
TOTAL SUBCONTRACTS AND PARTNERS	**$ 50,000**	**$ 296,323**	**$ 251,363**	**$ 223,798**	**$ 174,500**	**$ 5,000**	**$ 1,000,984**
Subcontract Burden - on first 25K only							
LaRC - (Direct fund thru NASA-No IDC)	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
SSI	$ -	$ 12,625	$ -	$ -	$ -	$ -	**$ 12,625**
ASU MEP	$ -	$ 2,525	$ 7,575	$ 2,550	$ -	$ -	**$ 12,650**
Az Space Grant/NAU	$ -	$ 10,353	$ 2,273	$ -	$ -	$ -	**$ 12,625**
PSIP Coordinator	$ -	$ 12,625	$ 4,040	$ -	$ 8,670	$ -	**$ 25,335**
Visualizations - JPL-(Direct fund thru NASA-No IDC)	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
Arizona Aerospace Foundation- Models & SOC Exhibit	$ -	$ 12,625	$ -	$ -	$ -	$ -	**$ 12,625**
McDonald Observatory	$ -	$ -	$ 9,090	$ 3,570	$ -	$ -	**$ 12,660**
Documentary	$ -	$ 4,545	$ 4,545	$ 3,570	$ -	$ -	**$ 12,660**
TOTAL SUBCONTRACT BURDEN	**$ -**	**$ 55,298**	**$ 27,523**	**$ 9,690**	**$ 8,670**	**$ -**	**$ 101,180**
Direct Costs	**$ 163,138**	**$ 541,891**	**$ 610,597**	**$ 610,066**	**$ 686,228**	**$ 167,382**	**$ 2,729,302**
Indirect Cost (includes subcontract burden)	**$ 49,329**	**$ 172,745**	**$ 209,459**	**$ 206,687**	**$ 269,651**	**$ 82,815**	**$ 990,685**
TOTAL FY ANNUAL BUDGET	**$ 212,466**	**$ 714,636**	**$ 820,057**	**$ 816,753**	**$ 955,880**	**$ 250,197**	
CUMULATIVE BUDGET	**$ 212,466**	**$ 927,102**	**$ 1,747,159**	**$ 2,563,912**	**$ 3,519,791**	**$ 3,769,988**	**$ 3,769,988**

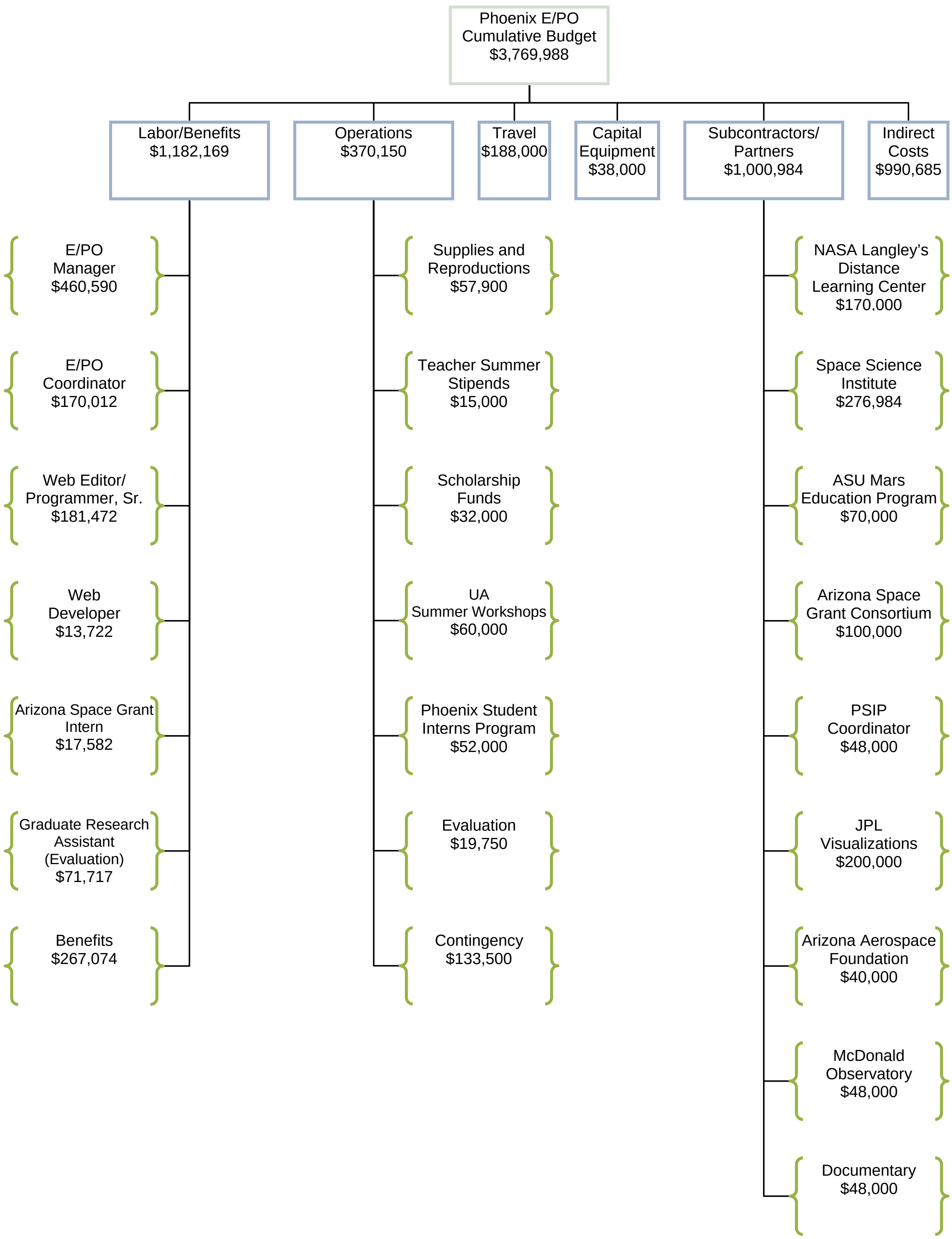

Figure 5. Phoenix E/PO categorical budget breakdown.

Table 10. Phoenix E/PO Cost Sharing

Partner/Subcontractor	Funding	Estimated Cost Sharing Amount
ASU Mars Education Program	$70,000	—
NASA's SEMAA Program	—	$8,000
Phoenix Student Interns Program (Coordinator)	$48,000	$5,000
Arizona Space Grant Consortium	$100,000	$16,000
Space Science Institute	$276,984	—
Arizona Aerospace Foundation	$40,000	$6,000
NOAO	—	$1,500
NASA Langley's Center for Distance Learning	$170,000	—
JPL Visualizations	$200,000	$200,000
Mars Public Engagement Plan	—	$80,000
McDonald Observatory	$48,000	$5,000
Documentary	$48,000	TBD
Total	**$1,000,984**	**$321,500**

6.3 Web Site Design and Performance

As stated in Section 1.2.2, the Phoenix Mission Web site will be have a parallel construction to the Mars Mission program sites that currently reside on the Mars Exploration Program Web site at JPL. Because of this parallel construction, the main NASA portal and Mars Exploration Web sites will link directly to the Phoenix Mission Web site, located at the University of Arizona, and so will not have to create their own Phoenix Mission page. **This will prevent any potential discontinuities in information that could occur with two Web sites that in essence, serve the same function**.

During the entry, descent, and landing and surface operation phases of the mission, the Phoenix Mission Web site anticipates significant traffic. The Mars Exploration Rover Mission drew an unprecedented amount of traffic at both the NASA portal and Mars Exploration Program Web sites, with over 225 million hits[11] in a 24 hour period after the landing of the Spirit Rover and over 6.5 billion hits in the first six weeks of the rovers' missions. This represents the greatest traffic ever to any U.S. government Web site.

In 2005, the University of Arizona will install a 2 Gigabyte bandwidth Internet conduit to accommodate the data stream needs associated with its support of the Mars Reconnaissance Orbiter's High Resolution Camera. During the Phoenix Mission, the university will commit almost all of this bandwidth to accommodate the heavy traffic anticipated to occur during surface operations. This large bandwidth should be sufficient

[11]A Web site hit is defined as a request for at least one piece of information (e.g., an image, a video clip, or text) to a Web page. A Web page is often made up of many of these elements, and therefore, the number of pages visited is much less. Also, assessing Web traffic through hits may be too broad a measure because a single person can visit a page multiple times in one or more sessions. However, even using a more focused measure, such as the Nielsen/NetRatings, which reported 1.9 million unique visitors to the NASA portal during Spirit's landing and 2.6 million visitors during Opportunity's landing, the traffic is still the most ever experienced by a U.S. government Web site.

to allow full public access without significant degradation in Web site performance during periods of heavy traffic.

6.4 Public Release of Phoenix Scientific Data

The Phoenix Mission is committed to sharing images and scientific data with the public. During the mission, raw images from the Mars descent imager, robotic arm camera, and surface stereoscopic imager will be made available to the public in near real-time through the Phoenix Mission Web site. Data and information other than raw images will be released after approval by the Principal Investigator and the Science Team. Prior to public release, materials (e.g., processed images, spectra, captions, and summary of results) will be previewed with NASA's Science Mission Directorate and the Mars Public Engagement Plan. The intent is not to require concurrence of the release, but only to make sure that these groups are informed of the release content prior to the public. Examples of anticipated significant mission events include:

- the development of a full color panoramic image of the Phoenix landing site using the surface stereoscopic imager and associated images showing the robotic arm digging area;
- experimental results from the first series of surface sample experiments; and
- a descriptive analysis of the atmospheric composition at the Phoenix landing site, with comparisons to the Viking I and II atmospheric composition results.

One year prior to surface operations (currently scheduled for 06/01/08), the science and E/PO teams will conduct a series of work sessions to anticipate significant mission events and develop interpretive text, graphics, and animations. At the time of surface operations, the collected data would then be inserted into these previously developed materials to provide comprehensive and meaningful analysis of significant events to the public.

All data will be released to the public via NASA's Planetary Data System. Before data are deposited to the Planetary Data System, information concerning scientific results from a given study would be released by an Interdisciplinary Scientist, Participating Scientist, Co-Investigator, or Team Member only with the concurrence of the Principal Investigator. The initial plan for archiving data from the Phoenix Mission is being developed by Dr. Ray Arvidson, with a draft made available to the Phoenix team in September 2004.

6.5 Product Dissemination

All products developed through the Phoenix E/PO program, will be disseminated according to the NASA Communication Protocol (currently being developed). Products produced by partners at NASA Centers (e.g., teacher's guides developed by NASA Langley's Center for Distance Learning) will go through their center's E/PO product review cycle. Other products will be submitted to the Solar System Education Forum for review, and ultimately made available through the Space Science Resource Directory. Additional dissemination of products through the Phoenix Mission, Mars Exploration Program, and partners' Web sites will ensure a wide distribution.

6.6 Disposition of Review Panel Findings and Recommendations

Table 11 summarizes the findings and recommendations from Phoenix E/PO review panel convened on November 9, 2004. The disposition of each finding and recommendation are also included.

Table 11. Disposition of Findings and Recommendations from the Phoenix E/PO Review Panel, November 9, 2004

Finding Number	Panel Finding	Panel Recommendation	Disposition
1	The management plan is robust and well organized with a detailed and aligned budget.	The implementation plan as presented provides a good template for the level of maturity expected of a NASA Mission Education and Public Outreach program of this scale by the end of Phase B.	No additional action necessary.
2	The plan captures an excellent diversity of program types and program audiences. Clarification and clear articulation of the connectivity between these programs is a natural next step. The evaluators should play an important role to play in helping to identify potential interconnection and synergy.	A. Derive a set of Guiding (or Operating) Principles that are relevant to all program elements and that be would be useful to evaluators in assessing the success of the program.	A set of guiding principles have now been added to the implementation plan.
		B. The E/PO Manager should work with evaluators to think through a basic concept mapping of the E/PO program and to identify natural opportunities for interconnectedness and synergy between the various Phoenix E/PO program elements.	The Phoenix E/PO Manager is working with evaluators to develop this concept map.
		C. E/PO Manager develops an appropriate electronic means (e.g., list-serve) for communication with and among the Phoenix E/PO team members.	The Phoenix E/PO manager will form a list-server to facilitate regular communication among partners.
		D. E/PO Manager works with evaluators, team members, and regional Brokers to decide how best to make everything created by this E/PO Program broadly accessible to educators. Because the products created by the program will be of value beyond mission specific activities, it is important to consider what other dissemination networks would be the most effective.	All products developed through the Phoenix E/PO program, will be disseminated according to the NASA Communication Protocol (currently being developed). Note: more details on dissemination are included in Section 6.5 of this implementation plan. Also, evaluation results will be published in scholarly journals.

Table 11. Disposition of Findings and Recommendations from the Phoenix E/PO Review Panel, November 9, 2004

Finding Number	Panel Finding	Panel Recommendation	Disposition
3	More should be done to leverage existing networks such as advertising distance learning and other Phoenix E/PO activities on key sites (Mars Program, MarsQuest) where Mars-interested visitors can easily be reached. Emails and dissemination to network partners is really important for extending reach.	Develop list of places/contacts where advertising upcoming events, featuring them (live or archived) and where disseminating products would generate increased levels of participation. Send out regular "upcoming events" lists, plus any teaser language for website links (e.g., Phoenix presents Kids' Topic X Webcast on [date] etc.) and flyers for partner networks.	The Phoenix E/PO Manager is going to be sending regular "upcoming events" to the Mars Public Engagement Program and other popular Mars venues to facilitate dissemination.
4	The animation's pre-release for ed purposes would be useful.	Small clip (low-res even!) would be great to have before release date currently in the schedule. Work with team leadership to determine when and in what contexts (with whatever constraints). Something sooner is "way better" than nothing.	The rough-cut entry-descent-landing animation has been approved for public release and will be made available on the Phoenix Web site.
5	Would like to see pages on the Phoenix site featuring student balloon satellite teams, their construction and operations challenges, and research results. Also has great documentary (and perhaps live Webcast) appeal.	Work with Mars Public Engagement to determine what documentary/visualization resources can be leveraged. Consider web and other means of allowing students to create their own pages to showcase their results (following guidance provided to them or some sort of upload/database). It would be great to show from a peer-mentoring, "Kids can do it!" perspective.	The Phoenix E/PO program will provide students access to the Phoenix Mission public site to develop pages showcasing their results. Also, Phoenix E/PO will coordinate with Mars Public Engagement to develop documentary footage.
6	In general the Phoenix web-site as presented is not a concern. Appreciate willingness to develop website with "parallel construction" in mind. That is, Phoenix has same navigation buttons, which was a recommendation from external customers who want to be able to find same content organization across Mars mission sites for easy access to info and cross-comparison with other mission facts.	Keep up the great work and integrate specific recommendations as noted within this report.	The Phoenix E/PO program will make revisions to the public Web site as suggested.

Table 11. Disposition of Findings and Recommendations from the Phoenix E/PO Review Panel, November 9, 2004

Finding Number	Panel Finding	Panel Recommendation	Disposition
7	The PI has an impressive, top-notch commitment to E/PO: full 2% budget with respected contingency funds and significant first-person E/PO involvement. The PI leveraged a ROSS E/PO award into a Phoenix E/PO program element that helps support the Pima Aerospace Museum in developing a Mars exhibit. The PI also encourages the E/PO involvement of all science team members (i.e. they are encouraged to contribute 5%. of their time), however there needs to be more clarity about how Phoenix team scientists will be involved and supported in the planned E/PO program elements. Phoenix E/PO needs to do more to mine this intended benefit of an E/PO program being embedded in a mission to do scientific research.	A. Recommend that E/PO manager devise a way to solicit input on the specific needs and opportunities for Phoenix scientist E/PO involvement in each program element (e.g. the conceptual design phase of the "Big Dig" robot arm exhibit will require the participation of at least one knowledgeable engineer and one soil-analyzing scientist – estimate a day of time for each. The 4-Corners event will need to have a Phoenix scientist or engineer engaged to give a public talk and then to serve as a resource for the educator workshop).	The E/PO Manager has already conducted such a solicitation at the September 2004 Phoenix Science Team meeting and the results of this coordination are listed in Section 2, Table 6 of the implementation plan.
		B. After such an inventory has been completed, recommend that E/PO Manger be given time on a science team meeting agenda to describe the E/PO program and to begin the process of matching scientists and engineers to specific opportunities for E/PO involvement in Phoenix E/PO elements.	The PI and the project scientist are committed in including E/PO in the science team meetings. In the past three meetings, E/PO has had the opportunity to discuss the program in detail and encourage science team involvement. This will continue in future meetings.
		C. Recommend distribution of Eric DeJong's animations and basic PPT presentation resources to all science team members to support and encourage their giving public talks, media interviews, etc in their local communities.	The animation was distributed to science team members at the September 2004 meeting. Also, the animation and all E/PO presentations are available on the Phoenix Team Web Site.
		D. Recommend working with the Larry Cooper and the Western Region Broker to make Peter Smith's E/PO contributions a case study for leveraging ROSS E/PO funds.	The Phoenix E/PO Manager has presented this recommendation to Larry Cooper for his future disposition.
8	Training the science team for operations can provide great video role-modeling opportunities, showing students that even professionals don't know everything and have to learn. Sharing their experiences, from challenges to accomplishments, could be very powerful.	Take advantage of MPE visualization/documentary resources (need to coordinate schedules etc.). Consider web cast opportunities to educational audiences. Student intern involvement can also create opportunities for them as peer role models. Student intern involvement at this stage would also be terrific and the Phoenix E/PO effort should identify potential opportunities for students.	Phoenix E/PO will coordinate with Mars Public Engagement to develop documentary footage of scientist training and will document student interns experiences in the mission.

Table 11. Disposition of Findings and Recommendations from the Phoenix E/PO Review Panel, November 9, 2004

Finding Number	Panel Finding	Panel Recommendation	Disposition
9	Based on recommendations from a Task Force that reviewed the NASA space science education program, there is a movement afoot to emphasize the professional development the E/PO community – the body of E/PO specialists working inside scientific research environments. The capabilities and extensive knowledge of the evaluation team for the Phoenix E/PO program has the natural potential to provide insights on evaluation methodology that could translate to papers, workshops, and other means of professional development that would be of broader value to the E/PO community. NOTE: The work of Phoenix E/PO could lead to a broader policy on mission E/PO programs finding ways to advance the state of the art with regard to E/PO planning, implementation, or evaluation.	A. The scholarship of engaging a PhD student on the study how best to do evaluation of a multi-faceted E/PO program embedded in a NASA mission could allow for developing documented advice and guidance that would be of value system-wide. This could also form the basis of a workshop on evaluation for E/PO managers.	The Phoenix E/PO program will support the development of an evaluation workshop highlighting the resources developed for the mission's E/PO evaluation.
		B. The Phoenix E/PO evaluation team could use the context of Phoenix E/PO to consider taking on the broader question of whether it's an advantage to have E/PO programs embedded in a research mission. These kinds of data are missing from the overall evaluation of the NASA space science education program and are sorely needed now in support of deliberations about the value of having E/PO embedded in scientific research environments.	Results of the evaluation will be published in the scholarly literature. The Phoenix E/PO team will seek external funding to address the broader questions recommended.
10	While this mission predates the above criteria, it's still a good idea to show alignment. The E/PO plan already well aligns with the criteria, but taking some time to show that will greatly help in showcasing allegiance to the topics that indicate what "success" looks like to the Agency. It will help Phoenix be prepared for impromptu inquiries re. Alignment.	Create a table/graphic that shows alignment and commitment to the criteria and the principles behind them.	This table will be created and submitted in the annual update of the E/PO implementation plan.

Table 11. Disposition of Findings and Recommendations from the Phoenix E/PO Review Panel, November 9, 2004

Finding Number	Panel Finding	Panel Recommendation	Disposition
11	The science learning outcomes for the programs described are tightly focused, however the mission should not overlook the opportunity to teach about (1) the nature of science and scientific discovery by explicitly telling the story of how this mission rose from the ashes of other missions, and (2) serve as a forum for discussion of the big issues related to the possibilities of life on other planets. This may be the most interesting hook to gain the broadest public interest by connecting science to deep philosophical issues about the nature of life. The mission presents several great stories that have the potential to engage students and/or informal learners and teach them not only about how science is done, but also about the humanity of the people who do it...their triumphs and disappointments. These stories could also be linked with the national science education standards related to nature of science and science and society.	Some of the formal or informal programs should tell the "Phoenix Story." Scientist PI's could also tell this story in their public lectures, panels, etc. Encourage museum partners too add programs related to the nature of life: lectures, panels, discussion forums, debates, etc. Include extensions in formal curriculum that allow students to write about, debate or otherwise engage with these issues.	The Phoenix E/PO program is actively working toward telling the "Phoenix Story" in its E/PO efforts. For example, activity code AAF-3, Section 3.2.2, summarizes our plans to develop an exhibit at the Pima Air and Space Museum that will provide authentic stories from mission scientists and engineers that reveal the nature of scientific inquiry to the public.

