2009 Revolutionary Aerospace Systems Concepts-

Academic Linkage (RASC-AL) Program Report

Figure 1: RASC-AL students and advisors at Kennedy Space Center during 2009 RASC-AL Forum

2009 Project Manager: Marcia Gibson, National Institute of Aerospace
2009 Project and Forum Coordinator: Audrey Staples, National Institute of Aerospace
Report prepared by: Shelley D. Spears, National Institute of Aerospace

NATIONAL INSTITUTE OF AEROSPACE

EXECUTIVE SUMMARY

The Revolutionary Aerospace Systems Concepts - Academic Linkage (RASC-AL) Program is an initiative of National Aeronautics and Space Administration (NASA) and the National Institute of Aerospace. The task is performed under Contract NNL08AA00B which was awarded in 2008 for the 2008/09 academic year to the National Institute of Aerospace, 100 Exploration Way, Hampton VA 23666.

RASC-AL, Revolutionary Aerospace Systems Concepts-Academic Linkage, is sponsored by NASA and is a design project competition aimed at university-level engineering students. RASC-AL was formed to allow engineering students a chance to integrate their academics into real life learning. The RASC-AL competition and themes are announced in September, and concludes with a competition between the different teams in June.

Teams are formed and made up of engineering students and a faculty advisor. Integrating their academia with real life concepts, students take a NASA engineering challenge, and come up with design solutions.

Submitted abstracts are then evaluated by the RASC-AL Steering Committee and the top chosen teams participate in the RASC-AL Forum, an educational competition meeting held in June. Selected teams receive $5875.00 to help with expenses, registration, at the RASC-AL Forum. Teams are required to submit abstracts and to do an education and public outreach (EPO). Participating teams must submit a written report, prepare a poster, and give an oral presentation at the educational forum. Scoring is based on the above criteria and the team's EPO.

Information about the event was posted on the RASC-AL website: www.nianet.org/RASC-AL

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PROGRAM OVERVIEW

The RASC-AL Program links colleges, universities, and other academic institutions with the NASA Langley Research Center's (LaRC) Exploration Systems Mission Directorate (ESMD). Within this framework, NASA communicates and interacts with the innovative minds of tomorrow, sharing concepts and technology that will lead to opportunities for future NASA Exploration research and discovery programs. Four (4) Themes were provided as a basis for the project competition (2009 RASC-AL Themes, Appendix D)

Each year the RASC-AL Program culminates in an annual forum at which students' present written and oral reports on the results of their studies and project activities to an audience of scientists, engineers, and managers from academia, industry, and government. In addition, there is an open Steering Committee Question & Answer Session prior to Forum Adjournment.

For RASC-AL 2009 fifteen (15) projects were selected to participate in the RASC-AL 2009 Forum, held June 1-3, 2009 at the Hilton Cocoa Beach Oceanfront in Cocoa Beach, Florida. Of those fifteen (15), ten (10) teams were under graduate and five (5) teams were graduate level. 94 students, faculty, staff and Steering Committee attended the RASC-AL Forum to compete.

The two winning teams received travel stipends present their projects at AIAA's Space 2009 Conference in Pasadena, California. In addition to delivering their technical presentation, the teams and advisors participated in AIAA's Education Alley and the Future Leaders Reception. The teams were also hosted by Space Exploration Technologies Corporation for an extensive tour of their facility.

2009 STEERING COMMITTEE

Lewis Peach, Consultant – Chair
Doug Stanley – Non-Voting Co-Chair
Pat Troutman, NASA-Non-Voting
Dallas Bienhoff, Boeing
Russ Joyner, Pratt and Whitney
John Olds, SpaceWorks
John Mankins, Managed Energy Technologies, LLC & ARTEMIS
Ken Bocam, Orbital

PROGRAM OBJECTIVES

RASC-AL was formed to provide university-level engineering students the opportunity to design projects based on NASA engineering challenges as well as offer NASA access to new research and design projects by students.

Forum objectives include:

1. Provide opportunities for universities, faculty, and students to interact with NASA by working on space exploration research and design problems relevant to ESMD;
2. Infuse concepts and data from RASC-AL into ESMD program planning;
3. Develop relationships between universities and NASA that could lead to additional opportunities for student participation in other NASA student research programs;
4. Demonstrate and leverage university-NASA and potential university-NASA-industry cooperation.

As the program manager for NASA ESMD on RASC-AL, NIA served to establish, enhance, and stimulate the involvement of the academic community in NASA's Explorations Systems through the following mechanisms:

- Program interface and interaction with university space science and engineering departments and programs;
- Establish, manage, and support program forums, conferences, hosting participants from academia, government, and industry to address and discuss Space Exploration, and RASC-AL themes;
- Utilization of RASC-AL Program Website as source of information concerning Exploration and RASC-AL, identifying program features and participants from academia, government, and industry to address and discuss Exploration, and RASC-AL themes;
- Preparation and distribution of program literature and documentation, including program brochures, flyers, and proceedings;
- Program management, evaluation, and survey process for dynamic and responsive program control and improvement;
- Participant tracking and metrics to evaluate the impact of the program on the academic, government, and industry participants; and
- Yearly review and selection of university project proposals as program finalists for RASC-AL Program sponsorship at professional and technical symposia.

