THE ACADEMIC AO PROJECT: THE RADIO ASTRONOMY ON THE MOON AND EUROPA MISSIONS. M.W. Turner[1], M.P.J. Benfied[1], P.A. Farrington[1], C.J. Runyon[2], and J. Hakkila[2], [1]The University of Alabama in Huntsville (301 Sparkman Drive, Huntsville, AL 35899), [2]College of Charleston (66 George Street Charleston, SC 29424).

Introduction: The NASA Discovery/New Frontiers/Lunar Quest Program Office is continuing to support an innovative educational program that seeks to train the next generation of scientists and engineers by providing the opportunity for them to respond to an official NASA Announcement of Opportunity (AO) [1]. This program, called the Academic AO Project, is divided into the traditional Discover/New Frontiers roles, with the overall project management and engineering functions being lead by Drs. Phillip Farrington, P.J. Benfield, and Matt Turner at The University of Alabama in Huntsville, while the science teams are lead by Drs. Cassandra Runyon and Jon Hakkila, at the College of Charleston. Other university partners include ESTACA (Ecole Supérieure des Techniques Aéronautiques et de Construction Automobile) University in Paris, France, Alabama A&M University, in Huntsville, AL, and California State University in Los Angeles, CA.

The first two iterations of this project were single-semester design courses [2-3], in the Spring and Summer semesters of 2010, while the current iteration expands the length of the project to two academic semesters (i.e., Fall 2010 and Spring 2011). During each iteration, student teams develop one of the missions from the Discovery or New Frontiers Announcement of Opportunity (AO) – this includes all the scientific justifications and conceptual engineering design. The end product from this project will be proposals, per the AO.

The 2010 Spring and Summer semester courses followed the 2009 New Frontiers AO, while the academic year (AY) 2010-11 (Fall 2010 through Spring 2011) are following the 2010 Discovery AO. There are two mission for the AY 2010-11 project – (1) a Radio Astronomy on the Moon (RAM) mission, which seeks to place one or more arrays of radio telescopes on the far side of the Moon, and (2) a Europa exploration mission, which seeks to map and determine the geologic history of Europa. While the goal of this academic program is to teach scientists how to be scientists, engineers how to be engineers, and all participants how to properly communicate with each other and to work together as a team, the authors believe that the students, with their propensity to think "outside of the box," will also design some interesting missions that will be valuable to future Principal Investigators and mission planners.

Background: The engineering and project management component of the Academic AO Project is lead by the capstone senior design course in the Department of Mechanical and Aerospace Engineering (MAE) at The University of Alabama in Huntsville (UAH). This class is known as the "Integrated Product Team" (IPT) class because the students work in interdisciplinary teams to solve a common design problem, and it draws from departments across the university, including MAE, Industrial and Systems Engineering and Engineering Management, Electrical Engineering, English, and Art. Since 1993, the IPT class has designed solutions for 25 projects, approximately half of which were from the Department of Defense and 40% from NASA. Until this project, the IPT class has always worked with an engineering customer. With this project, science is the primary objective of the mission; therefore, the IPT class needs a Science Definition Team (SDT) to define the baseline and threshold science objectives for each mission. The "NASA Space Missions" course, co-managed at the College of Charleston by the Departments of Geology/Environmental Geosciences and Physics/Astronomy, is currently being added into the College of Charelston curriculum to develop the science objectives for each mission. This interdisciplinary course merges the skills of upper level students majoring in space-related sciences with those of students having introductory-level science backgrounds.

Academic AO Organization: Consistent with traditional proposal organizations, the Academic AO Project is divided into three branches: (1) the Science Definition Team, (2) the Spacecraft Developer Organization (SDO), and (3) the Education/Public Outreach (EPO) activity.

The role of the Science Definition Team is filled by approximately 30 sophomore-through-senior level students from the College of Charleston (CofC). Drs. Cassandra J. Runyon, from the Department of Geology and Environmental Sciences, and Jon Hakkila, from the Physics and Astronomy Department, at the College of Charleston will mentor their students, as they take on the responsibilities of Principal Investigator(s) (PI), Co-Investigators (Co-I), Science Representatives, Instrument Leads, and Science Operations Leads. Just as in a real SDT , the students will define the baseline and threshold science goals, objectives, measurement requirements, and instrument functional requirements,

based on the 2010 Discovery AO. The PI and SDT will be responsible for completing sections D and E of the New Frontiers AO response, as well as the Science Traceability Matrix, which defines mission functional requirements for the engineering team.