Table 11. Disposition of Findings and Recommendations from the Phoenix E/PO Review Panel, November 9, 2004

Finding Number	Panel Finding	Panel Recommendation	Disposition
12	In view of the merger of earth and space science in NASA's Science Mission Directorate, it would be good strategy to give greater emphasis to the many dimensions of the Phoenix E/PO program that can integrate space and earth science education. This is an educational opportunity for Phoenix to take fullest advantage of its many natural means for doing comparative planetology vis-à-vis the climate, weather, and soil habitability.	A. Identify and promote the program elements with the greatest existing or potential synergy between space science and earth systems science.	The Phoenix E/PO program will actively seek synergistic opportunities and partnerships.
		B. Reach out to key educational programs related to global climate, weather, seasons, astrobiology (e.g. extremophiles in Antarctica) for partnerships that can strengthen the earth-space science connection for mutual educational benefit (e.g. ASU Soil Habitability Modules and GLOBE protocols, the Polar Year, NAI - extremophile, AMS - weather)	The Phoenix E/PO Manager is approaching the GLOBE program, the Solar Dynamics Observatory, and the International Polar Year E/PO programs and pursue collaborations.
13	The MECA experiments (and Phoenix's science goals overall) offer a unique opportunity to talk about planetary protection (and astrobiology) in an engaging way. While Mars Program language of follow the water, then follow the carbon (identify potential habitats & then look for the building blocks of life and then life) isn't always made public-friendly, Phoenix has much to contribute in communicating NASA's approach to Mars Exploration and to why scientists want to avoid "discovering life only to find out we brought it with us."	Include planetary protection topics in materials, focusing on why scientists want to ensure that whatever is found isn't what we brought etc. Link to astrobiology community for leveraging opportunities on this topic. The idea of classroom/informal ed projects where students understand earth/martian soil chemistry and what "grows" has potential tie-ins to Imagine Mars in the Mars Public Engagement Plan. Prior to operations, earth-soil plant-growing activities could be developed, and may even be possible to partner with JSC on "martian" soil samples for classroom use.	The program will seek innovative ways to incorporate planetary protection into its E/PO activities. As one example, Phoenix E/PO will work closely with NASA's Astrobiology Institute node at the University of Arizona.
14	There are some questions concerning the evaluation process proposed for Phoenix that should be addressed.	Documentation of the rationale for selected evaluation approach should be provided. A few pages that address the following questions are satisfactory (this does not need to be a formal or costly "evaluation of the evaluation").	The annual update of the implementation plan will address the technical issues highlighted in the recommendation.

6.7 Acronyms

Table 12 contains the list of the acronyms that are used in this report.

Table 12. List of Acronyms

AAF	Arizona Aerospace Foundation
ANSR	Arizona Near Space Research
ASG	Arizona Space Grant Consortium
ASU	Arizona State University
CAC	Central Arizona College
CAPER	Conceptual Astronomy and Physics Education Research Team, University of Arizona
E/PO	Education and Public Outreach
EdCats	The common name for NASA's E/PO tracking and reporting system
EDL	entry-descent-landing
EVAL	evaluation
FY	fiscal year
IDC	Indirect costs
JPL	Jet Propulsion Laboratory
K	kindergarten
KSNN™	Kids' Science News Network™
LaRC	NASA Langley Research Center
MESDT	Mars Exploration Student Data Teams
MO	McDonald Observatory
MPEP	Mars Public Engagement Plan
NASA	National Aeronautics and Space Administration
NOAO	National Optical Astronomy Observatory
PSIP	Phoenix Student Interns Program
ROSS	Research Opportunities in Space Science
SEMAA	NASA's Science, Engineering, Mathematics, and Aerospace Academy
SSI	Space Science Institute
SSV	Solar Systems Visualizations Project
STEM	science, technology, engineering, and mathematics

6.8 Partners' Statements of Work

This section contains the statements of work or letters of agreement from the various partners of the Phoenix E/PO program. Statements of work or letters of agreement have been received from all planned partners, except the McDonald Observatory. A letter of agreement will be developed with McDonald Observatory in the middle of 2005.

National Aeronautics and
Space Administration

Langley Research Center
100 NASA Road
Hampton, VA 23681-2199

June 9, 2004

Reply to Attn of: 400-DL

Mr. Doug Lombardi
EPO Manager
Mars Phoenix Project
University of Arizona
1415 North 6th Avenue
Tucson, AZ 85705

Dear Mr. Lombardi:

My colleagues and I in the NASA Langley Center for Distance Learning (http://dlcenter.larc.nasa.gov) are extremely proud to have been selected to work with you on the Mars Phoenix Project. We are also delighted that we had the opportunity to meet you and to discuss our participation in the Mars Phoenix Project.

We believe our award-winning programs will make a significant contribution towards accomplishing the education and outreach (E/PO) goals established for the Mars Phoenix Project (see enclosures A and B). Specifically, we are committed to being the Mars Phoenix Project's primary E/PO partner for developing the *Water and Life* educational strand, the primary objective for which, is to address the current void in science education by promoting the exploration and understanding of the physical and thermodynamic properties of water that make it an essential ingredient for life.

We welcome the opportunity to work with you throughout the duration of the Mars Phoenix Project. I mention this partly because this statement of work (SOW) only includes the cost of our participation for years 1 and 2 of the project. Although we can certainly talk about the out years, given the current volatility of today's environment, meaningful "out year" cost projections would be extremely difficult to make.

From June 1, 2004, to September 30, 2004, at the cost of $30K, we are prepared to:

1. Produce one (1) NASA's Kids Science News Network™ (NASA's KSNN™) news break in both English and Spanish (language). (http://ksnn.larc.nasa.gov)

   A. Estimated date to be placed on NASA's KSNN™ Web site: August 30, 2004.

B. Information needed from Doug Lombardi (DL): Script and Web text collaboration, review, and approval. (Receivable dates to be arranged with the program manager. Program manager will also provide a list of television stations airing NASA's KSNN™.)

C. Program Manager: Ron Shaneyfelt (r.k.shaneyfelt@larc.nasa.gov; 757-864-2193).

2. Include a 3-minute segment on the Mars Phoenix Project in the NASA SCI Files™ program (http://scifiles.larc.nasa.gov), *The Case of the Great Space Exploration*, which airs on Wednesday, September 22, 2004, at 11:00 AM (EDST) on PBS.

   A. Estimated delivery date for script: June 25, 2004. (*The Case of the Great Space Exploration*, together with the lesson guide, will be delivered on DVD no later than October 31, 2004.)

   B. Information needed from DL: Talent identification and script collaboration, review, and approval. (Receivable dates to be arranged with the program manager. Program manager will also provide a list of television stations airing the NASA SCI Files™.)

   C. Program Manager: Shannon Ricles (s.s.ricles@larc.nasa.gov; 757-864-5044).

3. Develop one (1) NASA CONNECT™ (http://connect.larc.nasa.gov) classroom (hands-on, minds-on) activity concerning the physical, chemical, and thermo-dynamic properties of water necessary for life. This activity will serve as the foundation for the mission's *Water and Life* educational strand described above.

   A. Although the funding will be provided in FY 04, the estimated delivery date is July 23, 2005. (NASA CONNECT™ activity will be delivered on DVD.)

   B. Information needed from DL: Background information and activity collaboration, review, and approval. (Receivable dates to be arranged with the program manager.)

   C. Program Manager: Chris Giersch (C.Giersch@larc.nasa.gov; 757-864-6590).

From October 1, 2004, to September 30, 2005, at the cost of $30K, we are prepared to:

1. Produce one (1) NASA's Kids Science News Network™ (NASA's KSNN™) news break in both English and Spanish (language). (http://ksnn.larc.nasa.gov)

   A. Estimated date to be placed on NASA's KSNN™ Web site: October 15, 2004.

B. Information needed from Doug Lombardi (DL): Script and Web text collaboration, review, and approval. (Receivable dates to be arranged with the program manager.)

C. Program Manager: Ron Shaneyfelt (r.k.shaneyfelt@larc.nasa.gov; 757-864-2193).

2. Develop a segment on the Mars Phoenix Project for NASA's Destination Tomorrow™ (http://destination.larc.nasa.gov). This segment will focus on the mission's *Water and Life* educational strand.

   A. Estimated delivery date: September 30, 2005. Program containing Mars Phoenix Project segment will be delivered on DVD no later than September 30, 2005.

   B. Information needed from DL: Talent identification and script collaboration, review, and approval. (Receivable dates to be arranged with the program manager. Program manager will also provide a list of television stations airing NASA's Destination Tomorrow™.)

   C. Program Manager: Kevin Krigsvold (k.krigsvold@larc.nasa.gov; 757-864-8711).

Enclosure A contains additional information on the programs offered by the NASA Langley's Center for Distance Learning. The approach to evaluating our six distance learning programs is included in this document. Enclosure B is a collection of our program promotional flyers. Our broadcast programs are taped in Digital Beta. That said, we will make reasonable attempts to tape the Mars Phoenix Project segment of NASA's Destination Tomorrow™ in HDTV. Although you and I will remain in close contact, I prefer that the individual program managers serve as the points-of-contact with you for the individual items included in the SOW. (Contact information for each program manager is provided.) Likewise, the establishment of all reporting requirements should also be made directly between you and the individual program managers. I am also including your contact information, plus the contact information for Mr. Charles "Chip" Phelps, our Business Manager. Chip is the point-of-contact for the transfer of funds.

Charles "Chip" Phelps
Business Manager
Office of Education
Mail Stop 400
NASA Langley Research Center
Hampton, VA 23681-2199
757-864-2420 (voice)
757-864-6521 (fax)
c.n.phelps@larc.nasa.gov

Doug Lombardi
EPO Manager
Mars Phoenix Project
University of Arizona
1415 North 6th Avenue
Tucson, AZ 85705
520-626-8973 (office)
520-906-0743 (mobile)
lombardi@lpl.arizona.edu

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Lastly, we had discussed the possibility of developing a Mars-related NASA CONNECT™ program for the 2005-2006 season. Although we cannot devote an entire program to the Mars Phoenix Project, it is very possible that the Mars Phoenix Project could be included as part of the overall program.

Again, I want to reemphasize that we are very pleased to be working with you and your colleagues on the Mars Phoenix Project, and we welcome the opportunity to work with you throughout the duration of the Mars Phoenix Project. I can be reached by mail at the NASA Langley Research Center, Office of Education, Mail Stop 400-DL, Hampton, VA 23681-2199; by telephone at 757-864-2491; by fax at 757-864-6521; and by e-mail at t.e.pinelli@larc.nasa.gov.

Cordially,

Thomas E. Pinelli

Thomas E. Pinelli, Ph.D.
Distance Learning Officer

2 Enclosures

cc (w/Encl.):
NASA—S/Philip J. Sakimoto, Ph.D.

NASA Langley's Distance Learning Programs:
Mission, Strengths and Unique Characteristics, Program Descriptions,
Program Metrics, Program Evaluation, and Pricing Data

NASA Langley's Center for Distance Learning is home to six of the Agency's most exciting, innovative, and inspirational instructional and educational programs. Founded in 1996 as an educational partnership with Christopher Newport University, the NASA Langley Center for Distance Learning http://dlcenter.larc.nasa.gov is an organizational unit of the NASA Langley Research Center's Office of Education. The six programs offered by NASA Langley's Center for Distance Learning "span the educational horizon" from grades K-12 through college (grades 13-18), to adult (lifelong) learners. These award-winning programs are research-, inquiry-, standards-, and teacher-based. These technology-focused programs (1) serve both formal and informal education; (2) are designed to increase interest, engagement, and understanding of science, technology, engineering, and mathematics; (3) are intended to motivate and inspire students to pursue careers in science, technology, engineering, and mathematics; (4) are planned to increase scientific and technological literacy; (5) use technology to enhance and enrich the teaching and learning process; and (6) are used to advance the theory and practice of teaching mathematics, science, and technology.

Mission

Extend the potential of traditional and emerging instructional technology to provide sustainable distance learning programs that inspire students, create learning opportunities, complement NASA's education and outreach mission, and contribute to the achievement of critical workforce development and national STEM goals, especially as they relate to women, minorities, and underserved segments of the population.

Strengths and Unique Characteristics

The six "high-energy," Emmy®-award-winning programs -

- Combine cutting-edge multimedia with technology to meet needs identified by the education community.
- Support the NASA pipeline and the Agency's workforce development initiatives.
- Use NASA projects, facilities, research, and people to motivate and inspire students, young adults, formal and informal educators, parents, and adults.
- Are research-, inquiry-, and standards-based and are developed with educator input for use by the formal and informal education communities.
- Use 12 partnerships, collaborations, and alliances to strengthen: and enrich our programs, extend their distribution, and provide nationwide classroom mentor programs.

- Epitomize continuous quality improvement through the use of "theory-based practice," sound instructional models, formal and informal evaluation, and longitudinal assessment.
- Use multichannel, global access, and digital distribution to maximize audience participation and minimize distribution costs.
- Draw from a multifaceted, national marketing program based on customer needs and service, a reliable management information system, market analysis, and e- commerce.
- Have a user base of over 500,000 registered educators (representing 15.1 million students and young adults) made possible through extensive marketing, registration, and "world class" customer service.
- Have won countless awards and are recognized throughout the world for their educational, technical, and artistic excellence.
- Are produced by the Agency's leader in educational programming and are the programs most requested through the NASA Educator Resource Centers, NASA CORE, and Voice of America (VOA).
- Collectively constitute the Agency's single largest contribution of educational programming for NASA TV.
- Are dubbed in Spanish and are used by more than 5,000 registered educators for students with limited English proficiency and in language emersion programs.

Program Descriptions

***NASA's Kids' Science News Network* ™ *(NASA's* KSNN™)**
Grades K-2, 3-5
http://ksnn.larc.nasa.gov **http://ksnn.larc.nasa.gov/awards**

A Parent's Choice "Gold" Award, Telly, and Communicator award winner, NASA's Kids' Science News Network™(NASA's KSNN™) is a research-, inquiry-, standards-based, teacher-based, and technology-focused educational program that explains the everyday phenomena of our world, corrects misconceptions, and answers frequently asked questions. Watch and interact as animated characters and kids explain math, science, technology, and geography and present NASA facts in an interesting, entertaining way.

For each question on the NASA KSNN™ web site, there is a 1-minute video newsbreak and a follow-up written explanation, a hands-on activity, related print and electronic resources, and a computer-graded quiz. Sponsored by NASA's Biological and Physical Science Enterprise, NASA's KSNN™ invites parents, formal and informal educators, and kids to experience a real adventure in learning.

Noticiencias NASA ™
Grades K-2, 3-5
http://ksnnsp.larc.nasa.gov **http://ksnnsp.larc.nasa.gov/awards**

Noticiencias NASA™ is a Spanish-language research-, inquiry-, standards-, and teacher-based, technology-focused educational program that uses the Internet, animation, and video to introduce young Latinos to the world of science, technology, engineering, mathematics, NASA missions and research in an entertaining, instructional format. Noticiencias NASA™ features Hispanic students explaining science, technology, engineering, mathematics (STEM), and NASA facts in an entertaining, instructional format. Using animated characters (for grades K-2), the Web, and video technology (for grades 3-5) helps children, parents, and educators understand the everyday phenomena of our world and answers frequently asked questions about STEM. The coordinating web site offers detailed written explanations, hands-on activities, supplementary resources, and computer-graded quizzes. Sponsored by NASA's Biological and Physical Science Enterprise, NASA's KSNN™ invites parents, formal and informal educators, and kids to experience a real adventure in learning.

NASA SCI Files™
Grades 3-5
http://scifiles.larc.nasa.gov **http://scifiles.larc.nasa.gov/awards**

The NASA SCI Files™ is an Emmy®-award-winning series of instructional programs for grades 3-5 that presents research-, inquiry-, standards-, and teacher-based programs that emphasize Problem-Based Learning (PBL) and science as inquiry. Each program has the following three components: a **60-minute** television broadcast, an educator guide containing hands-on activities, and an interactive PBL web activity that provides educators an opportunity to integrate technology into the classroom setting and enables students to further explore topics presented in the broadcast. These three components are designed as an integrated instructional package. The NASA SCI Files™ is sponsored by NASA's Aeronautics Enterprise.

***NASA* CONNECT™**
Grades 6-8
http://connect.larc.nasa.gov **http://connect.larc.nasa.gov/awards**

NASA CONNECT™ is a series of Emmy®-award-winning, integrated mathematics and science instructional programs for grades 6-8. These programs are research-, inquiry-, and standards-based. This teacher-based, technology-focused series uses NASA programs, projects, facilities, research, and people to establish relationships between the science, technology, engineering, and mathematics (STEM) concepts learned in the classroom. Each program has the following three components: a **30-minute** television broadcast that can be viewed live or taped for later use, an educator guide containing a hands-on activity, and an interactive web activity that provides educators an opportunity to integrate technology into the classroom setting and enables students to further explore topics presented in the broadcast. The three components are designed as an integrated instructional package. NASA CONNECT™ is sponsored by NASA's Aeronautics Enterprise.

NASA LIVE™
Grades 3-12, 13-18
http://live.larc.nasa.gov http://live.larc.nasa.gov/awards

NASA LIVE™ (Learning Through Interactive Videoconferencing Experiences) is a series of videoconferencing programs that strengthens NASA's commitment to educational excellence at the pre-college and university levels. NASA LIVE™ provides opportunities for learning, instructional enrichment, and professional development for students, formal and informal educators, and faculty by engaging them in an interactive, virtual environment with NASA researchers. NASA LIVE™ is sponsored by NASA's Biological and Physical Science Enterprise.

NASA's Destination Tomorrow™
Grades 9-12, 13-18, Adults
http://destination.larc.nasa.gov http://destination.larc.nasa.aov/awards

NASA's Destination Tomorrow™ is an Emmy®-award-winning series of 3D-minute educational programs that focus on NASA research- past, present, and future. Designed to increase scientific literacy, the series follows a five-segment magazine format. Each program segment gives viewers an inside look at NASA and demonstrates how research and technology relate to our everyday lives. An associated web site contains story summaries and links to related program material. NASA's Destination Tomorrow™ is sponsored by NASA's Aeronautics Enterprise.

Program Metrics

NASA's KSNN™	Video Streaming* ≈3,737	Web text materials* ≈1,500	Television Stations ≈237	Unique Web visits ≈13,540
Noticiancias NASA™	Video Streaming* ≈234	Web text materials* ≈46	Television Stations ≈69	Unique Web visits ≈6,099
NASA SCIence Files™	Registered Educators ≈187,834	3-5 Students ≈3,965,630	Television Stations ≈285	Unique Web visits ≈16,478
NASA CONNECT™	Registered Educators ≈282,514	6-8 Students ≈8,811,130	Television Stations ≈452	Unique Web visits ≈10,047
NASA LIVE™	K-12 Participants° ≈1908	Formal Participants° ≈245	Informal Participants° ≈98	Unique Web visits ≈1,469
NASA's Destination Tomorrow™	Domestic Television Stations ≈796	International Television Stations(VOA) ≈1200	Combined Potential Audience ≈326,541,631	Unique Web Visits ≈18,032

Updated April 2004
*Monthly Average since October 2003
°Cumulative since October 2003

Program Evaluation

We use evaluation to obtain objective information that can help us determine the success of our distance learning programs. We consider evaluation an on-going process that provides accurate, reliable information that will allow us to judge the merits, value, and worth of our distance learning programs. We believe that evaluation can be used (1) to approximate the "cost/benefit" of our programs (do our distance learning programs produce benefits that justify their costs?); (2) as a tool for determining (managerial) accountability; (3) to produce data that can be used to help make sound decisions relating to program design, personnel, and budget; and (4) to determine the extent to which program objectives are met.

Various tools help us obtain objective data we can use to determine the success of our distance learning programs. In addition to the NASA Educational Evaluation Information System (NEEIS), we use (1) focus group interviews, (2) telephone surveys, and (3) mail (electronic, self-reported) surveys to collect *qualitative* and *quantitative* data from two groups: intermediaries (television station managers that represent the stations that air our programs) and consumers who register to use our programs (formal and informal educators). In terms of product development, we extend the use of focus groups to include students. We use both *internal* and *external* evaluation to judge the merits, value, and worth of our distance learning programs and employ both *formative* and *summative* evaluation to help determine the merits, value, and worth of our distance learning programs and the extent to which program objectives are met.

NASA's Kids' Science News Network™ (NASA's KSNN™)
Noticiencias NASA™

In development for almost 2-years, both programs were officially released in January 2004. During their development, we used input from literally hundreds of interviews and focus groups with formal and informal educators and parents to help us develop, test, and evaluate both programs. For the K-2 portion of both programs, we conducted a number of small group interviews with students to help us develop and test this portion of both products. A randomly launched electronic survey (built into both web sites) asks users to evaluate the web site. Both sites have "user feedback" buttons that allow users to send comments. After 2-years of operation, we anticipate using an electronic (self- reported) survey to evaluate both programs.

Tools: interviews, focus groups, and (written and electronic) surveys, NEEIS
NASA SCI Files ™
NASA CONNECT™

These two programs are the oldest and have been evaluated the most. Both intermediaries (i.e., television managers) and users (i.e., formal and informal educators) form the basis for the program evaluations. The NASA SCI Files™ and NASA CONNECT™ web sites have "user feedback" buttons that allow users to send comments. We receive numerous messages regarding these two programs. We are presently evaluating five years of longitudinal (user) data that are presently being tabulated and analyzed by an external evaluator.

Intermediaries - Our customer service representative stays in touch with the television stations that air these programs and periodically calls the station managers during the course of the year to obtain feedback on our programs. Input from television managers is also obtained about every three years via telephone survey. Each year at the annual National Education Telecommunications Association (NET A) conference, we conduct focus group interviews with representatives from various state departments of education.

Users - We participate in a number of educational conferences (e.g., the Florida Education Technology Conference) during the school year. At most of these conferences, we conduct focus group interviews with program users (i.e., formal and informal educators). After each program airs, a smaller group of registered users is asked to complete a short, electronic, self-reported survey designed to determine the extent to which a particular program meets the objectives established for the program series. Users are also surveyed annually. We commission an external group to conduct an annual user survey. Each year, we send 1,000 registered users a written (self- reported) survey designed to determine the extent to which the objectives set for a particular series were met by all programs in a particular season. The results are documented in a NASA technical memorandum.

Tools: interviews, focus groups, and (written and electronic) surveys, NEEIS

NASA *L/VE™*

Approximately 5 minutes of each NASA LIVE™ videoconference is devoted to Q&A. During this time, the participants are asked to articulate what they liked and disliked about the session. The individual who arranged the videoconference is also asked to complete an online survey that includes provisions for identifying, as a learning tool, how the session could be improved.

Tools: interviews, focus groups, and (electronic) surveys, NEEIS

NASA's Destination Tomorrow™

Intermediaries - Our customer service representative stays in touch with the television stations that air these programs and periodically calls station managers during the year to obtain feedback about our programs. After each program airs, we ask a small sampling of television station managers to complete a short, electronic, self-reported survey designed to determine the extent to which a particular program met the objectives established for the program series. Input from television managers is also obtained every three years via a telephone survey. The results are documented in a NASA technical memorandum. Each year at the annual Alliance for Community Media (ACM) conference, we conduct focus group interviews with television station managers.