PROMOTION of RASC-AL

2009 RASC-AL Competition was promoted through joint press releases from NIA and NASA, and through direct mail and email to engineering faculty throughout the country. (Appendix E).

RASC-AL FORUM

Students, faculty advisors and the steering committee/judges convened in Cocoa Beach Florida from June 1-3 for the RASC-AL Forum. The Forum provided the students the opportunities to interact with some of the aerospace industry's leading experts, and present their team projects for evaluation.

Each day of the conference began at 8 AM with a guest speaker, team oral presentations, a luncheon guest speaker, followed by oral presentations and then dinner. One presenter, Kris Zacny with Honeybee Robotics, was a former RASC-AL student participant.

On the afternoon of the last day, June 3, the participants were invited to a tour of Kennedy Space Center, followed by the awards ceremony that evening. The poster session was held the afternoon of June 2nd, followed by free time and beach volleyball. (See Appendix A for full schedule of events). The students also watched the Shuttle approach for landing from the beach at the hotel.

The students received team colored RASC-AL logo polo shirts, red sports backpack, water bottle, lanyard and ball cap.

Forum objectives include:

1. Provide opportunities for universities, faculty, and students to interact with NASA by working on space exploration research and design problems relevant to ESMD;
2. Infuse concepts and data from RASC-AL into ESMD program planning;
3. Develop relationships between universities and NASA that could lead to additional opportunities for student participation in other NASA student research programs;
4. Demonstrate and leverage university-NASA and potential university-NASA-industry cooperation.

2009 RASCAL FORUM STUDENT DESIGN TEAMS

Graduate Team Participants and Winner

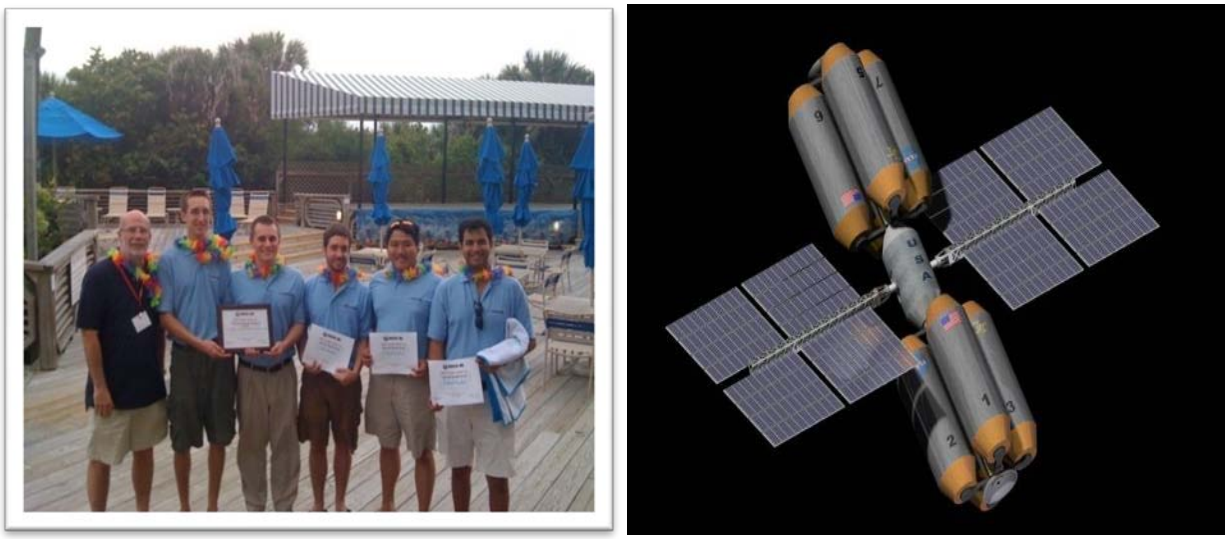

Figure 2: RASC-AL Graduate Team Winners and the LEO Propellant Depot

1st Place: Georgia Tech/NCSU-Graduate Team

Title: *Ceres: A Reusable Lunar Transportation Architecture Utilizing Orbital Propellant Depots*

