

CRONUS AND OCEANUS – TWO UNDERGRADUATE TITAN LAKE LANDER MISSION CONCEPTS . M.P.J. Benfield¹, J. Hakkila², E.R. Blevins³, M.W. Turner¹, P.A. Farrington¹, and C.J. Runyon², ¹The University of Alabama in Huntsville (301 Sparkman Drive, Huntsville, AL 35899), ²College of Charleston (66 George Street Charleston, SC 29424) Southern University and A&M College (Baton Rouge, LA 70813).

Introduction: The University of Alabama in Huntsville (UAH), in conjunction with the College of Charleston (CofC) and Southern University A&M College (SUBR), developed two mission concepts for the proposed Decadel Survey Titan Lake Lander mission [1]. Two teams competed over the course of the 2011 spring and fall semesters to develop the best mission concept as determined by an external review board of scientists and engineers from both NASA and the space exploration related industry.

Background: The Titan Lake Lander Mission concepts were developed via the senior design Integrated Product Team (IPT) class at UAH. The IPT senior design class has been in operation since 1993 but not until the past few years have planetary science missions been the focus.

The IPT class focuses on having undergraduate science and engineering students at universities throughout the world work together in a competitive integrated product team structure to develop candidate spacecraft concepts for missions of interest within NASA's Science Mission Directorate. This is the third full year that the project has had the participation of undergraduate scientists from the College of Charleston acting in the role of the Principal Investigator (PI). The previous two years have shown that this team-oriented project acts as a fairly accurate representation of the conceptual design phase for Discovery and New Frontiers -type spacecraft missions with all of the issues and successes that such a process undergoes. The student scientists come from multiple disciplines, just as they may in the "real world". Together, with their engineering colleagues, the science students are learning to communicate across boundaries, create partnerships, and share new ideas as they build a team.

Titan Lake Lander Mission Organization: Two teams were formed for the Titan Lake Lander Mission competition. Each team was comprised of a Science Definition Team (SDT) led by a Principal Investigator from the College of Charleston as well as a Spacecraft Design Organization (SDO) led by a Project Manager from UAH. Each team was required to develop three elements for a mission to safely deliver a lander in one of the lakes of Titan and provide science measurements for 90 Earth days. UAH students developed the Saturn orbiter, which also served as a primary relay between Earth and the Titan lander. Students at Southern University developed the atmospheric entry vehicle, which provided protection to the lander

through entry of Titan's atmosphere. A UAH team also designed the lander, which performed the primary science investigation defined by the SDT from CofC. 21 high school teams also participated in this competition to develop an additional science payload to be accommodated on either the orbiter or lander. Figure 1 depicts the team structure for each of the two teams competing.

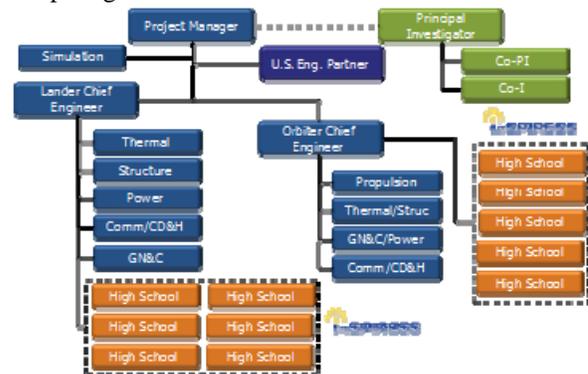


Figure 1. Titan Lake Lander Team Organization

CONCEPT I – CRONUS MISSION: The Cronus mission science objectives focused on the interaction between Titan's atmosphere and its lakes, paying particular attention to evaporation, precipitation, mixing, and the methane cycle. Figure 2 depicts the overall concept for Team 1, Cronus in the shroud for the Atlas V401 launch vehicle. The main body of the orbiter is the primary structure in the middle that provides the interface to all of the other components of the mission. The Titan Atmospheric Entry Vehicle (TAEV) is located on the top of the structure with the proposed lander concept inside.