Tools: interviews, focus groups, and (telephone) surveys, **NEEIS**

We take the evaluation of our programs seriously. We respond to every "message" we receive at our web site. Each year, we set aside time to talk, as a group, about "ways to improve" the programs and determine what changes to make based on user feedback.

For example, we dropped *Dan's Domain* from NASA CONNECT™ because users said their use detracted from the message of "integrating technology." We have also eliminated the cue cards because teachers said they were distracting. Furthermore, we have increased the amount of "hands-on and minds-on" science in both NASA SCI Files™ and NASA CONNECT™ based on user feedback. We also review the data from our annual surveys to determine what changes should be made. That said, we have made and will continue to make changes as theory, research, and feedback so dictate.

Pricing Data

The NASA Langley Center for Distance Learning operates as a "cost recovery" center. By definition, we are expected to make our programs available to all programs and projects in all NASA Enterprises. Our pricing structure has been fairly consistent (steady) from year to year. However, now with the advent of "full cost accounting" and the loss of our G&A baseline, our pricing structure has become somewhat "elastic" and is expected to remain so through FY '05. The following prices are valid through August 31, 2004.

Programs

NASA's Kids' Science News Network™ (NASA's KSNN™) Noticiencias NASA ™	**$25K per production (in both English and Spanish)**
NASA SCI Files ™	**$250K per production, $65 per 15 minute segment (Includes educator guide and associated web materials)**
NASA CONNECT™	**$175K per production (includes educator guide and associated web materials)**
NASA LIVE™	**(Contact D.L. Center for price quote)**
NASA's Destination Tomorrow™	**$200K per production (Includes dubbing in Spanish)**

Titled Segments	***Segment Costs***
How it Works?	**$50K**
Retrospective	**$30K**
TechWatch	**$50K**

Behind the Scenes	**$50K**
On the Runway	**$50K**

Statement of Work for the *Phoenix* Project
Martian Soil Habitability Curriculum Strand
Prepared by Keith Watt, M.A., M.S.
Assistant Director
Arizona State University Mars Education Program

1. TASK PURPOSE

The Arizona State University Mars Education Program will develop K-12 curricula, activities, and workshops in support of the *Phoenix* Mission Education/Public Outreach (E/PO) Strand, "Soil Habitability." The ASU Mars Education Program will develop, test, and implement each of these items, as outlined in the sections below.

2. TASK SUMMARY

2.1 Martian Soil Properties Curriculum

This curriculum package will contain activities that will teach students in grades 5-12 the basic composition and properties of Earth soil and how these factors differ from and are similar to Martian soil. The curriculum will include both Web- and print-based activities, as well as a teacher's guide. *National Science Education Standards* addressed by this package include:

- Content Standard A: Abilities Necessary to Do Scientific Inquiry
- Content Standard A: Understanding About Scientific Inquiry
- Content Standard B: Properties and Changes in Properties of Matter
- Content Standard D: Properties of Earth Materials
- Content Standard D: Structure of the Earth System

In addition, the curriculum package will also specifically address the following *Principles and Standards* from the National Council of Teachers of Mathematics (NCTM):

- Measurement: Understand measurable attributes of objects and the units, systems, and processes of measurement.
- Data Analysis: Formulate questions that can be addresses with data and collect, organize, and display relevant data to answer them.
- Data Analysis: Develop and evaluate inferences and predictions that are based on data.

2.2 Martian Soil Habitability Curriculum

This curriculum package will contain activities that will teach students in grades 5-12 how the properties of Earth soil make it suitable for habitation by Earth organisms and will explore how Martian soil may contain similar conditions or be modified to support the properties needed for life. The curriculum will include both Web- and print-based activities, as well as a teacher's guide. *National Science Education Standards* addressed by this package include:

- Content Standard A: Abilities Necessary to Do Scientific Inquiry
- Content Standard A: Understanding About Scientific Inquiry
- Content Standard B: Properties and Changes in Properties of Matter
- Content Standard C: Characteristics of Organisms

- Content Standard C: Organisms and Their Environments
- Content Standard C: Populations and Ecosystems

As with the Soil Properties curriculum, this package will also address the following NCTM *Principles and Standards*:

- Measurement: Understand measurable attributes of objects and the units, systems, and processes of measurement.
- Data Analysis: Formulate questions that can be addresses with data and collect, organize, and display relevant data to answer them.
- Data Analysis: Develop and evaluate inferences and predictions that are based on data.

2.3 ASU Mars Education Teacher Workshops

Activities from the above two curriculum packages will be featured at ASU Mars Education workshops, training master teachers from across the country in the use of these materials. The ASU Mars Education Program has trained thousands of teachers since its inception, and the program has a wealth of experience in conducting these workshops. Workshops are evaluated via participant survey at the end of each session. Follow-up surveys will be conducted via email three months after each workshop. ASU Mars Education workshops are structured around the professional development recommendations of the *National Science Education Standards*:

- Professional Development Standard A: Address topics significant in science and of interest to participants.
- Professional Development Standard A: Introduce teachers to scientific literature that expands their science knowledge and their ability to access further knowledge.
- Professional Development Standard A: Build on the teacher's current science understanding, ability, and attitudes.
- Professional Development Standard A: Encourage and support teachers in efforts to collaborate.
- Professional Development Standard B: Connect and integrate all pertinent aspects of science and science education.
- Professional Development Standard B: Address teachers' needs as learners and build on their current knowledge of science content, teaching, and learning.
- Professional Development Standard C: Support the sharing of teacher expertise by preparing and using mentors, teacher advisers, coaches, lead teachers, and resource teachers to provide professional development opportunities.
- Professional Development Standard D: Clear, shared goals based on a vision of science learning, teaching, and teacher development congruent with the *National Science Education Standards*.
- Professional Development Standard D: Options that recognize the developmental nature of teacher professional growth and individual and group interests, as well as the needs of teachers who have varying degrees of experience, professional expertise, and proficiency.
- Professional Development Standard D: Recognition of the history, culture, and organization of the school environment.

2.4 Mars Exploration Student Data Teams (MESDT)

Real-time data will be made available via the Internet to select student teams, who will evaluate this data according to concepts laid out in the above-mentioned activities. The students will post their evaluations of the habitability of the soil sampled within the current day's dataset. Web-based discussion forums and online training modules will be created for this program. *National Science Education Standards* addressed by this program include:

- Content Standard A: Abilities Necessary to Do Scientific Inquiry
- Content Standard A: Understanding About Scientific Inquiry
- Content Standard B: Properties and Changes in Properties of Matter
- Content Standard C: Characteristics of Organisms
- Content Standard C: Organisms and Their Environments
- Content Standard C: Populations and Ecosystems
- Content Standard D: Properties of Earth Materials
- Content Standard D: Structure of the Earth System

NCTM *Principles and Standards*:

- Measurement: Understand measurable attributes of objects and the units, systems, and processes of measurement.
- Data Analysis: Formulate questions that can be addresses with data and collect, organize, and display relevant data to answer them.
- Data Analysis: Develop and evaluate inferences and predictions that are based on data.

3. STATEMENT OF WORK

3.1 Curriculum Development

The ASU Mars Education Program will undertake all of the research and development needed to implement items 2.1 and 2.2 above. Curriculum packages will be made available in print, electronic (PDF), and Web-based formats.

3.2 Print-Based Curriculum Test and Revision

Curriculum modules will be pilot-tested in select classrooms by the ASU Mars Education Program. Based upon teacher feedback and direct observation, modifications will be made to the curriculum to ensure it is directly addressing national education standards. The print-based curriculum will be submitted to NASA for review and consideration as a NASA Exemplary Product.

3.3 Web Programming

Upon completion of the print-based curricula, Web-based versions will be created by staff at the ASU Mars Space Flight Facility which places these curricula in a distance-learning format. The ASU Mars Education Program staff will establish an online bulletin board system to foster collaboration and exchange among students and teachers who are using the distance-learning format of the curriculum. The *Phoenix* Mission Web site will link to these pages.

3.4 Web-Based Curriculum Test and Revision

Curriculum modules will be pilot-tested in select classrooms by the ASU Mars Education program. Based upon teacher feedback and direct observation, modifications will be made to the curriculum to ensure it is directly addressing national education standards. Bulletin board systems will be moderated by ASU Mars Education staff members to ensure facilitated communication among teams using the curriculum package and the discussion boards. The Web-based curriculum will be submitted to NASA for review and consideration as a NASA Exemplary Product. The *Phoenix* Mission Web site will link to these pages.

3.5 Workshop Presentations

Curriculum modules will be demonstrated during ASU Mars Education teacher-training workshops. Additional feedback will be collected and modifications made as appropriate. Master teachers will be trained to demonstrate and mentor other teachers in the use of the curriculum packages.

3.6 Mars Exploration Student Data Teams Website Creation

Staff members of the ASU Mars Space Flight Facility and the ASU Mars Education Program will jointly create a Web site and an electronic discussion forum that will serve as the central meeting place for members of the Mars Exploration Student Data Teams. This site will be hosted on existing ASU computer systems. The *Phoenix* Mission Web site will link to these pages.

3.7 Mars Exploration Student Data Teams Training Development

The ASU Mars Education Program will develop a course of programmed instruction for the use of the real-time data analysis tools made available by the *Phoenix* mission. This course will be pilot-tested with initial MESDT teams and modified in accordance with feedback received.

3.8 Mars Exploration Student Data Teams Moderation

The ASU Mars Education Program will contract with a professional educator to provide ongoing discussion forum moderation and program coordination for the Mars Exploration Student Data Teams. This moderator will also serve as the MESDT liaison to the *Phoenix* science team as well as to the ASU Mars Space Flight Facility computer staff, who will be providing hardware support for the program. The entire MESDT program will be submitted to NASA for review and consideration as a NASA Exemplary Product.

4. DELIVERABLES

4.1 Beta Martian Soil Properties Curriculum Module (Print-Based)

Beta-test version of the print-based Soil Properties curriculum module will be completed no later than February 2006. Beta test will be completed no later than June 2006.

4.2 Beta Martian Soil Habitability Curriculum Module (Print-Based)

Beta-test version of the print-based Soil Habitability curriculum module will be completed no later than April 2006. Beta test will be completed no later than June 2006.

4.3 Beta Martian Soil Properties Curriculum Module (Web-Based)

Beta-test version of the Web-based Soil Properties curriculum module will be completed no later than December 2006. Beta test will be completed no later than June 2007.

4.4 Beta Martian Soil Habitability Curriculum Module (Web-Based)

Beta-test version of the Web-based Soil Habitability curriculum module will be completed no later than February 2007. Beta test will be completed no later than June 2007.

4.5 Final Martian Soil Properties Curriculum Module

Final versions of both print- and Web-based Soil Properties curriculum modules will be completed no later than September 2007.

4.6 Final Martian Soil Habitability Curriculum Module

Final versions of both print- and Web-based Soil Habitability curriculum modules will be completed no later than September 2007.

4.7 ASU Mars Education Teacher Workshop Presentations

Presentation of *Phoenix*-related materials will be made at the Spring and Fall 2005 ASU Mars Education Teacher Workshops. Beta versions of the print-based Soil Properties and Soil Habitability curriculum modules will be presented as hands-on activities at the Spring and Fall 2006 ASU Mars Education Workshops. Beta versions of the Web-based curriculum modules will be presented as hands-on activities at the Spring and Fall 2007 ASU Mars Education Workshops. Final versions of both formats will be demonstrated as hands-on activities at the Spring and Fall 2008 and Spring 2009 ASU Mars Education Workshops.

4.8 Mars Exploration Student Data Teams Website Created

The MESDT Web site and supporting software will be configured and ready for operation no later than September 2007. The MESDT program will commence active operations upon successful landing of the spacecraft and will continue throughout the regular science mission.

4.9 Mars Exploration Student Data Teams Training Modules Created

MESDT training materials will be created and made available to participating MESDT groups no later than September 2007.

5. MANAGEMENT APPROACH

5.1 Cost Sharing

The *Phoenix* E/PO Program will provide funding to the ASU Mars Education Program according to the following schedule:

- FY05 $ 5,000
- FY06 $15,000
- FY07 $30,000
- FY08 $20,000
- **TOTAL $70,000**

The ASU Mars Space Flight Facility will provide software and hardware needed for the MESDT program, as well as Web space and technical support. The ASU Mars Education Program will provide the development expertise and materials needed to create the various modules outlined above. The ASU Mars Education Program will draw upon their programmatic support for workshop materials, preparation, and operation.

5.2 Roles and Responsibilities

- Overall Coordination: Sheri Klug, Director, ASU Mars Education Program (sklug@asu.edu)
- Curriculum Development: Keith Watt, Assistant Director, ASU Mars Education Program (k.watt@asu.edu)
- Web Programming: Brad Jones, Webmaster, ASU Mars Space Flight Facility (brad.jones@asu.edu)
- MESDT Moderator: TBD
- Workshop Presentations: Paige Valderrama, Meg Davis; ASU Mars Education Program (paigev@asu.edu)
- Financial Coordination: Tara Fisher, ASU Mars Space Flight Facility (tara.haden@asu.edu)
- Administrative Support: Meg Hufford, ASU Mars Education Program (marsmom@asu.edu)

5.3 Reporting

5.3.1 Weekly Staff Meetings

The ASU Mars Education Program will hold weekly staff meetings during which the status and progress of the *Phoenix* materials will be evaluated. Changes and revisions needed to maintain the proposed deliverables schedule will be worked out and implemented.

5.3.2 Monthly Status Reports

The ASU Mars Education Program will file monthly reports to the *Phoenix* E/PO Lead apprising him of the current status and progress of the *Phoenix* Soil Habitability Strand.

5.3.3 Final Product Presentation

The ASU Mars Education Program will provide a final *Phoenix* Soil Habitability Strand overview and summary of all work accomplished and the audiences reached as a result of the program at end of mission.

6. ASSUMPTIONS

6.1 Budget levels will remain as forecasted by the *Phoenix* E/PO Lead.

6.2 *Phoenix* data will be provided to the ASU Mars Education Program in a timely manner and in a compatible format as it is received and processed by the *Phoenix* team.

6.3 Real-time *Phoenix* data will be made available to members of the Mars Exploration Student Data Teams as soon as data is received from the spacecraft.

6.4 The *Phoenix* Mission will provide the data analysis tools needed by the Mars Exploration Student Data Teams to successfully analyze the real-time results according to their protocols. The analysis tools and explanations of their use should be provided by May 2007.

6.5 The *Phoenix* Mission will provide team scientists and engineers to serve as mentors for the MESDT teams. A list of mentors should be provided by May 2007.

6.6 The *Phoenix* Mission E/PO Team will assist in workshop presentations as required.

7. DEFINITIONS AND ACRONYMS

- **Adobe Portable Document Format (PDF):** Platform-independent document format created by the Adobe Corporation which allows easy distribution of print-based materials in electronic format. Materials printed from a PDF will precisely duplicate the printed original no matter what computer or printer is used to print the copy. PDF is the preferred distribution format of the ASU Mars Education Program for CD-ROM and downloadable materials.
- **Arizona State University (ASU):** Home institution of the ASU Mars Space Flight Facility and the ASU Mars Education Program.
- **Mars Exploration Student Data Teams (MESDT):** Student program modeled upon the Mars Exploration Rovers MESDT program, in which student teams from across the country collaborate in real-time via distance-learning technology to analyze and interpret data as it is received from the spacecraft.

July 1, 2004

Statement of Work
Space Science Institute
Boulder, Colorado

Introduction

In 2007, NASA will launch the Phoenix mission to the northern plains of Mars, an area revealed by remote sensing to be rich in subsurface water ice. The mission's goals are to search for more data about of the history of water on Mars and its potential for life. The Phoenix lander, equipped with a robotic arm and a rich complement of instruments, will dig a trench up to 1 meter deep and retrieve soil for analysis by the lander's instruments.

The Space Science Institute (the Institute or SSI) will collaborate with the Phoenix Mission's Education and Public Outreach program to design and fabricate a hands-on, interactive exhibit component. This component will be used in SSI's *MarsQuest* exhibition, which is currently on tour to museums around the country. Certain elements of the component will be duplicated for use in the public area of the Phoenix mission's Science Operations Center. A fully virtual version of the exhibit will also be developed.

The project includes the following five phases:

1. Concept Design (10/2004 – 12/2004)
2. Hardware & Software Development (1/2005 – 6/2005)
3. Fabrication (7/2005 – 9/2005)
4. Virtual Robot (10/2005 – 6/2006)
5. Training (2/2005 – 12/2006)

SSI will begin designing the interactive exhibit component on October 1, 2004 and complete the fabrication by September 30, 2005. The development of the virtual version of the component will begin in October 2005 with deployment on a Web site in Spring 2006. SSI will begin the museum training phase in 2005 and continue it through 2006.

This proposed Statement of Work (SOW) and any related contract is limited to phases 1, 2, 3, and 4. Another proposal/SOW will be submitted for phase 5, and if accepted, will be associated with a separate contract. This SOW describes the basic components of the proposed museum interactive, which may change during the concept phase of the project, subject to approval by the Phoenix EPO Manager. The following sections of this SOW describe the proposed exhibit components and the computer-based *Virtual Robot,* as well as information about the *MarsQuest* exhibition and SSI. The final four sections explain program evaluation, reporting, budget, and the deliverables schedule in more detail.

Development of Interactive Exhibit Component: The Big Dig

The Institute, under the direction of PI Paul Dusenbery, will oversee the design and fabrication of an interactive component that explores key elements of the Phoenix mission. Dusenbery will then oversee producing some elements of this component for use in the Phoenix mission visitor center.

The project designer will be Greg Sprick of Jeff Kennedy Associates – the firm that designed the

MarsQuest exhibition. The proposed component will include two parts: (1) a play area where visitors can build their own robotic arms, and (2) a mission simulation area. By making a variety of materials available, such as pulleys, hinges, and other mechanical parts, the play area will invite visitors to seek their own solutions to the problem of creating a working robot arm. The design of this piece will incorporate open-ended inquiry principles. The second part of this component will include a fairly realistic simulation of how the Phoenix lander will operate. A working model of the lander will be displayed on a simulated Martian terrain. Visitors will be able to use two computer stations to interact with the lander. One station can be used to control the robot arm and the other one to analyze the soil sample collected by the robotic arm. Taken together, visitors will gain an appreciation of both the engineering and science aspects of the mission.

Particular care will be given to designing the component in a way that fosters collaborative learning, especially between family members. The questions to be answered in the design process include whether a museum docent will be needed to facilitate the activities, or whether a stand-alone version will accomplish the goal of collaborative learning. The national standards in science, math, and technology will guide the exhibit design.

Virtual Robot

Once the museum exhibit has been completed, a fully virtual version can be built for relatively little additional funding. This version would be deployed through Web sites (such as *MarsQuest Online* and the Phoenix mission's Web site), and made available to museums for installation on their own hardware. This last option is of particular interest to small science centers that do not have the resources to rent traveling exhibits or develop content independently to take advantage of events such as the Phoenix landing.

This interactive component would be a Flash or Shockwave activity designed to match as closely as possible the activities and learning goals of the museum component.

Evaluation

The results of the formative evaluation of *MarsQuest* will guide the design and fabrication of the proposed interactive. Based on past evaluation efforts, the Institute will create an evaluation instrument that can be used by host museums to gather visitor responses and provide the necessary feedback to SSI. With regard to the *Virtual Robot* component, SSI has a very sophisticated means of tracking Web user interactions and can even assess various types of learning. Program evaluation activities will be coordinated with the Phoenix mission's EPO Manager to ensure that data can be gathered and compiled for overall formative and summative evaluation of the Phoenix mission's education and outreach efforts. It is assumed that Phoenix EPO Manager will communicate the mission's data needs to SSI during the development and implementation of both the real and virtual exhibits.

Reporting

Informal monthly progress reports will be delivered to the Phoenix EPO Manager. These reports will include (a) descriptions of the technical accomplishments over the past reporting period, (b) an explanation of any variances from the established plan (e.g., missed milestones, deliverables), (c) a proposed resolution to any plan variances, and (d) an accounting of workforce and cost expenditures for the past reporting period.

About the *MarsQuest* Exhibition

In order to engage the public in the adventure of Mars exploration, the Space Science Institute developed a 5,000-square-foot traveling exhibition called *MarsQuest: Exploring the Red Planet*. The *MarsQuest* exhibition recently ended a three-year national tour and was refurbished and enhanced. It is now out on a second three-year tour, which began in early 2004. Ongoing and future Mars missions (like Phoenix) create an unprecedented opportunity to use the public's excitement over Mars exploration to draw visitors to museums and science centers and generate interest in science in general. During its six-year tour, *MarsQuest* will reach two to three million people, including many families and school groups.

MarsQuest has been a tremendously successful exhibit not just in terms of attendance, but in achieving its education goals. Randi Korn and Associates (RK&A) performed evaluations of *MarsQuest* at different stages in the project, including a final summative evaluation. In the summative evaluation, RK&A found that all of the interviewees at two different host sites (Tucson, Arizona, and Hampton, Virginia) were able to articulate at least part of *MarsQuest*'s main message. This finding indicates that the exhibit is unusually successful in terms of meeting its educational goals. With other science exhibits, RK&A has found that it is more common for visitors to be unaware that there is an overarching theme connecting exhibit components, or to be unable to describe the exhibition's main message. After visiting *MarsQuest*, all of the interviewees were also able to recall specific facts about Mars, especially information that compared Mars with Earth. For example, some visitors correctly indicated that some landscape features on Mars are much larger than similar features on Earth, while others noted differences between Earth and Mars in terms of size, temperature, and gravity. *MarsQuest* was originally developed in conjunction with scientists involved in NASA's Mars missions, science educators, and museum professionals. It is one of the largest public outreach projects ever developed by the planetary science community. *MarsQuest* currently includes a 40-minute planetarium show narrated by Patrick Stewart and a comprehensive education program comprised of workshops for museum staff and teachers. The enhanced exhibition includes an interactive component that allows visitors to examine a slice of a meteorite that scientists believe came from Mars, a "Follow the Water" station, and a full-scale model of a Mars Exploration Rover. The Institute's overall Mars education project is also enhanced by the launch in 2003 of an interactive Web site -- www.marsquest.org -- that offers online visitors a host of Mars-related activities and learning experiences. Major support for *MarsQuest* has come from NSF and NASA.