Faculty Advisor: Dr. Alan Wilhite

2nd Place: University of Maryland-Graduate Team

Title: *Habitability and Life Support for Early Lunar Habitats and Rovers*

Faculty Advisor: Dr. David Akin

Graduate Teams, cont'd

Georgia Tech—Graduate Team

Title: *Antares: A Lunar Surface Systems Architecture*

Faculty Advisor: Dr. Alan Wilhite

University of Florida and Arizona State University—Graduate Team

Title: *Babel Caelestis: Progression from an Outpost to Full Lunar Settlement*

Faculty Advisor: Dr. Carl D. Crane III

The University of Texas-Austin—Graduate Team

Title: *Lunar Sample Transport and Return II*

Faculty Advisor: Dr. Wallace Fowler

UNDERGRADUATE TEAM PARTICPANTS AND WINNER

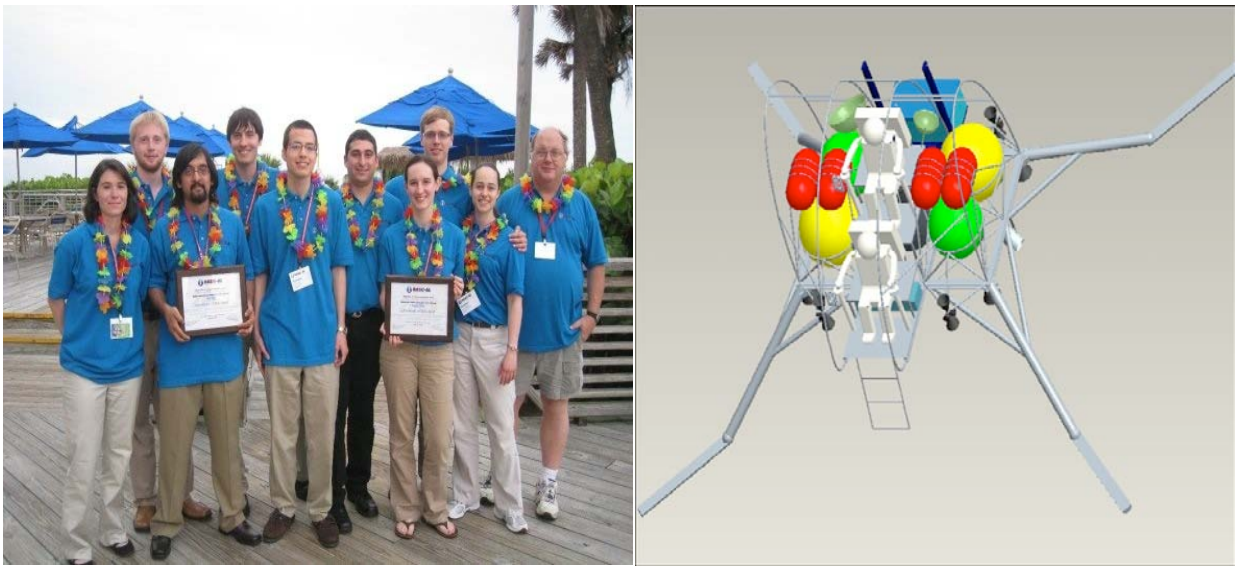

Figure 3: 2009 RASC-AL FORUM UNDERGRADUATE WINNING TEAM and the ALSHIAN LUNAR FLYING VEHICLE

1st Place: University of Maryland – Undergraduate Team

Title: *Project Alshain: A Lunar Flying Vehicle for Rapid Universal Surface Access*

Faculty Advisor: Dr. David L. Akin

2nd Place: North Carolina State University – Undergraduate Team

Title: *Lunar Texshield*

Faculty Advisor: Dr. Russell Gorga and Dr. Warren Jasper

University of Notre Dame – Undergraduate Team

Title: *Satellite Solar Energy Redirection as a Means of Short-and Long-Term Power Generation*

Faculty Advisor: Dr. Vikas Tomar

Worcester Polytechnic Institute – Undergraduate Team

Title: *Advanced Ballistic Lunar Explorer (ABLE)*

Faculty Advisor: Dr. John Blandino

Virginia Tech – Undergraduate Team

Title: *A Design for a Sustainable Permanent Lunar Settlment*

Faculty Advisor: Dr. Kevin Shinpaugh

Penn State University, Georgia Tech, NYU-Poly – Undergraduate Team

Title: *Mutopia*

Faculty Advisor: Dr. Jack Matson, Dr. Jeannette Yen, Dr. Richard Wener

Arizona State University – Undergraduate Team

Title: *ARTEMIS – our Return to the Moon*

Faculty Advisor: Dr.Kip Hodges

Colorado School of Mines – Undergraduate Team

Title: *Advanced Lunar Base Approach*

Faculty Advisor: Dr. Joel Duncan

Clarkson University – Undergraduate Team

Title: *Project COILS: Colonization of Initial Lunar Settlement*

Faculty Advisor: Dr. Kenneth Visser

The University of Alabama-Huntsville – Undergraduate Team

Title: *An Extended Duration Lunar Exploration Rover for Remote Lunar Surface Exploration*