The role of the SDO will be filled by the UAH IPT class, as well as senior engineering design classes from ESTACA, Alabama A&M, and Cal State LA. The SDO will be responsible for Program Management (PM), Systems Engineering (SE), Cost, Risk, Programmatics, Propulsion, Attitude Control, Command and Data Handling, Software, Power, Thermal, Structures, Telecommunications, and EPO management. The SDO will be responsible for completing sections F and G of the Discovery AO response, as well as the Mission Traceability Matrix.

In "the real world" when a team responds to a Discovery AO, the EPO aspect typically includes a component designed by university students. Since the engineering and science teams for the Academic AO Project are university students, the EPO experiment will be designed by high school students. Multiple high schools from the North Alabama area are currently working with students from UAH to develop student experiments which will "fly" aboard the spacecraft developed by the SDO. This initiative is known as the Innovative Student Project for the Increased Recruitment of Engineering and Science Students (InSPIRESS) program.

Approach: For AY 2010-11, the Academic AO project has two missions – Radio Astronomy on the Moon (RAM), and Europa. The RAM mission was chosen as a joint SMD and ESMD venture. Students will utilize precision landing technologies to design a mission that places one or more arrays of radio telescopes on the far side of the Moon. The Europa mission was chosen as a representative outer-planet mission. Furthermore, the Europa mission allows for interaction/observation of Jupiter, as part of the science enhancement option. Three teams (SDT+SDO) compete for the "best" design for each of the two missions. The winning team for each project is chosen by a Review Board made up of professionals from NASA, DoD, and private industry.

During this second year of the Academic AO Project, the overall science and engineering mission design has been extended to two semesters. During the first semester (Fall 2010), the SDT developed the overall science objectives, baseline and threshold mission objectives, and the science tracability matrix. The SDO developed the preliminary mission tracability matrix, and performed an overall mission architecture analysis based on the science objectives. During the Spring 2011 semester, the SDT will refine the science mission and detail the instruments to be used, while the SDO will develop the detailed spacecraft and mission design (a pre-Phase-A, up to Phase-A level of fidelity). During both semesters, graduate students at UAH serve as the mission design engineers, performing the trajectory trades and analyses.

Finally, during the Fall 2010 semester, instructors and students in leadership positions from the UAH teams visited the College of Charleston. During this two-day working session, PIs and engineers were able to begin mission planning and work break-down structures. Furthermore, the meetins simply offered the students a time to get to know each other.

AO Modifications. Because this is an academic exercise, ertain sections, for example, the Small Business Subcontracting Plan and the Export Control Compliance sections, have been omitted from the Academic AO. Furthermore, some of the requirements for the Master Equipment List and Funding Profiles have been reduced.

Total Disclosure. As part of the agreement with the NASA, the results of this class will be subject to a "Total Disclosure" agreement. This can be thought of as the exact opposite of a non-disclosure agreement. All the results from the class – mission analysis/design, spacecraft designs, lessons-learned, etc – will be posted on a public website at UAH upon completion of the projects and oral presentation in front of a review board of professional scientists and engineers. The authors believe that these results will benefit the PIs of future NASA missions.

Summary: The University of Alabama in Huntsville and the College of Charleston are continuing an educational program, supported by the NASA Discovery/New Frontiers/Lunar Quest Program Office, called the Academic AO Project. This project seeks to simulate the NASA AO response process in the classroom, where the undergraduate students assume the roles of Principal Investigator, Instrument Lead(s), Project Manager(s), Systems Engineer(s), Subsystem Specialists, etc. The goal of this project is to teach scientists and engineers how to communicate properly and work together to accomplish a common goal. Furthermore, the results/designs from this class will be available to the public.

References: [1] National Aeronautics and Space Administration (Release Date: June 7, 2010) *Announcement of Opportunity: Discovery 2010*. NNH10ZDA007O. Proposal Due Date: September 3, 2010. [2] Benfield, Turner, Runyon, and Hakkila. *The New Frontiers Academic AO Experiment*. LPSC 2010. [3] Turner, Benfield, Runyon, and Hakkila. *The Mars Sample Return Integrated Product Team Academic Experiment.* LPSC 2010.