Figure 2. Cronus Overall TLL Concept

Figure 3 depicts the concept for the Cronus lander. The Cronus team decided to have two deployables on the lander: one as a weather balloon to make atmospheric measurements above the lander and one to act

as an anchor to provide measurements of the lake below the lander.



Figure 3. Cronus Lander Concept

CONCEPT II – OCEANUS MISSION: The Oceanus mission concentrated its science objectives on Titan lake chemical composition and structure, as well as on the ability of the atmosphere to harbor pre-biotic life. Figure 4 depicts the overall concept for the TLL mission from Team 2, Oceanus, in the shroud for the Atlas V401 launch vehicle. Unlike Cronus, Oceanus chose to mount their TAEV (housing the lander) on the side of their orbiter. The primary feature of their orbiter concept is the large parabolic antenna for communication with Earth shown in Figure 4 at the top.



Figure 4. Oceanus Overall TLL Mission Concept

Figure 5 depicts the lander concept for Team Oceanus. The overall design of the lander was modeled after a donut. The team felt that this design would provide the greatest stability while on the surface of the lake. The primary feature of this lander design is the large parabolic antenna on the top of the lander. Unlike Cronus, Oceanus chose to obtain samples of the atmosphere on the way to the surface of the lake instead of after landing, thereby eliminating the need for an atmospheric balloon. Like Cronus, the team had a small deployable device (in the inner ring of the donut) that was deployed after landing to explore the bottom of the lake.

High School Teams: Figure 6 depicts a sample of the high school team designs for the TLL competition. Twenty-one teams from nine local high schools entered the competition. The teams were competing to be selected as an additional science payload on either the orbiter or the lander for both Cronus and Oceanus. After careful evaluation of the high school team's payload concept proposals by the students on Cronus

and Oceanus and evaluation of the concept briefings by professionals from NASA and the local aerospace community, teams from Lincoln County High School (TN), Lee High School, Bob Jones High School, and Holly Pond High School were selected as the winning concepts.

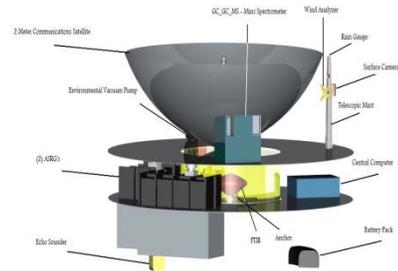


Figure 5. Oceanus Lander Concept

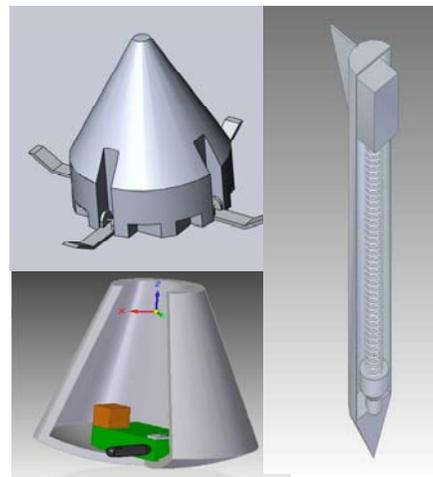


Figure 6. Selected High School Payload Concepts

Summary: Two concepts were developed for the proposed Decadal Survey Titan Lake Lander mission from the Planetary Science Division of the NASA Science Mission Directorate. An external review board, chaired by the Discovery, New Frontiers, and Lunar Quest Program Office[2], reviewed the two proposed mission concepts for the mission. Three components were evaluated for the competition: an open house booth where each team provided the local aerospace community with an overview of the proposed mission concept, a 75-page mission concept proposal which outlined the science and engineering solutions to develop a Titan Lake Lander mission, and a 30-minute briefing to the review board on the proposed mission concept. After evaluation of all of the components, Cronus was chosen the winner of the competition.

References: [1] Jet Propulsion Laboratory, Mission Concept Study: Planetary Science Decadal Survey JPL Team X Titan Lake Probe Study Final Report, April 2010. [2] <http://discovery.nasa.gov/index.cfm>