Faculty Advisor: Dr. Thomas Percy

Figure 4: 2009 RASC-AL FORUM POSTER SESSION

Table 1: Breakdown of Forum Participants by State

- Figures include students and faculty advisors

HOME STATE	# OF PARTICIPANTS	HOME STATE	# OF PARTICIPANTS
ALABAMA	6	MARYLAND	10
ARIZONA	7	NEW YORK	16
COLORADO	5	NORTH CAROLINA	4
FLORIDA	2	PENNSYLVANIA	5
GEORGIA	11	TEXAS	9
INDIANA	3	VIRGINIA	5

Table 2: Participant Totals by Gender

- Figures include students and faculty advisors

	Total #	% of Total
Male	70	84%
Female	13	16%
Total Respondents	83	100%

ELIGIBILITY

The RASC-AL Program is open to full-time undergraduate or graduate students majoring in engineering or science at an accredited university. University design teams must include:

- One Faculty or Industry Advisor with a university affiliation;
- Two or more undergraduate or graduate students.

A group of universities may also work in collaboration on a design project entry. Multidisciplinary teams are encouraged.

EVALUATION/AWARDS

RASC-AL Steering Committee evaluated and scored the competition between participating educational forum teams. The Steering Committee was made up of experts from NASA, industry, and universities. Design projects was evaluated and judged based on the 2009 RASC-AL Theme. A detailed description of the scoring system is posted on the 2009 RASC-AL Project Evaluation Form (see Appendix B).

First and Second places were awarded under undergraduate and graduate categories. The winners received travel stipends to attend the AIAA Space 2009 Conference in Pasadena, CA, where they presented their projects, participated in Education Alley and the Future Leaders Reception, and toured Space Exploration Technologies Corporation.

PARTICIPANT EVALUATION

Students and advisors were invited to complete a program evaluation during the RASC-AL Forum, and 49 responses were received. Over 97% of participants rated the RASC-AL Forum and Program as Excellent or Very Good across every category (APPENDIX F). Participants were encourages to provide comments and suggestions to further improve the program. All suggestions and data will be carefully reviewed for continuous improvement for the 2010 RASC-AL Competition.

Figure 5: 2009 RASC-AL FORUM, Cocoa Beach FL

TEAM PARTICIPATION REQUIREMENTS AND SCHDULE

(1) Abstract – Each design team was required to submit an electronic copy of the project abstract in PDF format via email. The following information was required by February 6, 2009.

- Name of university or college
- Project Title
- Faculty/Industry Advisor
- Student Team Leader
- Education and Public Outreach efforts

Abstracts were limited to four pages (including figures, tables, and references) and must be submitted in PDF format.

(2) **Written Reports:**

Each team was required to submit two copies of the written report. One hard copy that was mailed and one copy sent electronically. Written reports were required to be in PDF format on a CD-ROM. Written reports were due on May 25, 2009.

Written Report Guidelines:

1. 10 – 15 pages (Cover page, references and appendices excluded in page minimum); singled space.
2. Cover page must include: Title of presentation; Full names of all team members; University name; and faculty advisor's full name.
3. CD-ROM must be labeled with: Title of presentation; University name; and faculty advisors full name.

Reports were distributed to the Steering Committee in black and white. The appendices were not included in the page limitation and the Steering Committee was not obligated to consider lengthy appendices in the evaluation process.

(3) Oral Presentations:

Each team submitted two copies of the oral presentation. One hard copy and one electronic copy of their PowerPoint presentation in PDF format on a CD-ROM. Oral presentations were due no later than June 1, 2009.

Oral presentations were based off of written reports. If errors were discovered after the written report was submitted, teams should take

this time to address them. Significant information discussed during the oral presentation that was not included in the written report will be penalized for scoring.

Oral Presentation Guidelines:

1. Presentations limited to 30 minutes. EPO must be discussed during this 30 minutes
2. Each presentation is followed by a 10 minute Q & A session
3. CD ROM must be labeled with: Title of presentation; University name; and faculty advisor's name
4. Requests for specific presentation schedule must be submitted in writing to the program manager no later than May 4, 2009. Request of schedule is based on travel and logistics only.

(4) Poster Presentations:

Each team was required to present posters describing their project. Poster display space was limited to 4' x 8'. Posters had to be attachable to a panel with push pins. Each display space included an 8' table and an electrical outlet.

DEADLINES CALENDAR FOR TEAMS

February 6, 2009	Deadline for Abstract submission
February 23, 2009	Team notification of abstract acceptance
March 13, 2009	Selected teams must be registered
May 1, 2009	Deadline for hotel reservation at group rate
May 25, 2009	Submission for written reports due
May 27, 2009	Submission of oral reports due
June 1-3, 2009	2009 RASC-AL Forum

TOP PROJECT MANAGEMENT TEAM AWARD

New in 2009, was the addition of a new top project management team award offered by the Project Management Institute (PMI). The award was based on the quality of the management approach used in conducting the student projects as well as a proposed project plan for its execution. This was an optional award, and was considered independently of the technical and scientific merits of the student projects that will be based on the standard RASC-AL evaluation criteria. Only team applied, and so the award was not competed.