July 1, 2004

Space Science Institute

SPACE SCIENCE INSTITUTE

The Space Science Institute is a nonprofit organization located in Boulder, Colorado. SSI's unique mission is to integrate scientific research with education and public outreach. SSI's research program includes earth science, space physics, planetary science, and astrophysics. As part of SSI's education program, we develop science exhibits for museums; provide professional development for teachers; conduct education workshops for scientists who are interested in education; and create curricular materials and classroom activities that are aligned with the national education standards in science, math, and technology.

Budget Explanation

The PI for this contract will be Dr. Paul Dusenbery, the PI and project director for the *MarsQuest* and *Destination: Mars* exhibitions. Dr. Dusenbery will assume primary responsibility for overall management of the proposed one-year project. He will devote 8% of his time (over years one and two) to the project. Exhibit Manager, Lisa Curtis (8% time in year one), will help the PI with the design, development, and fabrication phases of the project. Dr. James Harold (17% time for each of the 2 years of the project), the Institute's Information Systems Director, will have primary responsibility for coordinating the development of the software components of the project. Dr. Harold will also oversee the development of the *Virtual Robot*. He has extensive experience in educational software development for both classroom and museum use.

One trip is planned in order for Greg Sprick of Jeff Kennedy Associates to travel to SSI's offices in Boulder, Colorado, for a design meeting with the SSI team (Dusenbery, Harold, Curtis, and Morrow) and Doug Lombardi, the EPO Manager of the Phoenix mission. Design services are estimated to cost $10K. Most of the proposed the budget is the cost to build a fully functional, robotic interactive for *MarsQuest* and a low tech version for the Phoenix Visitor Center. The total cost for these interactives is estimated to be $84K. In addition to that cost, the budget includes $5K for a suitable crate to ship the interactive in during its national tour of science centers. To help control costs, the Institute is using its off-site overhead rate of 28.15%, rather than its usual on-site rate of 41.77%.

SSI Proposal No.: REVISED: 7/2/2004 AM

PROPOSED BUDGET DETAILS

Institution: Space Science Institute
4750 Walnut Street
Suite 205
Boulder, CO 80301

Title: Phoenix/MarsQuest Exhibit Budget

Duration: 10/1/2004 - 9/30/2006

Principal Investigator: Paul B. Dusenbery

	WM	Year 1	WM	Year 2	WM	TOTALS
A. Salaries and Wages						
Principal Investigator: Paul Dusenbery (@ $11,916.67/mo for Year 1)	0.75	$8,938	0.25	$3,277	1.00	$12,215
Software Developer: James Harold (@ $7,058.33/mo for Year 1)	2.00	$14,117	2.00	$15,528	4.00	$29,645
Exhibit Manager: Lisa Curtis (@ $5,958.33/mo for Year 1)	1.00	$5,958	0.00	$0	1.00	$5,958
Student Assistants: TBD (@ $2,080.00/mo for Year 1)	1.00	$2,080	1.00	$2,288	2.00	$4,368
Total Salaries and Wages	4.75	$31,093	3.25	$21,093	8.00	$52,186
B. Fringe Benefits						
Professional Staff: 20.45% of Salaries & Wages +$950/mo ins. Year 1						
Students: 10.45% of Salaries & Wages		$9,713		$6,335		$16,048
Total Salaries, Wages & Benefits		$40,805		$27,428		$68,234
C. Travel						
See Detail		$877		$0		$877
Total Travel		$877		$0		$877
D. Equipment						
None		$0		$0		$0
E. Other Direct Costs						
Materials & Supplies (1.5% of MTDC*, based on historical costs)		$2,187		$426		$2,613
Duplication & Communication (2.0% of MTDC*, based on historical costs)		$2,916		$568		$3,484
Design Services		$10,000		$0		$10,000
Fabrication						
Backdrop Piece with Graphics (2 @ $8,000/each)		$16,000		$0		$16,000
The Big Dig Unit		$40,000		$0		$40,000
Low Tech Component (2 @ $8,000/each)		$16,000		$0		$16,000
Analyzer Kiosk		$12,000		$0		$12,000
Fabrication Expenses Subtotal		$84,000		$0		$84,000
Shipping Crate for the MarsQuest Exhibit		$5,000		$0		$5,000
Total Other Direct Costs		$104,103		$995		$105,097
F. Total Direct Costs		$145,785		$28,423		$174,208
G. Indirect Costs						
MTDC (28.15% Off-Site)* Per Nonprofit Rate Proposal Dated 2/2/2004;		$41,038		$8,001		$49,040
Cognizant Agency: National Science Foundation						
H. TOTAL COSTS		$186,823		$36,424		$223,248
I. TOTAL REQUESTED FOR TWO YEARS		$223,248				

* MTDC: All direct costs except equipment (items with an acquisition unit cost of >= $3,000 & an expected useful life of two years or more); tuition; alteration & renovation costs; and subcontract costs in excess of the first $25,000 of each individual subcontract.

Travel Detail		Year 1	Year 2	TOTALS
Travel to Boulder, CO from Boston, MA				
1 Person, 3 days, 2 nights				
Airfare		$415	$0	
Per Diem @ $42/day meals, $93/night lodging		$312	$0	
Ground Transportation		$150	$0	
Subtotal		$877	$0	
1 trip in year 1 (inflated 5% per annum)		$877	$0	$877
	Total	**$877**	**$0**	**$877**

SEMAA Central Arizona College 8470 N. Overfield Rd Phone: 520-876-1953
Anne Howe, Director Coolidge, AZ 85228 anne_howe@centralaz.edu

Doug Lombardi
Mars Phoenix Scout Mission
University of Arizona
1415 N. Sixth Avenue
Tucson, Arizona 85705

August 24, 2004

Dear Mr. Lombardi,

Science Engineering Mathematics Aerospace Academy (SEMAA) at Central Arizona College has agreed to collaborate with the 2004-2005 Pinal County Gifted Consortium and Phoenix Mars Scout Mission to offer the gifted students of Pinal County a Mars and Robotics curriculum titled <u>Quest to the Red Planet</u> for grades 4-12 and <u>Mission to Mars</u> for grades 1-3. We are pleased to be working with these outstanding organizations and providing benefits to the gifted students in our county.

Our organization is committed to developing grades 1-3 learning modules with Katy Wilkins taking on the role as Program Coordinator, participating in the teacher training workshops and sponsoring student field trips for grade 1-3 and a culminating invitational event at CAC Campuses, plus provide the resources necessary to the development of the curriculum. (see Attachment A).

After the pilot testing of the curricula is completed, CAC SEMAA will share the learning modules on a national level through the National SEMAA Office. This will have an impact on over 40,000 underserved and underrepresented students each year. CAC SEMAA also enthusiastically supports national dissemination of the learning modules through Jet Propulsion Laboratory's Solar System Educator Program and teacher training workshops conducted by Mars Education Program at Arizona State University.

Sincerely,

Anne Howe
SEMAA Director

Attachment A

CAC SEMAA will provide the following:

Classroom facilities and services necessary for teacher training sessions, student field trips and culminating Invitational Event

Katy Wilkins time as the Program Coordinator, acting as the point of contact for all three organizations. She will be the contact for teachers giving them support and help as needed. Katy will also be responsible for the scheduling and facilitating the 1-3 student fieldtrips, coordinate and oversee the Rover exchange (grades 4- High School) that will be taking place between participating schools, and coordinating the culminating Invitational event that will take place on the Central Arizona Signal Peak Campus May 7, 2005.

Purchase of materials and payment for any other assistance for the development of the learning modules for grades 1-3.

Computers for several classroom teachers to use for the robotic programming software

Task	Person Responsible	Date
5 -12 Modules	Doug	8/2/04
1 - 4 Modules	Katy	8/2/04
Teleconference - Going over Curr. & Evaluation	Katy Calls everyone @ 10:00 am	8/10/04
Team Invitational @ CAC 5-07-05	Anne - Food	4/07/05
Team Invitational @ CAC 5-07-05	Katy - Facilities	3/07/05
Team Invitational @ CAC 5-07-05	Cyn-d	4/07/05
Team Invitational @ CAC 5-07-05	Doug - Event Activities, Day's Agenda	4/07/05
Teacher Training Session @ CAC 8/20-21/2004	Katy/Anne	7/07/05
Teacher Follow-up	Cyn-d - Use of Florence Mtg site	Jan & March
Teacher Follow-up	Katy & Doug - Agenda	Jan & March
Fieldtrip dates & Curr. For K - 3 (4) students	Katy	8/20-21/04
Ordering Team Challenge kits	Cyn-d	ASAP
Ordering Cameras for School sites to use	Doug	8/20-21/04
Invoicing Gifted Consortium	Katy	5/20/05
Consultant Fees for Curriculum Writers	Anne	June
Evaluation - teacher, student,	Anne	7/20/04
Send Anne Cyn-d's evaluation	Katy	5/3/04
Letter for students and teachers to sign for photo release	Anne	8/2/2004
Computers (on loan from SEMAA)	Anne	7/20/04

Pinal County Educational Service Agency
P.O. Box 667
San Manuel, AZ 85631
Phone (520) 866-7883
Fax (520) 385-3062

To: Doug Lombardi
From: Cyn-d Turner, Program Specialist
Re: Letter of Commitment
Date: June 8, 2004

The 2004-2005 Pinal County Gifted Consortium has agreed to collaborate with Science Engineering Mathematics Aerospace Academy (SEMAA) and Phoenix Mars Scout Mission to offer the gifted students of Pinal County a Mars and Robotics curriculum titled Quest to the Red Planet for grades 4-12 and Mission to Mars for grades 1-3. We are pleased to be working with these outstanding organizations and providing benefits to our gifted students.

All parties have agreed to the following:

The Gifted Consortium will provide the following:

- 51 robotics kits
- 200 hours of staff time
- correspondence with teachers
- coordination of workshops, trainings and culminating event
- county facility for training associated office supplies
- supplemental materials for teachers

The Gifted Consortium and collaborating parties must adhere to the following:

- To be impartial and fare to all districts involved
- To service gifted students

Estimated cost - $16,000
Estimated number of students serviced - 300

Statement of Work for Phoenix Student Interns Program (PSIP)

Goals

The Phoenix Student Interns Program uses a proven active-participation educational model to support the Phoenix E/PO vision to “engage the community and nation by inspiring, challenging, and motivating students and the public to increase their understanding of space science.” Specifically, through the program students become part of the actual science team and participate fully in the scientific mission. Through this, they learn to “appreciate the role of robotics and technology in space exploration… the physical properties of water that are essential for life… and the role of matter-energy interactions in living organisms and their environment,“and share this with other students and the community through their own outreach efforts.

Schedule/Timeline

FY05 – FY06

4/2005 – 5/2006: Attend at least one science team meeting and select mentors for prototype and full-scale PSIP.

4/2006: Begin preparations for prototype PSIP.

5/2006: Select students/teachers from AZ to participate in Interoperability Test.

6/2006: Begin work with AZ-based student/teacher team—provide background information and support.

8/2006: Testing in AZ. Consider prototype activity in conjunction with Interoperability, involving small-scale, AZ based group in order to get scientists used to student involvement.

9/2006: Complete evaluation on prototype PSIP and begin planning for full-scale PSIP.

FY07

3/2007: Advertise pre-program information at NSTA, on Web (Phoenix, JPL/Mars, REP, HQ)

5/2007: Science Team Mentors identified

8-9/2007: Launch.

FY08
10/2007: PSIP application opens.

11/2007: Select PSIP Teachers (who in turn select students)

11-12/2007: New PSIP team orientation period

1/2008-6/2008: PSIP team preparation/work with mentors

6/2008-11/2008: Landed operations/PSIP Participation

11/2008-12/2008: Final evaluation.

Coordinator

Cassie Bowman will act as the coordinator, working .25 FTE on the PSIP project (the other .75 FTE covered by the Robotics Education Project and/or Mars Public Engagement), with Dr. Ray Arvidson as the "Mission Director" and lead scientist of the program. Both have carried out these roles in the precursor programs (LAPIS and ASIP) annually since 1999. Cassie will have received her doctorate in education in June 2007. (See CV, attached.)

Current .25 FTE for coordinator including travel and overhead through Raytheon contract at NASA ARC is $40,000. For FY06 .5 FTE is projected to be $50,000 (outlined in detailed budget, attached). The task manager for the Raytheon Contract is Ms. Pat Elson (pelson@mail.arc.nasa.gov, or 650-604-4498) and the NASA Manager is Mr. Mark Leon (mleon@mail.arc.nasa.gov, or 650-604-6498).

Logistics

Participants: With the Athena Student Interns Program (ASIP), there were 13 mentors, 13 teachers, and 26 students. This was challenging, but manageable. I think we could have as many as 15 teams (a mentor, teacher, and given number of students) without a problem. The biggest prohibiting factor in the number of participants is travel costs.

PSIP will strive to make sure that underrepresented/underserved teachers and students are participants in the program.

Application and Mentors: This should be a nationwide application program, in which the bulk of science team mentors are site-specific mentors (meaning that applicants wanting to work with those mentors need to be able to easily travel to meet with their mentor twice per month). An emphasis should be placed on getting mentors from a wide geographic area, as well as increasing the diversity of the mentor pool. There should also be a few (about 20%) of the mentors available as nationwide mentors so that schools located nowhere near a science team member can also have an opportunity to participate. In ASIP, these were Drs. Ray Arvidson, Mike Sims, and Mike Wolff. See http://mars.jpl.nasa.gov/mer/classroom/asipApplication01.html for the application process used in 2003 for ASIP.

Because this is a relatively small-scale program, the PSIP teams' outreach component is especially important. As such, added to the application should be a requirement for each applicant to submit an outreach plan and have established a partnership with a middle or elementary school in their area with which they will have regular, sustained interaction.

Teacher Selection: The coordinator and the mentor with whom the teacher applied to work should select each teacher. This assures that educational, outreach, and research needs and requirements are taken into account. A final selection should be made only after the coordinator and mentor have talked with the top few finalists (for each mentor) and their principals.

Student Selection: As in ASIP, we recommend that the teachers be the ones to apply and then asked to select students for whom this would be a particularly high impact experience (not students who have already had a lot of extra experiences and opportunities). This ended up producing positive results in ASIP in that we had students who were the first in their families to think about higher education, who said they "never thought NASA would pick a student like me," or who had never thought of themselves as capable of doing science.

Travel and Lodging for Teams: This will be managed by the coordinator and worked through UA. An estimated breakdown of costs is provided below:

Based on a 1-week stay for one teacher and two students in Tucson during the mission we estimate approximately $3000, unless lodging can be arranged at UA:

Lodging: $125/night for 7 nights (preferably in an apartment with a kitchen—they tend to be cheaper and we found that often the teacher/students liked to cook their meals.)

Airfare: $500/per person (or less depending on their location)

Meals: $30-35/pp/per day for 7 days

TOTAL: For 15 teams, the cost is ~$45,000

Travel and Lodging for Coordinator:

Lodging: $100/night for 30 nights during mission

Airfare: $1000 (for 2-3 trips)

Meals: $35 per day for 30 days

TOTAL: For coordinator, the cost is ~$5,000

Note: Travel costs to Science Team Meetings starting in 2005 should, if possible, be paid directly by UA. If not, another mechanism will need to be discussed.

Other Resources: Each team will be provided with an outreach kit, including mission and Mars-specific stickers, posters, educational activities, hand stamps, etc. Cost should not exceed $100 per package for a total of $1500.

Additionally, the budget should include funds for certificates for individual participants and plaques and large format images for participating schools, totaling approximately $1000.

Optional: If possible, having the students and teachers participate in either a team meeting or an operational readiness test is highly advisable. This allows the teams to get to know each other and to become comfortable with the environment. Costs could possibly be shared with schools/communities/Space Grants.

Budget Bottom Line: ~$50,000 + coordinator salary (see attached detailed budget)

Receivables/Deliverables

The E/PO lead will provide materials for outreach packets for teams, help finding a local group for the prototype activity, coordination of travel and lodging for teams during the mission, and a graduate student to aid the coordinator in on-site duties during the mission.

The graduate student will preferably come from the Department of Education and be enthusiastic about helping the students and teachers have the best experience possible.

The coordinator will provide a monthly report to the E/PO lead and quarterly reports on outreach completed by the student/teacher teams. The coordinator will also create presentations/plans and occasionally present at Phoenix Science Team meetings.

Task Description	Element Deliverable	Element Receivable	Date
Select mentors from Science Team for prototype and full-scale PSIP	Finalized list for Interoperability test and initial list for full-scale implementation		4/1/2006
Select AZ teams to participate in Interoperability Test		Names and contact information of AZ teacher/student teams.	5/1/2006
Provide background information and support to AZ teams	Materials on the mission, mentors specific science duties, student duties, etc.		6/1/2006
AZ teams participate in prototype	Involve teams successfully in Interoperability test		8/1/2006
Evaluation of prototype	Evaluation report		9/1/2006
Advertise pre-program information		Booth at NSTA national meeting and posts on NASA/HQ, REP, JPL/Mars, and Phoenix Web sites.	3/1/2007
Science team mentors identified	List of 15 mentors		5/1/2007
PSIP application opens	Develop application to be posted on Web.	Post application on Website(s)	9/1/2007
Select PSIP teams	List of 15 participating teacher/student teams		11/1/2007

Task Description	Element Deliverable	Element Receivable	Date
Provide orientation information to PSIP teams	Materials on the mission, mentors specific science duties, student duties, etc.		11/1/2007
PSIP preparation with mentors begins	Help teams set up meetings with mentors, hold telecons, set-up and monitor team Website		1/1/2008
PSIP preparation with mentors ends	Make sure teams are prepared for mission		6/1/2008
PSIP participation begins	Coordinate student and teacher participation in mission		6/1/2008
PSIP participation ends	Hold final evaluation meetings with students and teachers		11/1/2008
Final evaluation	Evaluation report		12/1/2008

Evaluation

The design of PSIP is informed by data gathered through an evaluation technique called “Empowerment Evaluation” used with LAPIS and ASIP. It has proved to be highly successful and manageable, so we propose to continue using it with PSIP.

With this approach, all participants will continuously contribute to improving the program as it evolves and help provide a strong set of lessons-learned to be applied to future programs. Qualitative methods (survey, interview) will enhance this empowerment evaluation.

The people involved in this evaluation will include the all participants: the students and teachers, the mentors, and the coordinator. Since the program mainly takes place via email, teleconferences, and a team Web site, the evaluation will follow suit. It consists of three phases: Identifying the mission/vision of the program, taking stock of where the program stands, and planning for the future.

The evaluation will be implemented during the course of the project: November 2007 through November/December 2008. The use of empowerment evaluation will provide a variety of checkpoints throughout the program.

The stakeholders exist on two levels. Main stakeholders are Bowman, the Phoenix Mission, and NASA. A secondary level of stakeholders includes the participants of the program--the mentors, teachers, and students. The information gathered at the start and the mid-point of the program will affect this group’s experience as it is used to make mid-course changes and enhancements.

Information about how this technique has been used with LAPIS and ASIP can be accessed through:

Bowman, C.D., D.M. Sherman, R.E. Arvidson, S.V. Nelson, S.W. Squyres. Students and Scientists Test Prototype Mars Rover. *Journal of Geoscience Education*, v. 51, n. 1, January 2003.

Fetterman, D. and C.D. Bowman. Experiential Education and Empowerment Evaluation: Mars Rover Educational Program Case Example. *Journal of Experiential Education*, v. 25, n. 2, Fall 2002.

Evaluation instruments will conform to the overall Phoenix evaluation plan.

PSIP Budget

	FY 05	FY 06	FY 07	FY 08	FY 09	TOTALS
Coordinator @ .25 FTE		$8,000		$40,000		$48,000
Travel						
Coordinator to science team meetings twice per year						$0
(For each meeting, $500 air, $500 per diem + lodging + transportation)						
Coordinator for 30 mission days				$4,500		$4,500
($500 air+ $4000 per diem + lodging + transportation)						
Team Travel and Lodging				$35,000	$10,000	$45,000
(Each team, including 1 teacher and 2 students, staying a 7 night visit, $1500 airfare, $1600 per diem + lodging + transportation)						
PSIP Pilot		$1,000				$1,000
Outreach Kits ($100 per kit for 15 teams)				$1,200	$300	$1,500
Team Awards and Recognition				$1,000		$1,000
Total Costs	$0	$9,000	$0	$81,700	$10,300	$101,000

Statement of Work for the *Phoenix* Project
Changes in Altitudes
The 5th-12th Grade Balloon Satellite Program
Barry L Lutz
Associate Director
Arizona Space Grant Consortium

1. Task Purpose

The Arizona Space Grant Consortium (AZSGC) will develop and implement a balloon satellite program for 5th -12th grade teachers and students in support of the *Phoenix* mission Education/Public Outreach (E/PO) efforts. The goal of this program is to establish the elements of a small weather balloon satellite program at each school that could be sustained by the school districts at a minimal cost. Specifically, the program will address the robotics strand through teacher-student built scientific payloads that conduct ***in situ*** measurements of the Earth's atmosphere and remote sensing image of the Earth's surface and atmospheric layers from a high altitude weather balloon that reaches an altitude of approximately 100,000 feet.

2. Task Summary

Teachers selected from schools across Arizona form student teams to design, construct, and launch small balloon payloads that can robotically measure the physical properties of the Earth's atmosphere as a function of time during the ascent and descent of a high altitude weather balloon, such as pressure, temperature, and relative humidity. In addition, they will imbed a photographic camera in the payload that can be timed to image the Earth's surface and its atmosphere during the ascent and descent of the balloon.

