

SPACEWARD BOUND: FIELD TRAINING FOR THE NEXT GENERATION OF SPACE EXPLORERS.

C. P. McKay¹, L. K. Coe², M. Battler³, D. Bazar⁴, P. Boston⁵, L. Conrad⁴, B. Day⁴, L. Fletcher², P. Graham⁶, R. Green⁴, J. Heldmann², T. Muscatello⁶, J. Rask², H. Smith⁷, H. Sun⁸, R. Zubrin⁶ ¹Space Science Division, NASA Ames Research Center Moffett Field, CA 94035, cmckay@mail.arc.nasa.gov, ²NASA Ames Research Center Moffett Field, CA 94035, ³University of New Brunswick, Saint John, NB Canada E2L 4L5, ⁴Planners Collaborative, NASA Ames Research Center, Moffett Field, CA 94035, ⁵New Mexico Institute of Mining and Technology, Socorro, NM 87801, ⁶Mars Society, Lakewood, CO 80215, ⁷Utah State University, Logan, UT 84341, ⁸Desert Research Institute, Las Vegas NV 89119.

Introduction: Spaceward Bound is an educational program developed at NASA Ames in partnership with The Mars Society, and funded by the Exploration Systems Mission Directorate (ESMD) at NASA Headquarters. The focus of Spaceward Bound is to contribute to the training of the next generation of space explorers by having students and teachers participate in the exploration of scientifically interesting but remote and extreme environments on Earth as analogs for human exploration of the Moon and Mars. 2006 was the first year of the program.

Why Education: The generation of students who will become the first astronauts to return to the Moon (in 2018) and explore Mars are currently in middle school. The senior managers and scientists that will plan and organize these missions are now in college and graduate school. In order to fulfill NASA's mission, these students need to learn about exploration science. This training consists of both STEM (science, math, engineering, and technology) education, as well as education that leads to the understanding of exploration concepts and skills. In order to provide the latter, teachers must be trained not only in exploration science content and skills, but also pedagogy and pedagogical content knowledge. The Spaceward Bound program targets traditionally underserved and underrepresented communities by recruiting teacher participants from the NASA Explorer Schools Program that selects schools from these same populations (see: <http://quest.nasa.gov/projects/spacewardbound>).

Fieldwork in the Atacama: The program is comprised of two expeditions per year. The focus of one expedition is to involve teachers in authentic fieldwork so that they can bring that experience back to their classrooms and assist in the development of curriculum related to human exploration of remote and extreme environments. In June 2006, seven middle school teachers from around the U.S. teamed with seven teachers from Antofagasta, Chile to work alongside scientists in exploration of the Mars-like soils in the Atacama Desert in Northern Chile.

This expedition was comprised of three components: 1) Education, 2) Science, 3) Technology. The overarching theme that united the three components was exploration. Scientific activities were approached

from the perspective of how similar activities would be performed on the Moon or Mars, how research here on Earth could assist the analysis of research results from the Moon/Mars, and what infrastructure was needed to support the research which will, in turn, need to be provided on the Moon/Mars surface. The technology component was approached similarly.



Figure 1. View of the University of Antofagasta Desert Field Station at Yungay Chile in the hyperarid core of the Atacama Desert.

Education activities were guided by the motivation to train teachers to inspire students to be the next generation of explorers. While exploration is often presented in classrooms as a motivational supplement to existing curriculum, and components of exploration are taught, no pedagogy of exploration itself exists.

A true pedagogy of exploration would provide unparalleled experience in affective and cognitive motivations such as curiosity, discovery, bravery, disappointment, tenacity, flexibility, etc. But it also requires a synthesis of currently segregated academic disciplines, i.e. "hard" science, "soft" science, and non-science. In modern schools, curriculum and pedagogy are ill-equipped to embrace this synthesis, and much less able to develop the content, concepts, and skills to teach it.

In a broader sense, however, the contribution of this expedition to the education community as a whole (including research) and to NASA is the creation of a program that enables the amalgamation of the expertise and experience of master teachers with the knowledge,

practice, and experience of today's explorers to begin the conceptualization and development of a pedagogy of exploration.

Analysis of the teacher's final reports (see web site) reveals how this new pedagogy may look. It also provides clear evidence of the intrinsic power of authentic exploration to motivate, engage, frustrate, and thrill.

Mission Simulations at MDRS: The focus of the second expedition was to enable students at the upper undergraduate and graduate level to participate as crew members in two-week long immersive full-scale simulations of living and working on the Moon and Mars at the Mars Desert Research Station (MDRS), established and operated by The Mars Society. The first Spaceward Bound 2006 crew rotations at MDRS took place between November 2006 and March 2007.



Figure 2. The Mars Society Desert Research Station in the desert near Hanksville, Utah.

The students were interested, enthusiastic, and came from a variety of schools and backgrounds. At the start of each simulation, we held a meeting to discuss the shape and goals of the Spaceward Bound student activities. The students were very excited by the fact that they were defining and creating this training program through their simulations. Interacting with these students in the field was inspiring for the science PI, as well as for the students.

From these discussions have emerged three particular products that will be used to enhance Spaceward Bound student activities in the future:

1. The Habitat User Guide and Operations Manual.
2. Spaceward Bound Training Curriculum. There are a range of skills that are essential for field astronauts working on Mars or in Mars-analog field environments on Earth. These include working in bulky suits, mechanical skills, equipment repair, biology and geology skills, greenhouse operations, electronics, navigation, field documentation, ATV operation, etc.

We have developed a training course for Spaceward Bound that will train every student in these basic skills.

3. "The Lovely Planet" Guide to Science and Field sites at MDRS. This will be a series of mini-reviews and orientations for each site or topic of research at the Hab, written at the Scientific American-level with images, detailed maps, etc. Note that these three products are being prepared by the students. See poster by the students at this session.

Future Expeditions: To expand the success of Spaceward Bound 2006, we plan to reach even more students and teachers and continue developing the approach and methodologies for the field training of the next generation of space explorers and those who are teaching them. The next expedition (for teachers) in March/April 2007, will take place at the California State University Desert Studies Center (CSUDSC) in Zzyzx, CA—on the western edge of the Mojave National Preserve in Southern California. Teachers will work with scientists and engineers to investigate lunar and planetary surface systems, e.g. extended surface operations, environmental analysis, robotics, radiation protection, spacesuits, and life support. They will also investigate human machine interface software and hardware.

As a result of Spaceward Bound 2006, we will incorporate two new concepts into the design of the teacher portion of Spaceward Bound 2007. First, in partnership with San José State University we intend to recruit pre-service teachers and in-service teachers from the NASA Explorer Schools and Mojave area. Second, in partnership with the National Park Service, we will recruit in-service teachers from the Mojave area and from NASA Explorer School teachers nationwide. We found during the Atacama Expedition that collaboration between local and non-local teachers was extremely beneficial.

In the fall of 2007, we will again sponsor Spaceward Bound Crew student simulations at the MDRS.

One of the keys to the success of Spaceward Bound's pilot year was the training of participants prior to the field expedition via utilization of the NASA Distance Learning Network (DLN) and webcasting. We will continue this aspect of the program for all expeditions.

Another key to success was the incorporation of a broadcast component into the program to significantly increase the quantity and quality of participation by teachers/students not on the expeditions. While the technical challenges involved in broadcasting from Chile were significant, and only possible via partnership with the NASA Robotics Alliance Project, both Cal State Desert Center and MDRS already have the infrastructure to webcast from these locations.