STUDENT RESOURCES

To assist student teams in the preparation and development of the abstracts, oral, poster and education and public outreach portions of the project, students were encouraged to utilize the provided the following information and resources on the RASC-AL website.

Education and Public Outreach (EPO):
All teams must participate in an education and public outreach activity as required by the RASC-AL guidelines. EPO examples include actively participating in school career days, science fairs, technology fairs, extracurricular science clubs, or setting up exhibits in local science museums or a local library. Other ideas include organizing a program with a Boys and Girls Club, Girl Scouts, local library, museum, etc. We encourage students to have fun with their EPO and share their knowledge of science and engineering with the local community.

. **Oral Presentations:** Below are a few example sites that may be useful when preparing your presentations. We encourage teams to research how to give professional and effective presentations.

Oral Presentation Guide
http://people.eku.edu/ritchisong/oralpres.html
(University of Kansas Medical Center)

Poster Presentations:

How to Prepare a Poster
http://www.siam.org/meetings/guidelines/poster.php
Society for Industrial and Applied Mathematics

How to Make a Great Poster
http://www.aspb.org/education/poster.cfm
University of Washington

Abstract Guidelines:

AIP Style Manual – Physics Manuscripts
ttp://www.aip.org/pubservs/style/4thed/toc.html
American Institute of Physics

Earth Science Abstract Guidelines
http://www.earthresearch.com/writing-abstract.shtml
Earth Research

Engineering Abstract Guidelines
http://www.ecf.toronto.edu/~writing/abstract.htm, University of Toronto

Appendix A:

2009 RASC-AL FORUM AGENDA

Cocoa Beach Hilton Oceanfront, Cocoa Beach Florida

June 1-3, 2009

SUNDAY, MAY 31, 2009

4:00 PM – 6:00 PM	Early Registration and Check-in *at Front Lobby*
6:00 PM	Steering Committee Dinner at Atlantis Bar & Grill *(Located in Hotel)*

MONDAY, JUNE 1, 2009

7:30 AM – 8:00 AM	**Registration and Breakfast -** *Seagrapes Room*
8:00 AM – 8:30 AM	Welcome and Introductions Dr. Marcia Gibson, NIA Dr. Douglas Stanley, NIA
8:30 AM – 9:10 AM	Guest Speaker Pat Troutman, NASA Langley Research Center
9:10 AM – 9:50 AM	University of Florida and Arizona State University – Graduate Team Title: *Babel Caelestis: Progression from an Outpost to Full Lunar Settlement* Faculty Advisor: Dr. Carl D. Crane III
9:50 AM – 10:30 AM	North Carolina State University – Undergraduate Team Title: *Lunar Texshield* Faculty Advisor: Dr. Russell Gorga and Dr. Warren Jasper
10:30 AM – 10:45 AM	**Break**
10:45 AM – 11:25 AM	The University of Texas-Austin – Graduate Team Title: *Lunar Sample Transport and Return II* Faculty Advisor: Dr. Wallace Fowler
11:25 AM – 12:05 PM	Guest Speaker Kris Zacny, Honeybee Robotics

12:05 PM – 1:00 PM	**Lunch**
1:00 PM – 1:40 PM	Guest Speaker
	Dallas Bienhoff, Boeing
1:40 PM – 2:20 PM	Georgia Tech/NCSU – Graduate Team
	Title: *Ceres: A Reusable Lunar Transportation Architecture Utilizing Orbital Propellant Depots*
	Faculty Advisor: Dr. Alan Wilhite
2:20 PM – 3:00 PM	University of Maryland – Graduate Team Title: *Habitability and Life Support for Early Lunar Habitats and Rovers* Faculty Advisor: Dr. David Akin
3:00 PM – 3:15 PM	**Break**
3:15 PM – 3:55 PM	University of Notre Dame – Undergraduate Team
	Title: *Satellite Solar Energy Redirection as a Means of Short-and Long-Term Power Generation*
	Faculty Advisor: Dr. Vikas Tomar
3:55 PM – 4:35 PM	Worcester Polytechnic Institute – Undergraduate Team
	Title: Advanced Ballistic Lunar Explorer (ABLE)
	Faculty Advisor: Dr. John Blandino
4:35 PM – 6:00 PM	**Free time**
6:00 PM	**Dinner** *provided in hotel*

TUESDAY, JUNE 2, 2009

8:00 AM – 8:30 AM	**Breakfast** *in Seagrapes Room*
8:30 AM – 9:10 AM	Guest Speaker
	Russ Joyner, Pratt & Whitney Rocketdyne
9:10 AM – 9:50 AM	University of Maryland – Undergraduate Team
	Title: *Project Alshain: A Lunar Flying Vehicle for Rapid Universal Surface Access*
	Faculty Advisor: Dr. David L. Akin