The resulting data will be used to characterize the structure and dynamics of the atmosphere, including phenomena such as the thermal inversion that occurs at the tropopause, the speed and direction of the winds up to 100,000 feet, the topography of the Earth below the balloon track, and the curvature of the Earth' surface. Examples of the types of data and imaging, taken from a recent flight in the pilot program that was seeded and tested by the temporary AZSGC funds for Work Force Development, are shown in the figures below:

Figure 1. Curvature of the Earth

Figure 2. Topography of the Earth near Phoenix

As photographed from a Student Payload during the balloon flight on April 17, 2004

Page 1

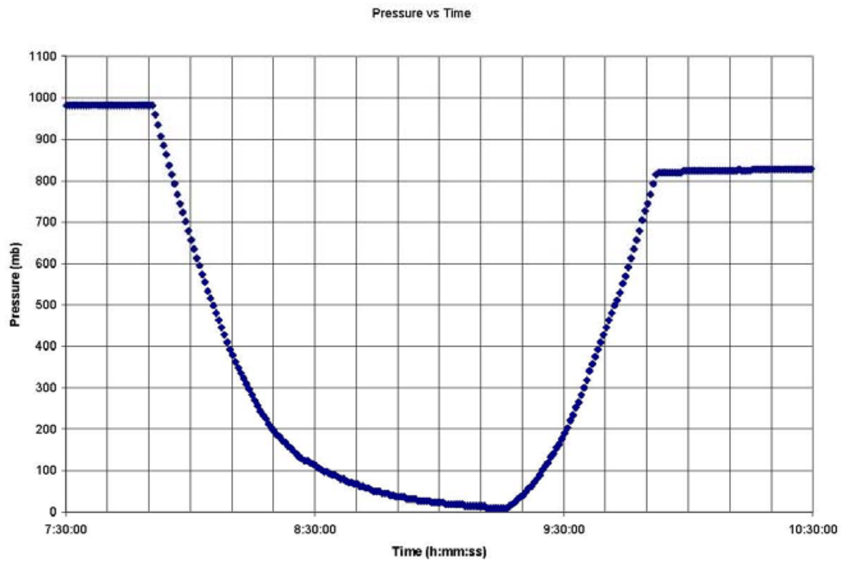

Figure 3: Payload Ambient Atmospheric Pressure as a Function of Mountain Standard Time during the Flight on April 17, 2004

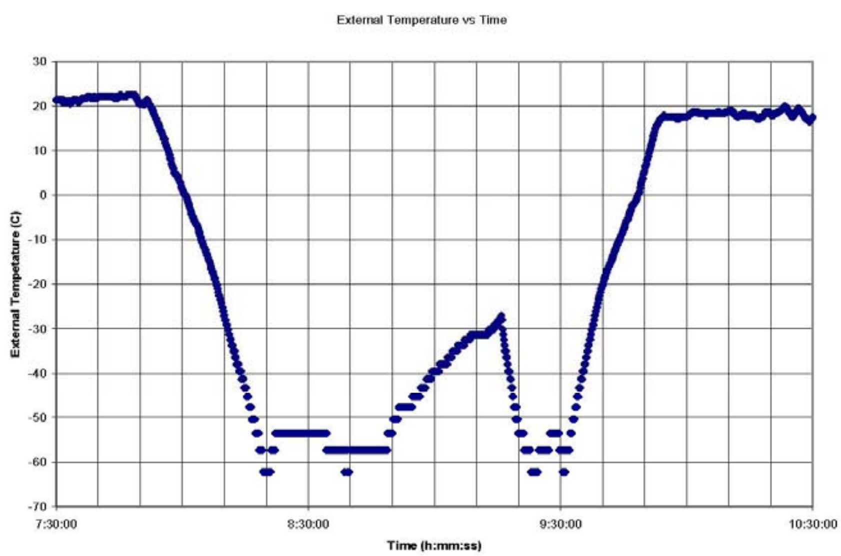

Figure 4: Payload Ambient Atmospheric Temperature as a function of Mountain Standard Time during the Flight on April 17, 2004

Page 2

Statement of Work

3.1 Teacher Training

Each year, for the proposed four years of this program, five teachers will be selected from schools across Arizona to participate in the 5th-12th Grade Balloon Satellite Program, *Changes in Altitudes*. The schools will be a diverse mix of rural, urban, reservation, and locality over the four-year lifetime of the program, although recruitment at underserved and rural schools, especially those on the Native American reservations, will be emphasized.

These teachers will attend a workshop designed to train them in the design, construction, and launch of balloon satellites. Each teacher will be part of a team that builds and flies a balloon satellite as part of the workshop. This workshop may initially be the "Starting Student Space Hardware Program" sponsored by the Colorado Space Grant program for colleges and universities, but the goal is to have a workshop specifically for 5th-12th grade teachers, which is delivered by the AZSGC at Northern Arizona University (NAU).

The teachers will also learn how to use the collected data and images to teach how robotic experiments can be used to explore the atmospheres and surface of planets. The workshop will also be an opportunity for the *Phoenix* project E/PO Lead to introduce the *Phoenix* project mission and objectives and provide educational materials to the teachers.

3.2 5th-12th Grade Student Involvement

Teachers from each of the selected schools will form teams of up to four students to design, construct, and eventually launch balloon satellites of their own which will be used to study the properties of the atmosphere and the topography of the Earth, through real scientific experiments. Each school can select up to four teams that will build balloon satellites for four separate launches over two years, one each fall and one of each spring of the two years, recycling the reusable payload materials for each launch.

More students can be invited by the teacher to participate in the design and building of the payload, but the launch team is limited to four primary team members, selected by the participating teacher. Any additional students can serve as alternate team members, filling in, in the event that any of the primary members drop out.

The AZSGC will provide the schools with the materials for the satellites and offer technical support, if needed, by staff and students from the universities for all four launch payloads. The teams will be taught by the teachers to analyze the data and images to extract physical properties of the Earth and its atmosphere, and each team would be expected to present their experiences and results to other students at their schools, either through classroom activities or at school-wide assemblies.

3.3 Launch Activities
Each year, the AZSGC will sponsor two launches, one in the fall and one in the spring. The site (or sites) of the launches will be determined by the Arizona Near Space Research (ANSR…see below), based on weather, terrain, and wind constraints. Typically the site will be in the area of the town of Maricopa, although Flagstaff and Tucson sites will also be considered.

The launch provides the students with a "proof of concept" experience for the team payloads through the actual launch of the payloads on a high altitude weather balloon. Teachers selected for that year, and teachers from the previous year will be invited to bring a team of four students to each launch. This schedule insures that each school has the opportunity to send up to four separate, four-student teams for the four launches that will occur in a two year period. The goal is to establish the elements of a small weather balloon satellite program at each school that could be sustained by the school districts at a minimal cost.

Launches will be conducted by ANSR, a scientific-educational, 501(c)(3), amateur radio balloon group that conducts high altitude balloon flights often reaching up to in excess of 100,000 feet, each of which is followed by a payload recovery expedition in which the students participate.

Each launch consists of pre-flight preparation talks the evening before the actual launch, during which, launch and chase activities is outlined and final preparations to the student payloads are made. The pre-flight prep session will be another the opportunity for the *Phoenix* project E/PO Lead to introduce the *Phoenix* project mission and objectives and provide educational materials to the students.

The launch is carried out in the early morning following the evening pre-flight session. Based on wind data and GPS data radioed back to the launch site by the ANSR telemetry package on the balloon, the teams embark on the payload recovery "chase." Real-time updates to the balloon's co-ordinates are provided to the student teams, who remain in contact with each other via Family Service radios in their chase vehicles. Each team has a GPS which can be used to track the satellite's position.

Once the payloads are recovered, the atmospheric data is downloaded to a central site and film is collected for development. A post-flight debriefing follows the evening of the launch at which preliminary looks at the data are provided and students are encouraged to share their experiences and thoughts about the entire program.

3.4 Post-Launch Activities
All teams are provided with a complete set of all data and images, including the ANSR telemetry, as soon as possible after the launch. Teachers are encouraged to use the data and images in their lessons on earth and space science. The teams will be taught by the teachers to analyze the data and images to extract physical properties of the Earth and its atmosphere, and each team would be expected to present their experiences and results to other students at their schools, either through classroom activities or at school-wide assemblies. The student teams are expected to write a report of their experiences and experiments which will be submitted to the AZSGC.

3.5 Balloon Satellite Web Site
The AZSGC will develop and maintain a web site for the 5th-12th Grade Balloon Satellite Program. The target date of going "live" with the website is Spring 2005. Once established, this site will be linked to the Phoenix mission website as soon as possible. The website will also be a contact point for schools wanting to participate in the program as well as serving to disseminate data, images, and photographic documents of various activities including the launches.

3.6 Assessment
Teachers will be provided with surveys in which they can evaluate the program's effectiveness and usefulness, and provide feedback for changes and improvements.

3. Deliverables

4.1 Teacher Selection
Teachers from five schools across Arizona will be selected in the spring of each fiscal year to participate in the program by the AZSGC.

4.2 Teacher Training Workshops
Workshops to train the selected teachers in the design, construction, and launch of small robotic payloads on high altitude weather balloons will be sponsored by the AZSGC in May or June of each of the first three fiscal years. The goal is to host these workshops at NAU, but practical consideration may require using the "Starting Student Space Hardware Program" sponsored by the Colorado Space Grant Consortium, initially.

4.2 Balloon Launches
Two balloon launches will be sponsored by the AZSGC each fiscal year (one in the fall and one in the spring) at sites to be determined by ANSR, each of which will host up to 40 students from ten schools.

4. Receivables

5.1 Funding
The Phoenix Project will provide the AZSGC with a four-year budget totaling $100,000, to carry out the 5th-12th grade Balloon Satellite Program. The fiscal year breakdown of this funding is shown in the Management section of this task statement.

5.2 Phoenix *Project E/PO Materials and Team Participation*
The *Phoenix* E/PO Lead or his designate will participate in the teacher training workshops and launches to provide talks and materials on the *Phoenix* project for the teachers and students.

5. Management

5.1 Budget
The detailed budget for the 5th-12th Grade Balloon Satellite Program is given below. It contains matching funds from the schools in the form of a launch fee of $60 per student per launch. Currently, we are exploring options to establish a limited number

of "scholarships" for students whose parents or school boards are unable of afford the fee.

Balloon Grant Projected Costs

	FY 2005	FY 2006	FY 2007	FY 2008	Totals
TRAVEL					
Workshop	$4,750	$4,000	$4,000		$12,750
Launches	$10,300	$17,600	$17,600	$17,600	$63,100
Materials & Supplies	$6,040	$6,540	$6,540	$2,940	$22,060
ANSR Launch Cost	$1,000	$1,200	$1,200	$1,200	$4,600
Personnel + ERE	$3,124	$3,358	$3,564	$3,764	$13,810
Sub-Total	$25,214	$32,698	$32,904	$25,504	$116,320
School Match	($1,920)	($4,800)	($4,800)	($4,800)	($16,320)
TOTAL	$23,294	$27,898	$28,104	$20,704	$100,000

5.2 Roles and Responsibilities

5.2.1 Overall Coordination
Barry L Lutz, Associate Director, AZSGC-NAU (Barry.Lutz@nau.edu)

5.2.2 University of Arizona Coordination
Susan Brew, Program Manager, AZSGC (sbrew@lpl.arizona.edu)

5.2.3 Arizona State University Coordination
Helen Reed, Associate Director, AZSGC-ASU (Helen.Reed@asu.edu)

5.2.4 Administrative and Financial Support
Kathleen Stigmon, Administrative Associate, AZSGC-NAU (Kathleen.Stigmon@nau.edu)

5.3. Reporting

5.3.1 Periodic Status Reports
The AZSGC will file periodic reports to the *Phoenix* E/PO Lead appraising him of the current status and progress of the 5th-12th Grade Balloon Satellite Program. During the most active part of the fiscal year activities, these reports will be at least monthly; during the less active phases, the reports will be less frequent, depending upon need.

5.3.2 Final Report
The AZSGC will provide a final report on *Changes in Altitudes*, the 5th-12th Grade Balloon Satellite Program, to the *Phoenix* project E/PO Lead describing the programs overall accomplishments.

Statement of Work for the Phoenix Project
Simulated Launch, Entry Descent and landing (SLED)
Prepared by Eric M. De Jong Chief Scientist, Space Science Data Systems Section,
Principal Investigator, Solar System Visualization (SSV) Project
Jet Propulsion Laboratory

1. TASK OBJECTIVE

The object of the Simulated Launch, Entry Descent and landing (SLED) task is to depict the simulated launch sequence, entry, descent and landing of the Phoenix lander onto the surface of Mars. The SLED task is an Education and Public Outreach (EPO) task and will produce high resolution still frames and High Definition Television (HDTV) segments displaying the Launch, Entry, Descent and Landing phases of the Phoenix mission. The SLED task will fund only the cost of the labor required to create these products.

Other Phoenix tasks will fund the development of the hearare and software used by the SLED task. The Phoenix Solar System Visualization and Animations (SSV -A) task will develop, integrate, test, deliver, and operate a system for Phoenix science which provides: 1) a Modeling and Image Simulation Test-bed (MIST) consisting of a dedicated computer cluster and high speed communications interfaces, and 2) a modeling and image-terrain simulation development environment, with Image-Terrain Simulation software (ITS). MIST will be optimized for the creation of three-dimensional world models from Mars images, elevation maps, and meshes. With these environments, we will create the Phoenix animations and visualizations.

2. TASK SUMMARY

2.1 HDTV Animation Segments and High resolution Images

For SLED we will create a 6 minute HDTV animation containing individual segments which display a summary of the major events from the time of the Phoenix launch until its safe arrival at the planet Mars. We will also produce high resolution images characterizing major events in this sequence.

2.2 Modeling and Image Simulation Test-bed (MIST)

MIST is: 1) the modeling and image simulation component of the Visualization and Analysis Test- bed (V AT), 2) being developed and operated by the Space Science Data Systems Section (SSDS) Digital Image Animation Laboratory (DIAL), and 3) a dedicated cluster with a ten to thirty terabyte disk and high speed communications interfaces to DIAL HDTV recording /display equipment. MIST provides the hardware required to: 1) Create three-dimensional image-terrain based world models of the Martian surface, 2) Composite lander CAD-CAM models with surface models, and 3) Create HDTV stereo animations which display photo realistic virtual views of the Phoenix lander from any point in time and space.

The installation of the MIST cluster and disk array will be accomplished in four phases. Each phase provides the opportunity to incorporate new technology into the cluster. In each phase we will add a small number of disks to the MIST. For operations, we expect to have a dedicated MIST clusters with 16 to 32 high-speed processors. MIST development is funded by a separate task.

2.3 Image Simulation Software (ITS)

In order to make full use of the MIST hardware, it is essential that the ITS and associated modeling environment is optimized to use the multi-processor, large memory, and the high-speed communication architecture of the modem computer cluster. Accordingly, we will use
Screamer Net technology to make optimal use of the MIST cluster. The ITS uses a combination of Commercial off the Shelf (COTS) software like LightWave, combined with both JPL and commercially developed "plug-ins", pre-processing and post processing modules, and scripts to achieve the objectives of this task. The current ITS is based on Mars Pathfinder (MPF), Mars Polar Lander (MPL), and Mars Exploration Lander (MER) heritage code. ITS code will be tested, and optimized for execution on the MIST cluster architecture and delivered to the MIPL VICAR Visualization Software Library (VSL). ITS development is funded by a separate task.

3. STATEMENT OF WORK

3.1 SLED Support

Provide the staff required to use the MIST and ITS to create stereo HDTV simulated animations. This support will begin development in FYO4 and continue until end of mission.

4. DELIVERABLES

The milestones for this work are included in the attached schedule. Section 7 identifies the data sources required for animation development and test.

4.1 **ITS Script Development and Visualization Test Products**

4.1.1 We will create world models, and HDTV animations during each phase of product development. These products will be created and delivered in accordance with the attached schedule.

4.1.2 We will deliver Class C image simulation scripts to the VICAR Visualization Software Library (VSL), on or before December 2008.

5. MANAGEMENT APPROACH

The technology required to complete the SLED task is being collaboratively developed during phase B/C/D by the Phoenix SSV team and the Solar System Visualization (SSV) project,

5.1 MIST and ITS Cost Sharing

During Phase B/C/D the cost of the MIST hardware purchases are funded by an EIC loan; with loan payback spread across the users of the equipment, over the useful life of the equipment.

During Phase B/C/D the cost of the operation and maintenance of the MIST, and the development of the required software is funded jointly by Phoenix and SSV - Experiment Product Delivery Service (EPDS). During Phase E, the operation and maintenance of the MIST hardware is funded solely by Phoenix.

5.2 Roles and Responsibilities

SSV Science and Technical Lead: Dr. Eric M. De Jong
Administrative and Financial Lead: - -
MIST System Support: Zareh Gorjian / Steve Levoe
ITS Animations: Zareh Gorjian / Jeffrey R. Hall

5.3 Reporting

5.3.1 Weekly Coordination meetings

The SSV Technical lead conducts an informal weekly coordination meeting at which all members of the SSV team are encouraged to provide status on their work, and discuss any issues, which relate to their or any SSV task.

5.3.2 Monthly Management Reports

Deliver informal monthly reports on this task to the Phoenix Principal Investigator and EPO Manager. These reports include: a) technical accomplishments over the past reporting period, b) explanation of any variances from the established plan (e.g. missed milestones, deliverables, changes workforce level, etc.), c) proposed resolution to any plan variances, workforce and cost expenditures for the past reporting period.

5.3.3 Technical Presentations

Each of the five SSV basic tasks is required to provide summary demonstrations, twice each year.

6. BUDGET

Task	FY04	FY05	FY06	FY07	FY08	TOTAL
Simulated Launch -EDL	$20K	$ 20K	$60K	$70K	$30K	**$200K**

Simulated Launch, Entry, Descent & Landing ***6/22/04***

Page 3 of 5

7. ASSUMPTIONS

7.1 There is no contingency for this task.

7.2 The JPL EIC will approve a loan to purchase the equipment required for this task. Users of the equipment will repay the loan.

7.3 SSV -EPDS baseline budget will be maintained at the FYO4 funding level. Significant cuts to the budget put this task at risk.

7.4 SSV - EPDS will provide funds for the upgrade, replacement, and network charges associated with personal computers required for this task.

7.5 Four of the basic SSV tasks (Simulated Launch, Entry, Descent, and Landing (SLED); Special Science Products (SSP); Solar System Visualization Animations (SSV -A); and Visualization and Image Processing (VIP)) are interdependent and interconnected. Reductions to the budget of any of the three tasks put all tasks at risk.

7.6 The current SSV OAO machines are sufficient to meet all interoperable requirements for this task. All non-GAG SSV machines will remain non-GAG machines.

7.7 During Phoenix landed operations and tests, the Beowulf Architecture Test-bed (BAT) will provide mosaics, range maps, and three-dimensional meshes to the MIST. These mosaics, range maps, and three-dimensional meshes will conform to existing Phoenix Software Interface Specifications (SISs).

7.8 PHOENIX engineering telemetry data will be available from the project to the MIST in a timely manner in a known format.

7.9 Geometric, and radiometric calibrated camera models will be provided to the MIST by the project.

7.10 During PHOENIX landed operations and test, an office and control room (264-647) and computer room 264-640G will be provided. This space is needed for the SSV equipment and personnel required to support Phoenix SSV.

8. DEFINITIONS AND ACRONYMS

8.1 JPL Software Classes. These classes are documented in "The JPL Software Development Process Description", Rev. D, D-15378 in DMIE.

8.2 Cluster. A cluster is a physical collection of homogeneous or heterogeneous computers. For this task we are only considering homogeneous collections.

8.3 Node. A node is a single element of a cluster. Nodes may contain multiple processing units. To avoid confusion we use a single CPU as the metric for processing power in a cluster.

8.4 VAT. The Visualization Analysis Test-bed (VAT) is one of six elements, which form the Inter Planetary Network - Information Systems Directorate (IPN-ISD) End-to-End Test-bed.

8.5 ScreamerN et provides a method for the parallel processing of animation frames. Each render node must share the common directory, each other, and the master node. The master node controls all the other nodes using daemons. The communication between the master node and slave nodes is accomplished by the reading and writing of files in a common shared directory.

8.6 MIPL. The Multi-mission Image Processing Laboratory.

8.7 SSV-EPDS. Solar System Visualization Experiment Product Delivery Service element oft11 Inter Planetary Network - Information Systems Directorate.

8.8 VICAR. VICAR stands for Video Image Communication And Retrieval. It is a general purpose image processing software environment that has been developed since 1966 to digit process multi-dimensional imaging data. VICAR was developed primarily to process image: from the Jet Propulsion Laboratory's unmanned planetary spacecraft. It is now used for a variety of other applications including biomedical image processing, cartography, earth resources, astronomy, and geological exploration.

9. RECEIBABLES/DELIVERABLES

Task Description	Element Deliverable	Element Receivable	Date
Deliver NTSC Rough Cut of Simulated EDL Visualization	NTSC ED2	Modeler	9/30/05
Deliver NTSC Rough Cut of Simulated Lander	NTSC-L	Modeler	9/30/06
Deliver HDTV Animation of Launch and EDL	HDN-L + EDL	Modeler	9/30/07
Deliver DVD Animation of Launch and EDL	DVD-L + EDL	Modeler	12/31/07

Statement of Work for Phoenix Mars Mission Partnership

Prepared by David Klanderman
Curator of Exhibits
Arizona Aerospace Foundation

1) The Partnership:

The Phoenix Mars Mission has invited the Arizona Aerospace Foundation to participate in the development of education/public outreach programming, funded by NASA, to ensure the greatest possible level of public understanding and support of the Phoenix Mars Mission's scientific objectives and the relevance of the mission to NASA's continuing exploration of our solar system.

Phoenix Mars Mission and Arizona Aerospace Foundation personnel will participate in cooperative projects designed to provide the background information and evolving science necessary to meet this objective. Projects will include the development of interpretive exhibits focusing on the scientific objectives addressed by the Phoenix Mars Mission, on the importance of water to the evolution of biological organisms on Earth and potentially on Mars, and to the ongoing search for water and biological activity on the other planets and their satellites in our solar system.

