Team X: Planetary Spacecraft Development

EAS 4801/8801
Available for 1-3 credit hours, and S/U grading
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Objectives

Planetary science relies on spacecraft missions to explore the solar system. Such missions require highly developed science and engineering concepts in order to plan, develop, and execute these exciting activities. During the proposal development stage, scientists and engineers work together to prepare full studies of the mission, from its instrumentation and spacecraft accommodation, to launch, trajectories and orbital tours. At NASA's Jet Propulsion Laboratory, these are referred to as "Team X" studies, where Team X is the name of the group of skilled scientists and engineers that craft the mission. This course satisfies the Astrobiology certificate mission design course requirement.

In this term of the course, students from both engineering and science programs will form a full engineering and science team to complete a mission development study of the *Vertical Entry Robot for Navigating Europa (VERNE),* a proposed mission concept for a melt probe and ocean sampling vehicle that could launch to Europa, Jupiter's innermost icy moon, as soon as the late 2030's. The mission in its conceptual stage includes a three-stage through-ice vehicle (the landing stage will not be studied here). The designed spacecraft must survive a 3-year lifetime, 15 km or longer trip through the ice to the ocean, or into the shallow water, and the study will identify and mitigate major risks. The spacecraft will be required to deliver sampled materials to the payload system, helping to achieve the science goals of understanding how Europa evolved and whether life has originated there. These are key goals of the Astrobiology Roadmap, the 2013 NAS decadal survey, and the central mission of NASA. Students will work together to study the complete mission profile. The course will be taught for 4 semesters, and students can participate for any number of semesters. During the four-semester course, some of the students will have the opportunity to travel to present the concept at various meetings.

VERNE Study Objectives

This activity will work to accomplish four main Mission Design tasks:

1) Develop design for a nose cone hybrid thermo-mechanical drill for the front of the vehicle and interface between the vehicle and nose cone (Drill Module with RTGs).

2) Develop designs for the VERNE science bay adapted from already-proven vehicles for through-ice and ocean operations to a fully encapsulated monolithic body, and ensure the spacecraft can deliver samples to the vehicle sensors (Science Module).

3) Develop a design for a "base station" for the rear of the spacecraft that would act as a communications center for ocean sampling activities. (Comms Module)

4) Prove a concept through modeling and testing for acoustic communication through the ice from acoustic pucks deployed behind the vehicle to relay information to the surface station.

Science: To support each of these activities, the science team will study science sensors and help the team to understand how the environmental conditions at Europa including radiation, chemistry, mechanical, ocean and liquid properties affect the mission design.

Schedule:

Fall 2019—Preliminary design phase begins, science framework established

Spring 2020—Preliminary design completes, Preliminary Design Review

Summer 2020—Concept Design Review

Fall 2020—Prototyping of low-TRL equipment to benchtop functionality

Spring 2020—Prototyping complete and mission concept fully developed

Grading

This is a project course. We will be developing a full concept for the spacecraft. Each individual will be responsible for contributing to the overall team as well as to take an active role in a subsystem project. **You are expected to work all semester on this project, it is not a book report!**

Grades will be determined as follows:

In Class Discussions:	40%
Subsystem Final Project:	50%
Final Presentation:	10%

Reading

There is no required text for this course. However, all students will be expected to read the papers and materials assigned in class, in addition to any they will present.

The goal for this course is to understand not only how to design a spacecraft mission, but also to interact with the science and technology drivers that make missions possible, and to work with scientists, engineers to accomplish the task.