9:50 AM – 10:30 AM	Georgia Tech – Graduate Team
	Title: *Antares: A Lunar Surface Systems Architecture*
	Faculty Advisor: Dr. Alan Wilhite
10:30 AM – 10:45 AM	**Break**
10:45 AM – 11:25 AM	Virginia Tech – Undergraduate Team
	Title: *A Design for a Sustainable Permanent Lunar Settlement*
	Faculty Advisor: Dr. Kevin Shinpaugh
11:25 AM – 12:05 PM	Penn State University, Georgia Tech, NYU-Poly – Undergraduate Team
	Title: *Mutopia*
	Faculty Advisor: Dr. Jack Matson, Dr. Jeannette Yen, Dr. Richard Wener
12:05 PM – 1:00 PM	**Lunch**
1:00 PM - 1:40 PM	Arizona State University – Undergraduate Team
	Title: *ARTEMIS – our Return to the Moon*
	Faculty Advisor: Dr.Kip Hodges
1:40 PM – 2:20 PM	Colorado School of Mines – Undergraduate Team
	Title: Advanced Lunar Base Approach
	Faculty Advisor: Dr. Joel Duncan
2:20 PM – 2:35 PM	**Break**
2:35 PM – 4:30 PM	Poster Session
4:30 PM – 6:30 PM	**Free Time**
6:30 PM	**Dinner** *provided in hotel*
6:30 PM – 8:30 PM	**Blacklight Volleyball on Beach – meet in Front Lobby**

WEDNESDAY, JUNE 3, 2009

8:00 AM – 8:30 AM	**Breakfast** *in Seagrapes Room*
8:30 AM – 9:10 AM	Guest Speaker
	Ken Bocam, Orbital Sciences Corp.

9:10 AM – 9:50 AM	Clarkson University – Undergraduate Team
	Title: Project COILS: Colonization of Initial Lunar Settlement
	Faculty Advisor: Dr. Kenneth Visser
9:50 AM – 10:30 AM	Guest Speaker
	Dr. John Olds, Space Works Engineering
10:30 AM – 11:10 AM	The University of Alabama-Huntsville – Undergraduate Team
	Title: *An Extended Duration Lunar Exploration Rover for Remote Lunar Surface Exploration*
	Faculty Advisor: Dr. Thomas Percy
11:30 AM – 12:30 AM	**Lunch**
12:30 AM – 4:30 PM	**Tour of NASA Kennedy Space Center**
6:00 PM	**Award Ceremony** *on outside back patio*

THURSDAY, JUNE 4, 2009

11:00 AM	**Check-Out**

Appendix B

RASC-AL Forum Team Evaluation Forum

Project Evaluation Form

RASC-AL

Project Team: _____

Faculty Advisor: _____

Graduate/Undergraduate *(circle)*

2009

Abstract & Written Report *(50 points)* Total _____

Oral Report & Presentation *(50 points)* Total _____

Education and Public Outreach *(25 points)* Total _____

Written Criteria	*Point Scale*	*Actual Points*	*Comments/Notes*
Compliance & alignment with 2009 NASA RASC-AL Themes & Research Objectives, as stated in the RASC-AL Call for Student Projects.	*10*		
Innovative, unique and/or synergistic advanced concepts and applications of to enhance the Exploration mission, architectures, capabilities, or technologies.	*15*		
Technical/scientific evaluation and rational of mission concept	*10*		
Systems Analysis of requirements, incl. identification of challenges and issues, including Technical Readiness Level(s) of mission-enabling technologies	*10*		
Realistic assessment of project cost/schedule	*5*		
Oral Criteria	***Point Scale***	***Actual Points***	***Comments/Notes***
Oral Presentation Consistent with Written Report	*20*		
Quality of Presentation (incl. Style)	*10*		
Presence of Teamwork and Integration	*10*		
Quality of Response to Questions	*10*		
Outreach Criteria	***Point Scale***	***Actual Points***	***Notes***
Education & Public Outreach Activities (campus, Community, K-12)	*15*		
Forum Participation & Engagement, incl. Poster Session & Q&A	*10*		

National Institute of Aerospace

Judge _____ Total Score _____

National Institute of Aerospace

APPENDIX C

RASC-AL Competition Welcome Letter

2009

RASC-AL
Revolutionary Aerospace Systems Concepts Academic Linkage

Dear RASC-AL Forum Participants:

Welcome to the ***2009 RASC-AL Forum Competition!*** On behalf of NASA Langley Research Center and the National Institute of Aerospace we extend a hearty welcome and invitation to gain as much as you can from the next three days of exposure to renown guest speakers and interesting conceptual engineering designs. We hope you will enjoy the Forum events such as the speeches, the competition presentations, the poster session, and networking opportunities.

Your participation in this competition is an excellent opportunity for furthering your learning and experience in conceptual design for space exploration. Be sure to take advantage of this time to develop your network by getting to know each other as well as the guest speakers and NASA and NIA representatives.

If you have any questions about the Cocoa Beach, FL area while you are here be sure to address them to the hotel concierge.