By creating a coordinated approach utilizing facilities located at both the Pima Air and Space Museum and the Phoenix Mars Mission Science Operation Center, **our goal is to create the broadest opportunity for public access to the information in general and to the specific operations of the Phoenix mission to Mars.** The development of complimentary interpretive programming at both the Museum and Phoenix Mars Mission headquarters will draw on the strengths of the established museum and on the uniqueness of having a major NASA mission headquartered in Tucson.

2) The Projects: Pima Air and Scace Museum:

Four separate interpretive projects are planned for installation at Pima Air and Space Museum.

- **2005 (calendar year. Start project: *10/01/05.* Deliverable: *12/31/05). An introduction* to *the Phoenix Mars Mission, its science, and its objectives.*** The exhibit will include general dialogue on the identification of potentially habitable zones and the development of a robotic explorer and a model of the spacecraft. Timing of the exhibit will offer the opportunity to help advertise the Phoenix Mars Mission and the existence of its public-access Science Operation Center to local residents and seasonal visitors and will provide time for teacher scheduling of classroom activities and field trips to the Museum prior to the launch.
- **2005-2006 (calendar year. Start project: *10/01/05.* Deliverable: *4101106). An introduction* to *the physical properties* of *water and the search for water and biological activity elsewhere in our solar system.*** The exhibit will focus on data-collecting missions to planets and satellites other than Mars that are designed to search for water and biological activity. 80th NASA and international-cooperative missions will be highlighted. Timing of the exhibit will provide information to visitors on NASA's broad philosophical concept that we should *"follow the water."*
- **2006-2007 (calendar year. Start project: *10/01/06.* Deliverable: *4101107). An introduction* to *the behind-the-scenes workings* of a *NASA mission* to *Mars.*** The exhibit will include a look at project-related infrastructure, the people involved in the project, and the design and fabrication of the instrumentation that will be the heart of the project. Timing of the exhibit will generate renewed interest in "Tucson's own Mars mission" and will serve to remind visitors that launch time is quickly approaching.
- **2007-2008 (calendar year. Start project: *10/01/07.* Deliverable: 4/01/08). *An introduction* to *the mechanics* of a *Mars mission launch and flight profile.*** This exhibit will be the most

fluid of the four in that it will coincide with mission launch in August 2007 and touchdown in June 2008 and will be updated regularly as the mission progresses. Opportunities will exist for special focus on the landing and the collection of scientific data. A NASA link may be provided for mission updates and special educational opportunities may be developed in conjunction with The Challenger learning Center of the Southwest, located at the Museum.

- **Interactive.** Static displays will be complemented by an interactive, ongoing computer display, tentatively entitled, "Meet the Team." Visitors will be introduced to Phoenix Mars Mission team members from the Principle Investigator to the engineer to the fabricator to the launch control technician through short interviews. The concept can be transferred to a museum educational workshop or mini-lecture format on a periodic basis.

3) The Projects: Phoenix Science Operation Center:

- **2005 (calendar year. Start project: 10/01/05. Deliverable: 12/31/05).** ***An introduction to the Phoenix Mars Mission, its science, and its objectives.*** The exhibit will parallel the installation at Pima Air and Space Museum in content and timing. An end-of-2005 installation will coincide with the projected completion and installation of the Phoenix lander engineering model, slated for March 2006 and the public opening of the Science Operation Center.
- **2005-2006 (calendar year. Start project: 10/01/05. Deliverable: 4/01/06).** ***An introduction to the physical properties of water and the search for water and biological activity elsewhere in the solar system.*** The exhibit will parallel the installation at Pima Air and Space Museum in content. NASA's *"Follow the water"* theme will be highlighted. Timing of the exhibit will serve as a reminder that launch time is quickly approaching.

4) Personnel:

Interpretive Project Coordination:

Douglas Lombardi, Education Public Outreach Manager, Phoenix Mars Mission
David Klanderman, Curator of Exhibits, Arizona Aerospace Foundation

The Arizona Aerospace Foundation staff will, in addition, provide **project accounting** for Foundation expenditures as well as **administrative oversight** and **interpretive design, fabrication, and installation** staff as required to meet the terms of the partnership agreement. **Consulting services** will also be made available to the Phoenix Mars Mission on technical interpretive issues, as requested. Arizona Aerospace Foundation staff will make **Phoenix Mars Mission marketing materials** available to Pima Air and Space Museum visitors.

The Phoenix Mars Mission staff will provide **assistance on scientific matters related to the project and development of exhibit scripting.** All efforts will be made to provide technical data in as timely a manner as possible. Phoenix Mars Mission staff will make **Arizona Aerospace Foundation marketing materials** available to Science Operation Center visitors.

The Arizona Aerospace Foundation will utilize its volunteer staff **model makers** to produce display models for the Museum's exhibits. Model makers will be made available to the Phoenix Mars Mission on an independent contract basis. Model-building performed for the Phoenix Mars Mission must be cleared with the Museum's Curator of Exhibits for time scheduling purposes prior to the start of contract projects.

5) Accounting:

- **Time accounting reports.** Reports will be submitted on a quarterly basis, commencing 90 days after the start of the initiation of the first interpretive project.
- **Cost accounting reports.** Reports will be submitted on a monthly basis, commencing 30 days after the start of the first interpretive project. The Foundation will maintain its own purchase order and receipt storage systems and will submit monthly invoices to the Phoenix Mars Mission.
- **Project status reports.** Reports will be submitted either monthly or at the request of the Phoenix Mars Mission Education Public Outreach Manager.
- **Utilization of subcontractors and vendors.** The Foundation reserves the right to contract or purchase material from university or non-university vendors at its discretion.

6) Budget

- The Phoenix Mars Mission will fund the initial $35,000 of the cost of the interpretive programming to be created by the Arizona Aerospace Foundation.
- The Arizona Aerospace Foundation will be responsible for development and production costs in excess of the funding provided by the Phoenix Mars Mission for interpretive components produced for installation at Pima Air and Space Museum.
- The Phoenix Mars Mission will be responsible for excess development and production costs resulting from mid-course design additions or modifications made to interpretive elements produced by the Arizona Aerospace Foundation for installation at the Phoenix Mars Mission Science Operation Center.

Funding: four interpretive components to be installed at Pima air and Space Museum:
2005: $7500
2006: 7500
2007: 5000
2008: 5000

Funding: interpretive components to be installed at the Phoenix Mars Mission Science: Operation Center:
2005: $5000
2006: 5000

Annual funding (fiscal year, 1 October-30 September):
2005: $12,500
2006: 12,500
2007: 5,000
2008: 5.000

$35,000 total E/PO partnership expenditure over the life of the Phoenix Mars Mission

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Doug Lombardi
Education Public Outreach Manager
Phoenix Mars Mission
Lunar & Planetary Laboratory

P.O. Box 210500
Tucson, Arizona 85721
Phone: (520) 626-8973
Fax: (520) 626-1973

LETTER OF AGREEMENT

Date: June 21, 2004

To: Doug Isbell
Manager, Public Affairs & Educational Outreach
National Optical Astronomy Observatory

From: Doug Lombardi

Subject: Partnership with University of Arizona, Phoenix Mars Mission

With much enthusiasm, the University of Arizona, Phoenix Mars Mission is looking forward to partnering with the National Optical Astronomy Observatory's Public Affairs and Educational Outreach Office.

The attached sheets contain a list of areas in which we have agreed to collaborate. The areas of collaboration would not be binding, but rather potential venues of sharing information and resources. In essence, our partnership efforts represent in-kind contributions with no planned exchange of funds.

I am delighted to have the opportunity to work with your outstanding organization and am confident that our partnership will make a significant contribution toward achieving the Phoenix Mars Mission Education and Public Outreach goals.

AGREED

National Optical Astronomy Observatory Manager, Public Affairs and Education Outreach	Doug Isbell Signature Date 6/24/04
University of Arizona EPO Manager, Phoenix Mars Mission	Douglas Lombardi Signature Date 6/24/04

Attachment

LIST OF COLABORATIVE OPPORTUNITIES

1. Phoenix Exhibit at the Kitt Peak Visitors Center

An exhibit at Kitt Peak would include visualizations, a model, mission information (both written as public handouts and for panels in the exhibit), and a NASA TV link (during the mission only) about the Phoenix Mars Mission. One year prior to launch (currently schedule for August 2008), the visualizations and model would be provided by Phoenix Education and Public Outreach (EPO). The National Optical Astronomy Observatory (NOAO) would be responsible for creating and maintaining the exhibit.

2. NOAO Exhibit at the Phoenix Science Operation Center (SOC)

An exhibit at the SOC would include visualizations and information about NOAO. The exhibit would be developed by NOAO.

3. Kitt Peak Volunteers to work at the SOC

NOAO would offer its volunteers the opportunity to work outreach activities at the Phoenix SOC. The training and coordination of these volunteers would be provided by Phoenix EPO.

4. Sharing of Educator Resources

Through their RBSE and TLRBSE programs, NOAO has developed an outstanding cadre of teachers that are prepared for research opportunities at the Phoenix SOC, as well as NASA and the aerospace industry. This cadre of teachers would also be available to participate in workshops and develop and review curricula developed by Phoenix. NOAO would make this list of trained teachers available to Phoenix. Similarly, any educator mailing lists developed by Phoenix EPO would be shared with NOAO.

5. Collaboration on Teacher Workshops

NOAO has extensive experience in developing and managing high quality teacher workshops and would provide consultation to Phoenix on these matters. Also, personnel from NOAO would have the opportunity to participate in teacher workshops conducted by Phoenix. In this way, the Phoenix Mission would take full advantage of high-quality materials developed by the NOAO staff, such as Astronomy Village and the GEMS guides.

6. Distribution of Phoenix EPO materials

NOAO would distribute Phoenix EPO materials through Project Astro, Family Astro, the Kitt Peak Visitor Center, and other appropriate outreach venues.

7. Mars Night Events

NOAO would host Mars Night Events at the Kitt Peak Visitor Center in conjunction with the landing and some science operations of the Phoenix Mission.

8. Support for Media Activities

NOAO would be eager to jointly organize media tours of Tucson space science and astronomy venues for visiting members of the media, and has pledged their support to help staff the mission newsroom during landing events.

STATEMENT OF WORK

and estimated budget

(revised July 27, 2004)

Project Evaluation Coordination

Phoenix Mars Mission

Lunar and Planetary Laboratory

University of Arizona

SCOPE OF WORK

During the EPO Program for the Phoenix Scout Mission to Mars, Drs. Slater and Garvin-Doxas and Mr. Andrew Shaner will conduct an ongoing, internal/external EPO program. The evaluation team, lead by Dr. Slater, will report directly to Mr. Doug Lombardi. The team will (i) assist Mr. Lombardi in preparing reports and making presentations about the EPO program by providing both quantitative and qualitative evaluation data in a readily useful format; (ii) actively communicate with each of the EPO project partners to gather and combine evaluation data from those sites; (iii) serve as a confidential, formative feedback team with the goal of improving the EPO program impacts, effectiveness, dissemination, and efficiency; (iv) lead the production of scholarly publications describing lessons learned by the EPO team; and (v) assist compiling and gathering data for the final project summative evaluation. Further, the team will be available to make presentations on the EPO program to the scientific and educational community as appropriate.

TASKS

The first to be performed will to develop and E/PO Evaluation Plan based on consultation with the Phoenix Mission. The evaluation plan will be dependent on the implementation plan developed by and in accordance with the goals of the Phoenix E/PO Program. Annual evaluation reports will be produced based on multiple data sources (i.e., we will try to triangulate our data to make some conclusions) from Phoenix E/PO and its partners. These reports will provide formative guidance to the Phoenix E/PO team. A summative report will be produced at the conclusion of the Phoenix E/PO program. The schedule of task deliverables is detailed later in this Statement of Work.

KEY PERSONNEL

Dr. Tim Slater, an associate professor of astronomy at the University of Arizona and Director of the UA Science and Mathematics Education Center will serve as the team's intellectual leader and supervisor. Mr. Andrew Shaner, a Ph.D. student doing research on education and public outreach in space science, will conduct the day to day operations of the internal evaluation effort. Dr. Kathy Garvin-Doxas from the University of Colorado will serve as an external evaluator, working closely with Dr. Slater and Mr. Shaner of UA, to validate their results. She will work one day in FY 04 and two days in the

1

remaining years. This team has considerable educational evaluation experience (see attached CVs).

DELIVERABLES

Task	Item Receivable	Item Deliverable	Date
EPO Evaluation Plan		Draft Plan	11/20/04
	Comments on Draft Plan		12/1/04
		Revised Evaluation Plan	12/15/04
Annual Evaluation Report I		Draft Report	7/20/05
	Comments on Draft Report		8/1/05
		Revised Report	8/15/05
Annual Evaluation Report II		Draft Report	7/20/06
	Comments on Draft Report		8/1/06
		Revised Report	8/15/06
Annual Evaluation Report III		Draft Report	7/20/07
	Comments on Draft Report		8/1/07
		Revised Report	8/15/07
Final Report		Draft Report	11/20/08
	Comments on Draft Report		12/1/08
		Revised Report	12/15/08

GRADUATE STUDENT FUNDING STRUCTURE
(Phoenix is funding A. Shaner; Other funding sources are being used)

FY	Fall Semester	Spring Semester	Summer
FY 05	Phoenix	*Other sources*	Phoenix
FY 06	*Other sources*	*Other sources*	Phoenix
FY 07	*Other sources*	*Other sources*	Phoenix
FY 08	Phoenix	Phoenix	Phoenix
FY 09	Phoenix	*Other sources*	*Other sources*

ESTIMATED BUDGET

	FY 04	FY 05	FY 06	FY 07	FY 08	FY 09	TOTALS
TF Slater (Eval PD)	$0	$0	$0	$0	$0	$0	$0
Andrew Shaner (Eval GRA - Jan - July) @ $2500 per mo.	$2,500	$16,111	$8,354	$8,605	$26,589	$9,625	$69,285
Kathy Garvin Doxas (External Eval) 1-5 days @ $450/day	$450	$900	$900	$900	$900	$900	$4,500
Fringe Benefits (on GRA @ 31%)	$775	$4,994	$2,590	$2,668	$8,243	$2,984	$21,478
Travel to Pasadena for Mission Review Meetings ($500 air, $500 per diem + loding + transportation)	$0	$1,000	$1,000	$1,000	$1,000	$1,000	$5,000
Travel to One Professional EPO Meeting Per Year ($500 air, $500 per diem + loding + transportation)	$0	$1,000	$1,000	$1,000	$1,000	$1,000	$5,000
San Diego, Seattle, Washington DC, Boston,and then Austin TX External Evaluator Travel to Tucson (or GRA to Boulder) ($500 air, $500 per diem + loding + transportation)	$0	$1,000	$1,000	$1,000	$1,000	$1,000	$5,000
Misc Costs (Transcriptions, Software, Photocopies, Interent Connect, etc)	$0	$50	$50	$50	$50	$50	$250
Subtotal	$3,725	$25,055	$14,894	$15,222	$38,782	$16,559	$114,238
Overhead	$1,717	$11,018	$6,674	$6,881	$17,053	$7,458	$50,801
Total Costs	$5,442	$36,073	$21,568	$22,104	$55,835	$24,017	$165,039

Contact Information:

Timothy F. Slater, Ph.D. PI/PD
University of Arizona
Steward Observatory
933 N. Cherry Avenue
Tucson, AZ 85721 USA
Tel. (520) 621 – 7096
Fax (520) 621 – 1532
Email: tslater@as.arizona.edu

Steward Observatory Fiscal Officer
Joy Facio, jfacio@as.arizona.edu
Tel. 520-621-2371

Biographical Sketch – Timothy F. Slater, Ph.D.

(i) Professional Preparation

Kansas State University, Physical Science – BS, 1989
Kansas State University, Secondary Science Education – BS Ed, 1989
Clemson University, Physics and Astronomy – MS, 1991
University of South Carolina, Geological Sciences – Ph.D., 1993
Ph.D. Dissertation: The Effectiveness of a Constructivist Epistemological Approach to the Astronomy Education of Elementary and Middle Level In-Service Teachers

(ii) Appointments

2001-Present	University of Arizona, Department of Astronomy – Steward Observatory Associate Professor of Astronomy Director, UA Science and Mathematics Education Center
1996-2001	Montana State University, Department of Physics Research Associate Professor of Physics Lead Scientist, MSU/NASA Center for Educational Resources (CERES) Project
1994-1996	Pittsburg (KS) State University, Department of Physics Assistant Professor of Physics Director, Planetarium & Science Education Center.
1993-1994	University of South Carolina, Department of Physics and Astronomy Visiting Assistant Professor of Physics

(iii) Publications – (a) Five Most Closely Related

1. *A Review of Astronomy Education Research*, Astronomy Education Review, **2**(2), 2003. J.M. Bailey and T.F. Slater
2. *The Invisible Universe Online*: *Design and Evaluation of a Distance-learning Astronomy Course for Secondary Science Teachers*, Astronomy Education Review, **3**(2), 2003. J. Keller and T.F. Slater
3. *Hints of a Fundamental Misconception in Cosmology.* Astronomy Education Review, **2**(1), 28-34, 2002. E.E. Prather, T.F. Slater, and E.G. Offerdahl.
4. *Learning Through Sharing: Supplementing the Astronomy Lecture with Collaborative-Learning Group Activities.* Journal of College Science Teaching, **31**(6), 384-387, 2002. J.P. Adams and T.F. Slater
5. *A Systemic Approach to Improving K-12 Astronomy Education Using NASA's Internet Resources.* Journal of Computers in Mathematics and Science Teaching, **20**(2), 163-178, 2001. T.F. Slater, B. Beaudrie, D.M. Cadtiz, D. Governor, E.R. Roettger, S. Stevenson, GF. Tuthill

(iii) Publications – (b) Five Other Significant

1. *Student Beliefs and Reasoning Difficulties in Astrobiology*, Astronomy Education Review, **2**(1), 5-27, 2002, E.G. Offerdahl, E.E. Prather, T.F. Slater
2. *A Stronger Role for Science Departments in the Preparation of Future Chemistry Teachers*, Journal of Chemical Education, **80**(10), 1168, 2003. V. Talanquer, I. Novodvorsky, T. F. Slater, and D. Tomanek.
3. *Pre-Course Results from the Astronomy Diagnostic Test*, Publications of the Astronomical Society of Australia, **17**(2), 152-155, 2000. B Hufnagel, T.F. Slater, G. Deming, J.P. Adams, R. Lindell, C. Brick, and M. Zeilik.
4. *Long Term Sustainability of Teacher Attitudes in Astronomy.* Journal of Geoscience Education. **47**, 366-368, 1999. T.F. Slater, J.L. Safko, and J.R. Carpenter
5. *Using Real-Time Earth and Space-Science Data in the Classroom.* Leading and Learning with Technology Journal, **26**(2), 28-31,36, 1998. T.F. Slater

(iv) Examples of Synergistic Activities

1. COLLEGE TEACHING: Based upon our research on student misconceptions and recognizing a critical need for an integrated system of instructional materials, and clearly written pedagogical information to support innovative college faculty with teaching introductory astronomy to non-science majors, we formulated a multi-pronged support system that included: publishing a "teaching excellence" book, Learner-Centered Astronomy Teaching: Strategies for ASTRO 101, Slater and Adams, 2002, Prentice Hall, ISBN 0-13-046630-1; a series of classroom-ready, collaborative group activity books including Lecture-Tutorials for Introductory Astronomy, Adams, Prather, and Slater, 2002, Prentice Hall, ISBN: 0-13-101109-X, Mysteries of the Sky, by Jeff Adams and Tim Slater, Kendall/Hunt Publishing Company, Dubuque, Iowa, 2000. ISBN 0787251267, and Life in the Universe: Activities Manual, Offerdahl, Prather, and Slater, 2002, Addison Wesley, ISBN 0-8053-8735-8; and provided 2-day and 3-day teaching excellence workshops for college faculty through the NSF Chautauqua program and at professional society conference meetings, including the American Astronomical Society and the American Association of Physics Teachers conferences. In each of these venues, our research on student learning guides the development of the materials and workshops.

2. TEACHER PREPARATION AND ENHANCEMENT: As the need for improving the quality and quantity of science education in middle and secondary schools is reaching alarming levels across the country, our team has: (a) created an innovative pre-service science teacher preparation program where undergraduate students take all of their science, curriculum, instruction, and assessment classes within the college of sciences by science education faculty with tenure-eligible appointments in science departments that is enjoying unexpectedly high participation by science majors; (b) developed a MS Ed program for individuals with undergraduate degrees in science and mathematics; (c) implemented an early career science teacher induction and support program; and (d) offer and fund extramurally a year-round portfolio of teaching excellence workshops (currently focusing on GEMS Guides) to extend teachers' pedagogical content knowledge using an exciting and coordinating infrastructure of the U Az Science and Mathematics Education Center and local partnerships with teachers and school districts.

3. ONLINE LEARNING: To harness the overwhelming and rapidly growing scientific and communication resources of the Internet, we have facilitated teams of scientists and master teachers to develop and field-test instructional materials that focus on an inquiry-oriented and student-centered approach to science instruction. These materials have been carefully orchestrated into Internet-delivered distance learning graduate courses for teachers through the NSF-supported National Teachers Enhancement Network, housed at Montana State University and the National Science Teachers Association Professional Development Institute Program. These courses are uniquely characterized as highly interactive, based on collaborative learning principles, and serve the needs of teachers in the Interdisciplinary MS Science Education online degree program at Montana State University.

