

**LEADERSHIP CONTRIBUTIONS TO PLANETARY EXPLORATION AND AEROSPACE: NASA PLANETARY SCIENCE SUMMER SEMINAR MISSION STUDIES AND ALUMNI 1999-2017.** C. J. Budney<sup>1</sup>, L. L. Lowes<sup>1</sup>, K. L. Mitchell<sup>1</sup>, and A. S. Wessen<sup>1</sup>, <sup>1</sup>NASA Jet Propulsion Laboratory, 4800 Oak Grove Drive, Pasadena, California 91109.

**Introduction:** Sponsored by NASA's Planetary Science Division, and managed by the Jet Propulsion Laboratory (JPL), the Planetary Science Summer Seminar prepares the next generation of engineers and scientists to participate in future solar system exploration missions. Ten years after its inception in 1989 in a lecture format, JPL evolved the experience to focus on the process of developing a robotic planetary exploration mission concept into reality through concurrent engineering, mentored by members of JPL's advance project design team "Team X".

**The Planetary Science Summer Seminar Experience:** PSSS is an intensive one-week team exercise at NASA's Jet Propulsion Laboratory's Project Design Center, preceded by a series of about 10 weekly preparatory webinars and assignments (requiring 8 hours per week). Under the mentorship of a lead engineer and a lead scientist (most recently, Dr. Charles Budney and Dr. Karl Mitchell), students select, design, and develop a mission concept from the Planetary Science Decadal Survey, following the guidelines of the NASA New Frontiers Announcement of Opportunity.

During the preparatory webinars, students select the mission and science goals from options based on high-priority missions as defined by the scientific community, and develop a preliminary suite of instrumentation and a science traceability matrix. Students have both a science team role and a mission development role with a JPL Team X mentor.

Once at JPL, students participate in a series of Team X project design sessions — their mentors aid them in finalizing the design of their mission and instrument suite, and in making the necessary trade-offs to stay within the cost cap. Tours of JPL facilities highlight the end-to-end mission life cycle. At week's end, students present their Concept Study to a "proposal review board" of JPL scientists and engineers and NASA Headquarters executives, who feed back the strengths and weaknesses of their proposal and mission design.

**Participants:** Applicants are sought who have a strong interest and experience in careers in planetary exploration, and who are science and engineering postdocs, recent PhDs, doctoral or graduate students, and faculty teaching such students. Disciplines include planetary science, geoscience, geophysics, environmental science, aerospace engineering, mechanical engineering, and materials science.

Participants are selected through a competitive review process, with selections based on the strength of the application and advisor's recommendation letter.

The majority of students come from top US universities with planetary science or aerospace-related engineering programs, representing over 50 different universities total since 1999.

In 2017, 50% of the students were women, continuing the upward trend in gender balance of participants since 1999 (almost doubling in that time).

**Current Employment.** 617 individuals have participated in the Team X-based PSSS sessions since 1999. In winter 2017/2018, we conducted an online search to update their current occupations (primarily through LinkedIn and university and corporate websites, updating the initial search done in 2015 [1]). Results by industry sector show the majority are employed or conducting postdoctoral research at NASA Centers; are employed at Federally-Funded Research and Development Centers, science research organizations and aerospace companies; or they are university faculty or staff. A number of alumni, most from cohorts from the most recent years, are students or postdocs at universities. The majority of the remaining alumni are employed in other technical fields.

**Leadership Contributions: Alumni Leadership.** Information gleaned from the alumni employment study includes positions of leadership in planetary exploration and aerospace fields at institutions of employment or broader organizations serving the larger field. Alumni currently hold positions such as Program Officers at NASA and the National Academies; planetary science and related field missions and instrument principal investigators; a NASA astronaut candidate; project managers, vice presidents, directors of divisions for NASA or engineering firms; tenured university faculty and department chairs; institute directors; and founders/chief executive officers of independent technical and education companies. Leadership also includes efforts for organizations serving the professional fields, such as the AAS DPS chair. Many more alumni are making significant technological and scientific contributions. PSSS supports the development of skills needed for leadership and collaboration through its design as an authentic learning experience [2].

**Planetary Science Mission Studies.** While not a requirement, the mission concept studies that students develop during PSSS sessions can be of interest to the

broader community, as point designs in the trade space of potential missions or as novel selections and usage of science instrumentation. In 2017, for example, PSSS participants developed a concept for a mission to study Centaur objects, a cutting edge scientific destination lacking point designs in the trade space for potential missions at that time. Clarifications in the classification of Centaur objects by both photometric color and orbital dynamics (to distinguish from other debris) were necessary and limited the choice of specific destinations for the study. Students from a session in 2012 were invited to present their Venus Atmosphere, Descent, and Environmental Researcher mission concept at the 2013 Venus Exploration Analysis Group meeting. Some of the design elements from a 2003 PSSS Mars Geophysical Lander mission concept [3] were realized in NASA's InSight (Interior Exploration using Seismic Investigations, Geodesy and Heat Transport) mission, which is scheduled for launch in May 2018.

**Implementation:** The Planetary Science Summer Seminar is implemented by the JPL Education Office in partnership with JPL's Team X Project Design Center. URL: <http://psss.jpl.nasa.gov>

**References:**

- [1] Budney, C. J. et al. (2016) Career and Workforce Impacts of the NASA Planetary Science Summer School. *LPSC Meeting #47*, Abstract #1208  
<http://www.hou.usra.edu/meetings/lpsc2016/pdf/1208.pdf>
- [2] Herrington, J. et al. (2014) Authentic Learning Environments, *Handbook of Research on Educational Communications and Technology*. 401-412.
- [3] Shiro, B. R. et al. (2013) Mars Geophysical Lander Mission: A Mission Concept from the 2003 NASA Planetary Science Summer School. *LPSC Meeting #44*, Abstract #1706  
<https://www.lpi.usra.edu/meetings/lpsc2013/pdf/1706.pdf>