Some guidelines for your attendance at the Forum this week are:

1. Review the schedule and be on time for all sessions
2. There are some activities planned for the evening but after those are completed, you are on your own. You are responsible for your actions and accountable to your school advisor and school policies.
3. There is a tour of the Kennedy Space Center planned for Wednesday afternoon. There will be a couple of buses in the loading zone to take us to Kennedy. Please assemble in the lobby 10 minutes before the buses leave so we can ensure all are on board. Also, have identification with you in case it is requested. All foreign students will have been preapproved by NASA and if your name is not on our approval list, you will not be able to participate in the tour.
4. There will be time for you to shop at the Kennedy Space Center gift shop so plan your budget accordingly.
5. It is turtle hatching season so Do Not Disturb Turtles, Turtle Nests or Turtle Hatchlings - Sea turtles are an endangered species, if you are lucky enough to see a turtle come ashore, give it very wide berth, do not shine a flashlight or use a flash camera.
6. In case of an emergency or need for health services, please notify your school advisor. The nearest hospital is Cape Canaveral Hospital located at 701 W. Cocoa Beach Causeway, Cocoa Beach, FL 3293; 321- 799-7111
7. There will be a message board located near the registration area for posting messages to each other or from anyone trying to reach you during the Forum.
8. If you need the assistance of the RASC-AL Forum representatives you may contact them on their cell phones at: Audrey Staples: 703-869-0309 or Marcia Gibson: 757-577-5732
9. There is a Black Light Volleyball game scheduled for Tuesday night; come and participate. The NASA folks think they can win!
10. You will receive a RASC-AL Forum polo shirt. Please wear this to the Awards Ceremony held on Wednesday night.

Again, welcome and have a wonderful time as part of the NASA/NIA 2009 RASC-AL Forum Competition in Cocoa Beach, Florida!

Sincerely,

Marcia

Marcia R. Gibson, Program Director

NATIONAL INSTITUTE OF AEROSPACE

Appendix D

2009 RASC-AL Competition Themes

2009 RASC-AL THEMES

1. ***Outpost to Settlement***
   NASA has developed an outpost on the moon in 2020 with the Constellation Architecture and wants to plan for a permanent settlement. The space transportation and lunar surface system infrastructure needs to be upgraded to improve livability on the moon, to easily set up new communities and research facilities, and to have a global lunar transportation system. The costs and reliability of supplying resources to moon need dramatic improvements requiring innovative Earth-to-orbit and in space transportation systems. This topic allows your team to contribute ideas directly to the engineers tasked with developing solutions to these challenges. Some specific examples to be addressed are:

   - Utilizing lunar, space, and other planetary resources for infrastructure development, power, and consumables to minimize the logistics supply chain needed from Earth
   - Lunar transportation system(s) for routine access to lunar settlements and for exploration of remote regions for discovery of new resources.
   - Durable lunar settlement designs and settlement layouts, including all required utilities and infrastructure
   - Dramatically improved Earth-to-orbit and in-space transportation systems that can significantly reduce cost and improve safety.
   - A business plan on how to develop a self-sufficient lunar economy with unique utilization of lunar resources

   All improvements to the space transportation architecture should offer demonstrable improvements in safety, reliability, performance, or affordability over the planned Constellation architecture which should be assumed as existing to support the initial lunar outpost deployment.

2. ***Initial Lunar Outpost***
   NASA is developing concepts and technologies for the first lunar outpost and has architecture concepts for its development. One approach is based on the immediate establishment of an integrated long-stay outpost. An alternative approach would mitigate the initial cost by first establishing the surface mobility systems for exploration that could include a habitat with limited mobility, leading to the development of a long-stay outpost. Unique solutions are sought for surface system technologies and challenges that include
   - Alternative Packaging Options- Identify alternative packing options that eliminate or minimize waste generation from packing materials and allow optimal utilization of available stowage volume.
   - Minimum Functionality Habitation Element - Produce a conceptual design for a habitat based on a minimum set of functions that are required to perform the reference mission.
   - Long-term Lunar Energy Storage Systems - Identify novel energy storage concepts that enable longer crewed missions on the lunar surface with low mass and volume and require no maintenance or support.
   - Lunar Regolith Moving Methods & Techniques - Provide viable and innovative methods for moving lunar regolith to deploy and operate a lunar outpost.

3. ***Bringing the World Along with Virtual Exploration***
   An important element of NASA's return to the Moon is engaging the general public in human exploration missions. To capture the attention of a large cross section of the general population, NASA must use a variety of innovative and diverse approaches. A potential example might be the development of high-definition cameras on the rovers and in the habitats, with the ability to control rovers or monitor experiments from Earth. This would not only require a communications infrastructure that would enable the transmission of high-definition images from the Moon, but would also require the use of satellites and ground stations to provide communications connections and interfaces. Internet-enabled collaborative exploration capabilities on Earth would need to be developed that could handle everything from requests for camera feeds, to information about the lunar base, to even the organization of public-assisted exploration-like science investigations or student/corporate-developed activities such as rover races on the lunar surface.