(v) Collaborators & Other Affiliations – *(a) Collaborators and Co-Editors*
Jeff Adams, Michael Bennett, Gina Brissenden, Susana Duestua, Doug Duncan, Greg Francis, W. Michael Greene, Kevin Lee, Karen Meech, Cherilynn Morrow, Ingrid Novodvorsky, Kim Obbink, Ed Prather, Stephen Pompea, Vicente Talanquer, Michelle Thaller, George Tuthill, Debra Tomanek, Mike Zeilik

(v) Collaborators & Other Affiliations - *(b) Graduate and Postdoctoral Advisors*
PhD: John Carpenter and John Safko, University of South Carolina
MS: Raymond Turner and Phil Flower, Clemson University
BS: Steve Oliver, University of Georgia, and Larry Enochs, Oregon State University

(v) Collaborators & Other Affiliations - *(c) Thesis Advisor and Postgraduate-Scholar Sponsorship*
Thesis Advisees: Jessie Antonellis, Erik Brogt, Sanlyn Buxner, Janelle Bailey, Erin Dokter, Adrienne Gauthier, John Keller, Erika Offerdahl, Delphine Perrodin, Pebble Richwine, Elizabeth Roberts
Post-Docs Sponsorship: Christine Brick (U MT), Lauren Jones (Gettysburg), Ed Prather (U Az), Jennifer Mangan (U Az)

KATHY GARVIN-DOXAS
Alliance for Technology, Learning & Society (ATLAS) Institute
Evaluation and Research Group, CB-040UCB
University of Colorado, Boulder, CO 80309-040
(303) 735-3148, garvindo@ucsub.colorado.edu

Education
University of Colorado, Boulder, Colorado
Ph.D., 1998 Organizational Communication
University of Texas at Austin, Austin, Texas
B. S., 1988 Radio-Television-Film, College of Communications

Professional Experience
1999-present ***Research Associate: University of Colorado, Boulder***

- Conduct research and evaluation on educational technologies and on technology and education – using facilitation and principles of collaboration, work with developers, content specialists, educators, and users to create educational tools that enhance learning and are actually adopted by teachers/faculty in classrooms and to provide evidence of student learning, range of use, adoption, adaptation, and other issues related to project success and scalability
- As part of project evaluation, develop assessment instruments based on research on education and learning (discipline-specific whenever possible) which are designed to measure learning outcomes (including an understanding of what science, scientific rigor, and scientific method)
- Develop and conduct workshops on systemic reform in education and other forms of organizational change; enhancing teaching and learning in STEM disciplines; and on alternative methods for assessing student learning
- Conduct research on education in the physical, space, and geo sciences using a combination of quantitative and qualitative methods; including research on collaborative, cooperative, and other forms of peer learning; development of learning assessments; and program evaluation for initiatives in science education
- Conduct research on collaborative and cooperative learning interactions and initiatives in STEM classrooms in order to determine barriers and to develop strategies for successful implementation
- Conduct Information Technology pipeline research to examine recruitment of middle school students into two Computer Magnet high school programs, determine what practices and language encourage greater diversity among students who enter the programs with special attention paid to gender and minority issues
- Apply triangulated social science methods to understand what attracts and what repels women from information technology programs of study and work with these programs (particularly in computer science education) to improve their curricula and classroom environments in ways that encourage greater diversity among the student population as well as enhanced teaching and learning

Synergistic Activities
Chair: Distance and Other Educational Technologies Group of the American Evaluation Association. Serving a 3-year term that began in November, 2003.

Conduct yearly, invited workshops for the American Evaluation Association and the Preparing Tomorrow's Teachers to use Technology (PT3, Department of Education) * Leading, Linking, and Learning (L3, Wexford Inc.) on systemic reform in education, institutional change, and employing organizational improvement strategies and tools to lead systemic educational reform.

Member of the Evaluation Team at Wexford, Inc. for the University of Wisconsin System's PT3, VIVA grant awarded by the Department of Education to build the UW System's capacity to train and educate pre-service teachers in the ways to integrate technology with their teaching.

Member of the national PT3*L3 initiative for systemic educational reform that seeks to identify the threshold conditions which must be in place to graduate pre-service teachers with the necessary skills and knowledge to integrate technology in their classrooms.

Conduct workshop for SIGCSE that provides research-based approach to improving teaching and learning in CS classrooms that integrates principles of the learning environment, communication climate, Bloom's Taxonomy, and the teacher's learning goals. Reno, NV, February, 2003.

Advisory Board Member: Space Science Institute – NASA Broker.

Evaluation Consultant: Space Science Institute, Family Guides & NASA Broker.

Evaluation Advisory Board Member, Digital Library for Earth Science Education (DLESE).

Evaluator for Digital Library for Earth System Education (DLESE) annual meeting.

Facilitator and "Rapporteur" for the National Learning Infrastructure Initiative (NLII) focus session on Transformative Assessment.

Awards and Fellowships

1997-1998 National Communication Association, Organizational Communication Division award for Outstanding Published Paper. Democracy, participation, and communication at work: A multidisciplinary review. In M. E. Roloff (ed.), *Communication yearbook, 21* (pp. 35-91). Thousand Oaks, CA: Sage, 1998.

1997-1999 Professional research experience program fellowship: NIST/University of Colorado, Boulder

Relevant Publications

M. Klymkowsky, K. Garvin-Doxas, and M. Zeilik (2003). Bioliteracy and Teaching Efficacy: What Biologists can Learn from Physicists, *Cell Biology Education, 2*, 155-161.

K. Garvin-Doxas and L.J. Barker (2003). Creating Learning Environments that Support Interaction. Proceedings of the Annual Joint Conference on Integrating Technology into Computer Science Education (ITiCSE), ACM Press, NY:NY.

L. Barker, K. Garvin-Doxas, and M. Jackson (2002). Defensive Climate in Computer Classrooms. Proceedings of the 33rd SIGCSE Technical Symposium on Computer Science Education (pp. 43-47). ACM Press, NY:NY.

G. Cheney, K. Garvin-Doxas, and K. Torrens (1999). Kenneth Burke's implicit theory of power. In B. Brock (Ed.) *Kenneth Burke and the 21st Century* (pp. 133-150). NY: SUNY Press.

S. Planalp and K. Garvin-Doxas (1994). Using mutual knowledge in conversation: Friends as experts on each other. In S. Duck (Ed.) *Dynamics of relationships* (pp. 1-26). Thousand Oaks, CA: Sage.

Some Other Recent Presentations

Kathy Garvin-Doxas and Francis Bagenal. Student Misconceptions about Collaboration and how they Impact Learning. Presented at the Winter Meeting of the American Association of Physics Teachers, 2003. Austin, Texas.

Lecia Jane Barker and Kathy Garvin-Doxas. The Learning Environment and Learning in Computer Science Classrooms. Invited presentation for the Department of Computer Science, University of Colorado, 2002. Boulder, CO.

Kathy Garvin-Doxas. The Use of Multiple Evaluation Methods to Guide Development of Educational Technologies in the Geosciences. Presented at the Annual Fall Meeting of the American Geophysical Union, 2002. San Francisco, CA.

Kathy Garvin-Doxas. Designing Collaborative Learning into the Curriculum. Presented at the NASA Office of Space Science Education and Public Outreach meeting, 2002. Chicago, IL.

Close collaborators

Lecia J. Barker, ATLAS evaluation and research; Fran Bagenal, APS; Isidoros Doxas, CIPS; Michael Klymkowski, MCD Biology; Ron Cole, CSLR, University of Colorado, Boulder, Mike Zeilik, University of New Mexico.

Graduate Adviser: Brenda J. Allen, University of Colorado

6.9 Program Evaluation Plan

INTRODUCTION

This Education and Public Outreach (E/PO) Evaluation Plan has been developed to provide support for the Phoenix Mars Mission E/PO program and, specifically, to provide the E/PO manager, Mr. Doug Lombardi, with frequent, systematic, and objective evaluation data for decision-making. Administratively, program evaluation is now a required component to many programs funded by federal agencies such as NASA and the National Science Foundation, with five to eight percent of direct costs being allocated to evaluation expenses[12]. Fundamentally, evaluation provides information to help improve a program and determine the extent to which the program reaches its goals. Information on how goals are being met and on how different aspects of a program are working is essential to a continuous improvement process. Evaluation can also frequently provide new insights or new information[13] that can dramatically increase a program's impact beyond its original plans.

Just as the Phoenix E/PO program is being managed at the mission level[14], so will the coordination of E/PO evaluation efforts. The primary goals of the evaluation effort are to:

1. Determine the extent to which the E/PO program goals (listed in Table E-1) are supported by project activities (listed in Table E-2),
2. Make specific recommendations to the E/PO manager about ways to increase the effectiveness and impact of the program overall, and
3. To serve as a collection point for program-wide E/PO data.

The overarching goal of this evaluation will be to assist the Phoenix E/PO manager and the E/PO partners in conducting an effective, successful program that will inspire, excite, encourage, and nurture the exploration of questions from students and the public about Mars, the Solar System, and space exploration[15].

With these goals in place, the evaluation process takes the following posture:

- Evaluation will be an integral part of the E/PO program for the life of the mission by making data-driven recommendations to the E/PO manager.
- Evaluation will confirm that all E/PO activities are carried out in the manner stated.
- Evaluation will determine how learners are different after participating in E/PO activities.
- Evaluation will conduct expert reviews to ensure activities are scientifically accurate.

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[12] Bailey, J.M. & Slater, T.F. (2004). *Finding the forest amid the trees: Tools for evaluating astronomy education and public outreach projects*. In review for Astronomy Education Review.
[13] National Science Foundation's *The 2002 User-Friendly Handbook for Project Evaluation*, January 2002, pg. 3
[14] As opposed to the individual instrument level.
[15] From Phoenix E/PO Implementation Plan.

Table E-1. Phoenix E/PO Goals

Phoenix Mission Objective	Phoenix E/PO Goal	Thematic Strand
Study the history of water in the Martian arctic.	Facilitate understanding of the properties of water that are essential for life.	*Water and Life*
Search for habitable zones in the Martian permafrost.	Develop awareness of the role of matter-energy interactions in living organisms and their environment.	*Soil Habitability*
Develop a robotic system to successfully explore the environment near Mars' north pole.	Simulate challenges that provide authentic learning environments for appreciating the role of robotics and technology and space exploration.	*Robotics*

Table E-2. E/PO Partners' Activities[16]

E/PO Partner	Activity/Activities
NASA Center for Distance Learning – Langley Research Center	NASA SCI Files™ program; 2 NASA Kids Science Network™ shows (Spanish & English); NASA Connect™ middle school activity; NASA Destination Tomorrow™ segment
Arizona State University	Soil properties curriculum; Soil habitability curriculum; teacher workshops; Mars Exploration Student Data Teams
Space Science Institute	"Big Dig" exhibit; "Virtual Robot exhibit; update the *Family Guide to Mars*; Native American teachers workshop
Science, Engineering, Mathematics, and Aerospace Academy (SEMAA)	"Mission to Mars" science, mathematics, and technology curriculum for grades 1-4
Phoenix Student Interns Program (PSIP)	Arizona team participates in PSIP prototype; implement PSIP after successful prototype
Arizona Space Grant Consortium	BalloonSat launches; teacher workshops
Jet Propulsion Laboratory (JPL)	HDTV Phoenix launch & EDL animation
Arizona Aerospace Foundation	Museum exhibits
McDonald Observatory	*Stardate* & *Universo* radio programs

[16] Detailed descriptions of each activity are discussed in the E/PO Implementation Plan.

This program evaluation plan represents a collaborative endeavor between the evaluators and the Phoenix E/PO partners. Active participation among partners is vital to designing and implementing the overall evaluation of the Phoenix E/PO program. The evaluation is performed by the University of Arizona's Conceptual Astronomy and Physics Education Research (CAPER) Team. The evaluation lead, Dr. Timothy Slater, is responsible for the overall Phoenix E/PO evaluation effort. Mr. Andrew Shaner, a PhD candidate conducting research under the direct supervision of Dr. Timothy Slater on the effectiveness of NASA E/PO programs, conducts daily operations of the internal evaluation effort. Dr. Kathy Garvin-Doxas of the University of Colorado at Boulder serves as an external evaluator, validating evaluation data collected by the CAPER Team and Phoenix E/PO partners. For this mission, the evaluation team works directly for the E/PO manager. The evaluation team submits reports directly to the E/PO manager who then chooses which, if any, of the evaluation information will be passed to E/PO partners or to the mission leadership team. This process helps to ensure objectivity on the part of the evaluators.

METHODS OF EVALUATION

This evaluation uses both qualitative and quantitative methods of data collection (see Creswell, 2005[17]) to perform planning, implementation, formative, and summative forms of evaluation. Quantitative methods of research place an emphasis on:

- Collecting and analyzing information in the form of numbers.
- Collecting scores that measure distinct attributes of individuals and organizations.
- The procedures of comparing groups or relating factors about individuals or groups in experiments, correlational studies, and surveys.

Qualitative methods of research recognize:

- The need to listen to the views of participants in studies.
- That general, open questions need to be asked and that data can be collected in places where people live and work.
- That research has a role in advocating for change and a role in bettering the lives of individuals.

Table E-3 defines the specific types of evaluation methods used in the evaluation and which activities are being evaluated using these methods. A planning evaluation has been conducted to determine if program goals and activity objectives are clearly stated and achievable. Implementation evaluations are being conducted to determine if all E/PO activities are being carried out in the manner stated in the partners' statements of work. Formative evaluations will be conducted throughout the duration of the program to provide feedback to the partners and the evaluators. This feedback helps guide the development and implementation of E/PO activities as well as provides information to be used in summative

[17] Creswell, J.W. (2005). Quantitative and qualitative approaches. In *Educational research: Planning, conducting and, evaluating quantitative and qualitative research (pp. 38-57).* Upper Saddle River, NJ: Pearson Education, Inc.

program evaluations. Summative evaluations will be used to follow the progress of the activities towards the attainment of their objectives as well as determine the extent to which the E/PO goals are being met.

Table E-3. Evaluation Methods

Evaluation Type	Definition	Evaluation Question
Planning	Assesses and improves program design[18]	Are the E/PO Implementation Plan's program goals, activity objectives, target populations, expected outcomes, and methods for reaching program goals achievable, aligned with national standards, and of high value?
Implementation	Assesses whether the program is being conducted as planned[19]	Are E/PO activities being conducted as stated by partners and program manager consistent with their statements of work?
Formative	Assesses ongoing program activities and provides information to monitor and improve the program	What modifications, if any, need to be made to E/PO activities to ensure objectives are being met?
Summative	Assesses program success in reaching its stated goals	Did the individual E/PO activities meet their objectives? Did the E/PO program meet its overall goals?

Planning Evaluation

The planning evaluation of the E/PO Implementation Plan was conducted by the evaluation team with input from the E/PO partners. The evaluation team reviewed the Implementation Plan's program goals and activity objectives to assess the objectives' alignment with E/PO goals and the achievability of each. Additional feedback from E/PO partners was collected through telephone interviews and email requests and all recommendations were relayed to the E/PO manager. From these interviews and emails, a consensus was reached between the E/PO manager, partners, and evaluation lead that the E/PO goals and activity objectives were in alignment with one another and, if carried out as planned, will ensure activity and program success.

[18] Rossi, P.H., Lipsey, M.W., & Freeman, H.E. (2004). *Evaluation: A Systematic Approach,* ed. 7. Sage Publications, Thousand Oaks, CA.
[19] Implementation, formative and summative definitions from NSF's *The 2002User-FriendlyHandbook for Project Evaluation. pg 8 & 10.*

Implementation Evaluation

Implementation evaluations will be conducted throughout the 2005 calendar year. Procedures will be evaluated during this time (e.g., did receivables and deliverables arrive at the date designated? Were teacher workshops carried out in the manner described?). Implementation evaluations will not be limited to just the first year of the program. Implementation evaluations will be conducted throughout the project as various program activities are initiated.

Formative Evaluation

Formative evaluations will be conducted to assess the progress of activities and the overall program. Surveys will be given to retrieve quantitative data (e.g. measuring such things as student attitudes towards science) to provide the evaluation team with feedback on the impact and overall effectiveness of activities. Follow-up surveys will be distributed to the same participants one to two years later to measure the long-term impacts of E/PO activities. Whenever possible, these scores will not be recorded for individual students, but rather aggregated to serve as one part of the evidence collected to determine the extent to which the overall E/PO goals are being met. Open-response and Likert-scale evaluations[20] will be distributed to teachers during workshops to help workshop leaders make appropriate changes as needed. These evaluations will be given to assess the workshops' overall impacts and effectiveness. Follow-up surveys will be distributed to teachers one to two years later when appropriate to determine teacher implementation of workshop materials. Interviews will be conducted to provide qualitative data. Interviews will be used to elicit elaborations of quantitative scores from surveys in order to substantiate and clarify quantitative results. Pre and posttests will be given to students involved in particular E/PO activities to determine cognitive gains made by students. Different versions of the tests will be designed for different goals and different audiences. A justification for using a mixed methods approach to this evaluation is discussed on page 14 of the evaluation plan.

Summative Evaluation

Summative evaluations will be conducted annually, combining data gathered from formative evaluations into a coherent whole. These evaluations will give a descriptive summary of the progress of E/PO activities and the E/PO program as a whole. Most importantly, summative evaluations will attempt to provide answers to the following questions:

1. Are E/PO activities being carried out as described by the statements of work?
2. How are students different in understanding and attitudes as a result of participating in E/PO activities?
3. How does participation impact students in the long-term (one to two years down the road)?

[20] Likert-scales are used to measure attitudes, preferences, etc., usually on a 5-point scale (1-5) where 1 = strongly disagree and 5 = strongly agree.

Summative evaluations will be delivered confidentially to the E/PO manager on an annual basis at the dates listed in Table E-4 below.

Table E-4. Evaluation Deliverables

Activity Code	Activity	Delivery Date
EVAL-1	E/PO Evaluation Plan	12/15/04
EVAL-2	Annual Evaluation Report 1	08/15/05
EVAL-3	Annual Evaluation Report 2	08/15/06
EVAL-4	Annual Evaluation Report 3	08/15/07
EVAL-5	Final Report	12/15/08

External Evaluation

In addition to the learning and outreach goals of the program, the E/PO plan for the Phoenix Mission is designed to build a series of separate, but related educational programs and outreach efforts in ways that integrate best practices in terms of pedagogy and in terms of reaching, interesting, and influencing underrepresented populations in ways that contribute to future diversity in the fields of space science and engineering. In addition, many of the programs are faced with the challenge of building program infrastructure that can be adapted as launch and data transmission occur. These challenges span all of the E/PO partner programs and in addition to monitoring the overall evaluation plan described here, evaluation (particularly at the external level) will assist through the administration of instruments that provide documentation of attainment of these broader goals as well as assisting in the long-term development of E/PO efforts that integrate strong pedagogy, successful inclusion of underrepresented populations, and which integrate specific mission goals and standards into existing programs and practices. The primary means the evaluation team will rely on for focusing our efforts in these areas as well as providing the tracking and documentation to adequately judge overall E/PO success is through yearly administration of a survey designed to both collect the necessary data as well as to assist E/PO partners in determining their own degree of overlap and success with these broader issues.

Evaluation Matrices

Evaluation matrices (Tables E-5, E-6 and E-7) guide the overall program evaluation process. These matrices are intended to communicate and make transparent the evaluation process by connecting E/PO activities with 1) the E/PO program goal they address, 2) their specific objectives, 3) methods used to evaluate them, and 4) how the success of each activity is defined. The aim here is to evaluate the portfolio of program activities with respect to the E/PO goals, not the specific strengths and weaknesses of individual activities. As a result, the three matrices break down the evaluation of the E/PO program by the program goals. All activities which fall under Program Goal 1 are in Table E-5, activities under Program Goal 2 are in Table E-6, and activities under Program Goal 3 are in Table E-7. Evaluation methods in normal font are those methods currently in use by E/PO partners. Methods in *italics* are evaluation methods recommended by the evaluation team to be done along with the partners stated methods. The plan is to gather data concerning the overall impact of the program consistently among partners while still allowing partners to conduct their own evaluations already in place.

Table E-5. Phoenix E/PO Goal 1 Evaluation Matrix

E/PO Goal 1 - Water and Life - Facilitate understanding of the physical properties of water that are essential for life.				
Activity Code	**Objective**	**Activity**	**Evaluation Method**	**Indicator(s) of Success**
LaRC[21]-1	Deepen understanding about why scientists believe that the search for life beyond Earth is essentially a search for liquid water.	3-minute segment in the elementary level NASA SCI Files™ program *The Case of the Great Space Exploration.*	A) Mail surveys (electronic & self-reported); send to TV station mgrs and informal/formal educators. B) *Expert review* C) *Student pre and posttest, interviews*	A) Project managers state that surveys reveal that the project is meeting its goals B) Scientifically accurate[22] C) Statistically significant pre and posttest gains, Interview rubric[23]
LaRC-2	Deepen understanding about how scientists will search for water and life's precursors on Mars.	Two NASA's Kids Science Network™ (each in both English and Spanish) for elementary students.	A) Mail surveys (electronic & self-reported); send to TV station mgrs and informal/formal educators. B) *Expert review* C) *Student pre and posttest, interviews*	A) Project managers state that surveys reveal that the project is meeting its goals B) Scientifically accurate C) Statistically significant pre and posttest gains, Interview rubric
LaRC-3	Promote exploration and deepen understanding about the physical, chemical, and thermodynamic properties of water that are important for life.	NASA Connect™ middle school classroom activity.	A) Electronic and self-reported surveys to educators B) *Pre and posttests to students at UofAZ summer camp*.	A) Project managers state that surveys reveal that the project is meeting its goals B) Statistically significant pre and posttest gains

[21] NASA Langley Research Center - Center for Distance Learning
[22] 100% of expert reviewers state that science is accurate.
[23] Participants will demonstrate understanding of content as defined by a rubric designed in conjunction with interview questions.

E/PO Goal 1 - Water and Life - Facilitate understanding of the physical properties of water that are essential for life.				
Activity Code	**Objective**	**Activity**	**Evaluation Method**	**Indicator(s) of Success**
LaRC-4	Promote exploration and deepen understanding about the physical, chemical, and thermodynamic properties of water that are important for life.	NASA Destination Tomorrow™ segment for high school students.	Surveys – mail and pop-up	Project managers state that surveys reveal that the project is meeting its goals
AAF[24]-2	Inspire the public about the search for life beyond Earth and motivate them to develop a deeper knowledge of Solar System Exploration.	Interpretive exhibit covering the search for water and biological activity elsewhere in our Solar System (i.e. beyond Mars).	A) *Visitor counts* B) *Interviews* C) *Observations*	A) Attendance is at or above the norm B) Interview rubric C) 50% of attendees exhibit 80% of the desired behaviors on an observation checklist

Table E-6. Phoenix E/PO Goal 2 Evaluation Matrix

E/PO Program Goal 2 – Soil Habitability - Develop awareness of the role of matter-energy interactions in living organisms and their environment.				
Activity Code	**Objective**	**Activity**	**Evaluation Method**	**Indicator(s) of Success**
ASU[25]-1	Through comparison, facilitate understanding about the similarities and differences between soil properties on Earth and Mars.	Martian soil properties curriculum for grades 5-12.	Pre and posttests	Statistically significant pre and posttest gains
ASU-2	Facilitate understanding about the properties of Earth soil that make it habitable for organisms and how Martian soil will be explored to determine if it too is habitable or can be made habitable.	Martian soil habitability curriculum for grades 5-12.	Pre and posttests	Statistically significant pre and posttest gains

[24] Arizona Aerospace Foundation – Pima Air and Space Museum
[25] Arizona State University - Mars Education Program

E/PO Program Goal 2 – Soil Habitability - Develop awareness of the role of matter-energy interactions in living organisms and their environment.				
Activity Code	**Objective**	**Activity**	**Evaluation Method**	**Indicator(s) of Success**
ASU-3	Use inquiry, reflection, interpretation of research, modeling, and guided practice to increase understanding and skills in science teaching.	Activities from the two curriculum modules above and other materials developed by Phoenix E/PO in teacher workshops conducted by ASU.	A) Participant survey with follow-up surveys 3 months later B) *Observation*	A) 80% of workshop attendees would strongly recommend material to colleagues B) 50% of attendees exhibit 80% of the desired behaviors on an observation checklist
ASU-4	Provide authentic inquiry-based learning through the use of data collected by the Phoenix Mission to make assessments about potential soil habitability of Mars' arctic plains.	Mars Exploration Student Data Teams (MESDT) for grades 5-12.	*Pre and posttests*	Statistically significant pre and posttest gains

Table E-7. Phoenix E/PO Program Goal 3 Evaluation Matrix

E/PO Program Goal 3 – Robotics - Simulate challenges that provide authentic learning environments for appreciating the role of robotics and technology and space exploration.				
Activity Code	**Objective**	**Activity**	**Evaluation Method**	**Indicator(s) of Success**
SSI[26]-1	Foster collaborative learning through simulation of Phoenix Mission engineering and science operations.	The "Big Dig" interactive exhibit component with *MarsQuest* with duplicate exhibit to the Phoenix Science Operations Center.	A) *Interviews* B) *Observations*	A) Adequate or higher scores on interview rubric B) 50% of attendees exhibit 80% of the desired behaviors on an observation checklist
SSI-2	Foster understanding of how scientists operate a robot on Mars using web-based learning tools.	"Virtual Robot" exhibit patterned after the "Big Dig."	*Not yet determined*	Not yet determined
SSI-3	Provide activities based on Mars themes that stimulate co-learning between pre- and early-	Upgrading the *Family Guide to Mars* to include Phoenix mission	A) *Expert review* B) *Interviews with users.*	A) Scientifically accurate B) Adequate or higher scores on

[26] Space Science Institute – Boulder, CO

E/PO Program Goal 3 – Robotics - Simulate challenges that provide authentic learning environments for appreciating the role of robotics and technology and space exploration.				
Activity Code	**Objective**	**Activity**	**Evaluation Method**	**Indicator(s) of Success**
	school children and their parents or guardians.	science.		interview rubric
SSI-4	Use inquiry, reflection, interpretation of research, modeling, and guided practice to increase understanding and skills in science teaching.	Phoenix Mission science and educational materials to underserved Native American teachers presented in a summer workshop associated with the 4-Corners Alliance for Space Science.	*Workshop evaluation forms*	80% of workshop attendees would strongly recommend material to colleagues
SEMAA[27]-1	Students will experience several hands-on, minds-on, activities to investigate the Martian environment and technologies of space exploration, fostering a fundamental inspiration to study reading, science, and mathematics further.	"Mission to Mars" integrated reading, science, mathematics, and technology curriculum for grades 1-3.	*Pre and posttests to students at UofAZ summer camps*	Statistically significant pre and posttest gains
PSIP[28]-1	Provide an opportunity for local area students and teachers to participate in the Phoenix Science Operation test-bed providing authentic learning of science and engineering and get Phoenix mission members used to student and teacher involvement.	Local Arizona team to participate in a PSIP prototype.	Empowerment Evaluation	Interview with empowerment leader indicates that appropriate changes to the proto-type have been made in order to implement the model.
PSIP-2	Provide an opportunity for student/teacher teams to participate fully in Phoenix scientific missions and conduct educational outreach activities; thereby increasing the number of students motivated to pursue STEM careers.	Prepare and implement PSIP.	Empowerment Evaluation	Report from previous column
ASG[29]-1	Identify and select underserved and	Annual selection of five new Arizona	*Implementation Evaluation*	Interviews with project directors

[27] Science, Engineering, Mathematics and Aerospace Academy – Central Arizona College
[28] Phoenix Student Interns Program
[29] Arizona Space Grant Consortium

E/PO Program Goal 3 – Robotics - Simulate challenges that provide authentic learning environments for appreciating the role of robotics and technology and space exploration.				
Activity Code	**Objective**	**Activity**	**Evaluation Method**	**Indicator(s) of Success**
	underrepresented school teams that would provide maximum benefit to encourage students to pursue STEM careers.	schools to participate in the BallonSat program.		demonstrate that the activities were fully implemented
ASG-2	Use inquiry, reflection, interpretation of research, modeling, and guided practice to train teachers in the design, construction, and launch of small robotic payloads.	Annual teacher training workshops for the BalloonSat program.	A) Teacher surveys B) *Pre and posttests* C) *Observation*	A) Surveys indicate 80% of participants would recommend the workshop to peers B) Statistically significant pre and posttest gains C) 50% of attendees exhibit 80% of the desired behaviors on an observation checklist
ASG-3	In an authentic learning environment, student teams will operate their payloads to measure and image the atmosphere.	Balloon and payload launched.	A) *Observations* B) *Focus group interviews with participants*	A) 50% of attendees exhibit 80% of the desired behaviors on an observation checklist B) Interview rubric
AAF-1	Provide a free choice learning environment that deepens understanding about the fundamental science and engineering behind the Phoenix Mission.	Interpretive exhibit introducing the Phoenix Mars Mission, including the science goals.	A) *Visitor counts* B) *Interviews* C) *Observations*	A) Attendance is at or above the norm B) Interview rubric C) 50% of attendees exhibit 80% of the desired behaviors on an observation checklist
AAF-3	Provide authentic stories from mission scientists and engineers that reveal the nature of scientific inquiry to the public.	Interpretive exhibit providing “behind-the-scenes” workings of a Mars mission.	*Implementation Evaluation*	Interviews with project directors demonstrate that the activities were fully implemented
AAF-4	Display current mission information to enhance public involvement in the Phoenix Mission.	Interpretive exhibit examining the mechanics of a Mars mission, specifically its launch, flight, and entry-descent-landing profile.	*Implementation Evaluation*	Interviews with project directors demonstrate that the activities were fully implemented

E/PO Program Goal 3 – Robotics - Simulate challenges that provide authentic learning environments for appreciating the role of robotics and technology and space exploration.				
Activity Code	**Objective**	**Activity**	**Evaluation Method**	**Indicator(s) of Success**
MO[30]-1	Inspire and motivate the public about the Phoenix Mission and Mars exploration using engaging radio programs.	Series of radio programs in English (*StarDate*) and Spanish (*Universo*) languages that introduce the mission's science and engineering goals.	*Expert Review*	Scientifically accurate
SSV[31]-1	Inspire and motivate students and the public through realistic visualizations about Mars exploration.	Create a 6-minute HDTV animation displaying a summary of events from the time of the Phoenix launch until its arrival at Mars.	*Expert Review*	Scientifically accurate

METHODS OF EVALUATION (CONTINUED)

Throughout the life of the program, implementation evaluations, designed to ensure that activities are being carried out, will be utilized in the following ways:

- Implementation evaluations will be conducted to ensure E/PO partners are developing their activities as they described in their statements of work.
- Expert reviews will be conducted to determine the extent to which E/PO activities match their objectives.
- Interviews will be held with the project managers and, when appropriate, participants.

To measure educational gains made by participants in various E/PO activities, pre and posttests will be created by the evaluation team along with the assistance of Phoenix E/PO partners. These tests will:

- Evaluate the activities' effectiveness in meeting their objectives and goals of the E/PO program.
- Consist of six to ten multiple-choice questions for each topic area that will measure the educational gains of the participants in E/PO activities and consequently provide evidence for attainment of program goals. For younger participants, particularly K-4, focus group interviews may take the place of pre and posttests.

Long-term impact of the E/PO program will be measured by:

- Conducting follow-up surveys with participants one to two years after participation when appropriate.

[30] McDonald Observatory – The University of Texas
[31] Jet Propulsion Laboratory's Solar System Visualizations Project

- A universal workshop evaluation form designed in collaboration with partners and distributed to teachers who participate in Phoenix E/PO workshops, and then re-distributed again one to two years later to follow-up on teacher implementation of the workshop materials when appropriate.

Justification for Mixed Methods Testing

Evaluation for these initiatives will document change – change in attitudes and change in knowledge that result from participation in E/PO activities. The evaluation team will employ the use of multiple methods throughout the duration of the program as a means of validation of results (e.g., observations, interviews, surveys, pre- post-assessments, document analysis). This approach to program evaluation is consistent with the *Standards for Educational and Psychological Testing* (American Educational Research Association, American Psychological Association and National Council on Measurement in Education[32], 1999) and No Child Left Behind[33] (2002) recommendations. [Note: to reach the level of rigor aspired to in the evaluation, we draw on the standards for large-scale evaluation approaches primarily employed for making national and local policy decisions about education.]

When appropriate and possible, we will use pre and posttests designed to elicit participant understanding of the concepts that comprise the content goals of E/PO programs involved in this mission (see e.g., Baker, et al[34], 1996; Linn, et al[35], 1991; and Pellegrino, et al[36], 2001). In order to determine the extent which participant conceptual and factual understanding changed as a result of participation, we will administer pre-instruction knowledge surveys (or, in traditional evaluation language, pre-treatment). These questions will be designed to focus on the content areas covered in these initiatives as a means of providing baseline measures of participant knowledge. Following instruction/participation, we will administer the same questions in the form of a post-survey so that learning gains can be gauged. The learning goals for these initiatives will drive instrument development (e.g., are there some questions that should be open-ended; do concept questions based on misconception research already exist for these content areas; etc.). Results of the measure of content learning gains will be verified and validated through the application of the multiple methods approach embedded in all aspects of the evaluation plan.

Development and Implementation of Evaluation Methods

The evaluation team will use instruments developed internally. These instruments will be used for the various E/PO activities in concurrence with Phoenix E/PO partners. Surveys

[32] American Educational Research Association, American Psychological Association & National Council on Measurement in Education (1999). *Standards for educational and psychological testing*; Washington, DC: American Educational Research Association.
[33] No Child Left Behind Act of 2001, Pub. L. No. 107-110, 115 Stat. 1425 (2002).
[34] Baker, E.L., Abedi, J., Linn, R.L. & Niemi, D. (1996). Dimensionality and generalizability of domain-independent performance assessments. *Journal of Educational Research, 89,* 197-205.
[35] Linn, R.L., Baker, E.L. & Dunbar, S.B. (1991). Complex performance-based assessment: expectations and validation criteria. *Educational Researcher, 20,* 15-21.
[36] Pellegrino, J., Chudowsky, N. & Glaser, R. (eds.) (2001). Knowing what students know: The science and design of educational assessments. Committee on the Foundations of Assessment, Board of Testing and Assessment, Center for Education. Division of Behavioral and Social Sciences and Education, National Research Council). Washington, DC: National Academy Press.

created by the evaluation team will be peer-reviewed and field-tested before implementation. Surveys will be universal, i.e. every teacher workshop will use the same survey, every museum exhibit will have use the same survey, etc. Interview questions will be developed by the evaluation team along with a rubric. This rubric will help measure success by providing quantitative scores from information obtained through interviews. Observations will be conducted using pre-existing observation protocols or protocols developed by the evaluation team. An observation checklist will be developed by the evaluation team. This checklist will look for certain behaviors exhibited by museum visitors, workshop participants, etc.

Phoenix E/PO partners will have the opportunity to use these instruments should they choose to. Because these instruments are universal, these instruments will be developed during spring 2005 before the main thrust of Phoenix E/PO activities begin. Table E-8 outlines the implementation of evaluation instruments. Included in the table are the types/methods with which E/PO tasks will be evaluated, the timeframe in which the tasks will be evaluated, and the expected date the evaluations will be completed. Evaluation instruments will be implemented during E/PO activities or immediately following (e.g., teacher workshop surveys will be given at the end of sessions or immediately following the completion of the workshop). However, exact dates for the implementation of evaluation instruments for certain activities are not yet known. These instances are denoted by TBD. Completion of evaluations will include the collection and analysis of all relevant data.

Table E-8. Implementation of Evaluation Instruments[37]

Activity Code	Task(s) Evaluated	Evaluation Type/Method(s)	Evaluation Conducted	Evaluation Completed
ASG-1	BalloonSat teams selected	Implementation	Spring 05, 06, 07, 08 (specific dates TBD)	08/15/05 (2006, 2007, 2008)
ASG-2	Teacher workshop materials delivered by Phoenix E/PO & BalloonSat	Implementation	May/June 05, 06, 07, 08 (specific dates TBD)	08/15/05 (2006, 2007, 2008)
ASG-3	Balloon payload launches	Implementation	Fall/Spring of 05, 06, 07, 08 (specific dates TBD)	08/15/05 (2006, 2007, 2008)
ASU-3	Phoenix E/PO materials sent to ASU for teacher workshops in Spring and Fall 05	Implementation	Spring/Fall 05	03/15/06
LaRC-3	NASA Connect™ middle school activity DVD delivery to Phoenix E/PO	A) Implementation B) Formative-Surveys, Pre and posttests	A) 07/23/05 B) TBD	A) 08/15/05 B) TBD

[37] Evaluation Type/Method(s): Type - implementation, formative, or summative; Method(s) – survey, observation, interview, etc.

Activity Code	Task(s) Evaluated	Evaluation Type/Method(s)	Evaluation Conducted	Evaluation Completed
SEMAA-1	Final robotics curricula available for printing and posting on Phoenix website and National SEMAA office	Implementation	08/31/05	03/15/06
SSI-1	"Big Dig" interactive exhibit deployed with *Marsquest*	Implementation	09/15/05	03/15/06
SSI-1	"Big Dig" interactive exhibit duplicate to Phoenix E/PO	Implementation	09/15/05	03/15/06
LaRC-4	NASA Destination Tomorrow™ DVD delivery to Phoenix E/PO	A) Implementation B) Formative-Surveys	A) 09/30/05 B) TBD	A) 03/15/06 B) TBD
AAF-1	Phoenix science and engineering exhibit, including model of spacecraft, deployed at Pima Air and Space Museum	A) Implementation B) Formative – visitor counts, interviews, and observations	A) 12/01/05 B) Summer 06	A) 03/15/06 B) 03/15/07
MO-1	Seven, two-minute *StarDate* and *Universo* radio programs	A) Implementation B) Formative – expert review	A) 2006 (specific date TBD) B) TBD	A) TBD B) TBD
ASU-3	Phoenix E/PO materials sent to ASU for teacher workshops in Spring and Fall 06, 07, 08 & 09	A) Implementation B) Formative – survey, observations	A) Spring 06 B) Spring 06 (observation); Fall 06 (survey)	A) 08/15/06 B) 08/15/06; 03/15/07
ASU-1	Beta-test print-based soil properties curriculum module delivered to Phoenix E/PO	Implementation	02/01/06	03/15/06
AAF-1	Phoenix science and engineering duplicate exhibit, including model of spacecraft, deployed at Phoenix SOC	A) Implementation B) Formative – visitor counts, interviews, and observations	A) 04/01/06 B) Summer 06	A) 08/15/06 B) 03/15/07
AAF-2	Solar system exploration exhibit deployed at Pima Air and Space Museum	A) Implementation B) Formative – visitor counts, interviews, and observations	A) 04/01/06 B) Summer 06	A) 08/15/06 B) 03/15/07
AAF-2	Duplicate solar system exploration exhibit deployed at Phoenix SOC	A) Implementation B) Formative – visitor counts, interviews, and observations	A) 04/01/06 B) Summer 06	A) 08/15/06 B) 03/15/07
ASU-2	Beta-test print-based soil habitability curriculum module delivered to Phoenix E/PO	Implementation	04/01/06	08/15/06
SSI-2	On-line "Big Dig" – "Virtual Robot" deployed through Phoenix mission	Implementation	06/01/06	08/15/06

Activity Code	Task(s) Evaluated	Evaluation Type/Method(s)	Evaluation Conducted	Evaluation Completed
SSI-2	Upgrade *Family Guide to Mars* with Phoenix science	Implementation	06/01/06	08/15/06
PSIP-1	Begin PSIP prototype at Phoenix SOC	Implementation	08/01/06	08/15/06
PSIP-1	Evaluation report[38] to Phoenix E/PO	Implementation	09/30/06	03/15/07
ASU-1	Beta-test web-based soil properties distance learning module posted on ASU website	Implementation	12/01/06	03/150/7
MO-1	Seven, two-minute *StarDate* and *Universo* radio programs	A) Implementation B) Formative – expert review	A) 2007 (specific date TBD) B) TBD	A) TBD B) TBD
ASU-2	Beta-test web-based soil habitability distance learning module posted on ASU website	Implementation	02/01/07	03/15/07
AAF-3	Phoenix mission stories exhibit deployed at Pima Air and Space Museum	Implementation	04/01/07	08/15/07
SSI-4	*Family Guide to Mars* and Phoenix E/PO materials presented at 2007 4-Corners Alliance for Space Science Workshop	Implementation	Summer 07	08/15/07
AAF-4	Current Phoenix mission information exhibit deployed at Pima Air and Space Museum	Implementation	08/01/07	08/15/07
ASU-1	A) Final version of print and web-based soil properties curriculum modules B) Teacher implementation in classrooms	A) Implementation B) Formative – surveys, pre and posttests	A) 09/01/07 B) TBD	A) 03/15/08 B) TBD
ASU-2	A) Final version of print and web-based soil habitability curriculum modules B) Teacher implementation in classrooms	A) Implementation B) Formative – surveys, pre and posttests	A) 09/01/07 B) TBD	A) 03/15/08 B) TBD
PSIP-2	List of selected PSIP teams to Phoenix E/PO	Implementation	11/01/07	03/15/08
PSIP-2	Orientation information to PSIP teams and Phoenix E/PO	Implementation	11/01/07	03/15/08

[38] This evaluation (and final evaluation) is an internal evaluation conducted by the PSIP coordinator Cassie Bowman. (See PSIP statement of work.)

Activity Code	Task(s) Evaluated	Evaluation Type/Method(s)	Evaluation Conducted	Evaluation Completed
PSIP-2	Begin preparation of PSIP teams	Implementation	01/01/08	03/15/08
ASU-4	MESDT web site ready for operation	Implementation	01/01/08	03/15/08
ASU-4	A) MESDT operations commence concurrently with Phoenix landing B) Student participation in MESDT	A) Implementation B) Formative- pre and posttest	A) 06/01/08 B) TBD	A) 08/15/08 B) 08/15/08
PSIP-2	Begin PSIP participation with Phoenix mission	Implementation	06/01/08	08/15/08
PSIP-2	Final evaluation report to Phoenix E/PO	Implementation	12/01/08	12/01/08

DISCUSSION OF POSSIBLE STUDIES

One activity of the evaluation team described in the Phoenix E/PO Implementation Plan is leading the development of scholarly publications describing lessons learned by the E/PO team. Much of the data that will need to be collected to conduct such studies will be readily available through the evaluations of Phoenix E/PO activities and workshops. Among many possible topics, a list of potential topics which might be studied would include:

- A comparison of mission scientist and engineer outreach efforts in a mission-level E/PO program versus instrument-level E/PO programs. Since Phoenix science team members are not coordinating E/PO, this study would investigate the amount of time science team members spend on E/PO versus time spent when E/PO is coordinated by science team members in an attempt to shed light on how best to involve scientists in E/PO.
- A snapshot of educator (formal/informal) attitudes toward NASA E/PO programs. This study would look for a correlation between educators who use NASA E/PO products and their proximity to NASA centers (e.g. JPL, GSFC, JSC, etc.) or the virtual closeness of personal relationships with scientists. If there is a high correlation between close proximity and higher educator usage of products, why is it that educators farther in distance from NASA centers do not use them?
- Conduct a multivariate, longitudinal study on the long-term effects of Phoenix E/PO activities on student understanding of the nature of science and attitudes toward science and STEM careers. This study will measure the extent to which PSIP students (participatory learning[39]) develop a better understanding of the nature of science compared to non-PSIP[40] students (simulated learning[41]). Two questions that will be probed in the study are:

[39] Inquiry learning in which students work "elbow to elbow" with scientists in a community of learning. This can take place either in scientists' field work or a scientific laboratory.
[40] The students in this study representing non-PSIP students would be those students who participate in activities using inquiry and scientific processes, but involves no contact with scientists.

1. To what extent does participation in the PSIP influence students' pursuit of a science, technology, engineering, or mathematics (STEM) career as compared to non-PSIP students?
2. To what extent does participation in the PSIP improve students' attitudes toward science as compared to non-PSIP students?

[41] Simulated learning does not imply simulated science; rather it simulates the scientific learning community. Students still learn scientific processes of inquiry, but without being in the presence of scientists.