4. ***Novel Approaches to Increase Sample Return from the Moon***
   Past missions to the Moon, both robotic and human, provided critical information on the composition and nature of lunar regolith and rock exposures. However, the missions offered insight into relatively limited geographic and geologic settings. Many resources questions require a greater knowledge of material composition, age, and properties for a diverse number of surface sites. Given that landed elements have limited payloads and may only be able to measure a small number of properties, it is highly desirable to develop surface sampling techniques at relatively low cost that allow return of lunar surface materials from a diversity of lunar surface sites to Earth for examination and characterization. The challenge in this topic is to devise low-cost mission concepts that return sufficient critical material for analysis beyond the current Orion constrained capability. Challenges include suitable spacecraft/mission design, sample collection technologies to maximize sample value and quantity, and sample encapsulation techniques to maintain the integrity and pristine nature of samples.

Attention should be given to **synergistic applications** of NASA's initially planned mission or system elements and infrastructure for lunar exploration, innovative combinations of the planned elements, and unique combinations of the planned elements with new innovative capabilities and/or technologies to support the robotic and crewed exploration of the solar system. Scenarios should address **novel and robust applications**, with an objective of NASA sustaining a permanent and exciting space exploration program.

Key evaluation criteria elements that each RASC-AL project should address are:

- Scientific evaluation and rationale of mission destinations for the development of an exciting and sustainable space exploration program;
- Unique applications of NASA's planned lunar architecture for future missions;
- Synergistic application of innovative capabilities and/or new technologies for an evolutionary architecture development to enable future missions, reduce cost, or improve safety;
- Systems analysis of requirements and infusion and utilization of emerging technologies from all sources;
- Technical readiness level (TRL) of mission-enabling technologies and a technology roadmap outlining the development activities required for low-TRL technologies; and
- Realistic assessment of project cost/schedule and reliability/safety of the proposed architecture or system.

APPENDIX E

NIA-NASA PRESS RELEASE

NEWS RELEASE

National Institute of Aerospace (NIA)

100 Exploration Way

Hampton, VA 23666

FOR IMMEDIATE RELEASE

NIA News Release 2009-05

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NASA AND NIA ANNOUNCE MOON DESIGN TEAM COMPETITORS

HAMPTON, Va. – Fifteen teams have made it to the finals of a NASA and National Institute of Aerospace (NIA) sponsored competition that is challenging university students to think about the conditions astronauts will face when we return to the moon, and then design projects that could become part of real lunar exploration.

The undergraduate and graduate engineering students won the right to compete against each other at the 2009 Revolutionary Aerospace Systems Concepts Academic Linkage or RASC-AL forum to be held in Cocoa Beach, Fla., June 1-4.

"The RASC-AL steering committee of NASA and industry experts was impressed by the creativity, ingenuity and thoughtfulness of this year's student entries," said Pat Troutman, senior systems analyst at NASA's Langley Research Center in Hampton, Va. "Next generation engineers are going to be crucial in helping NASA get back to the moon, then go onto Mars and beyond."

The five graduate student teams will represent the University of Texas in Austin; the University of Maryland, College Park; a joint effort from University of Florida in Gainesville and Arizona State University, Tempe; and two Georgia Tech groups who are completing their graduate study at NIA.

Appendix F

Participant Evaluations of Forum

46 participants submitted an evaluation form

1. Gender
(8) Female (38) Male

2. Ethnic Background
(36) Caucasian (0) African-American
(6) Asian-American
(1) Hispanic/Latin American
(0) Native American
(1) Indian-American
(2) Other: (1 Asian; 1 “Irrelevant”)

3. Indicate the one that best describes you
(4) Faculty
(26) Undergraduate College Student
(14) Graduate College Student
(0) RASC-AL Steering Committee
(2) Other: (1 “Graduated”; 1 Guest Speaker)

4. Home State

(5) Arizona	(5) Alabama
(3) North Carolina	(1) Minnesota
(2) Pennsylvania	(1) Maine
(3) Massachusetts	(2) Virginia
(5) New York	(5) Texas
(1) Georgia	(1) Mississippi
(3) Connecticut	(1) Florida
(1) Kentucky	(1) Colorado
(1) Iowa	(5) Left Blank

5. RASC-AL was valuable education and learning experience
(0) Poor (0) Fair (0) Good (14) Very Good
(32) Excellent

6. Program met objectives and demonstrated the application of design theory to real-world challenges and problems

(0) Poor (0) Fair (2) Good (22) Very Good
(22) Excellent

7. Procedures and processes used for design project application were very clear.
(1) Poor (5) Fair (7) Good (17) Very Good
(13) Excellent (3) left blank, 1 of which had comment: "N/A advisor completed these steps for us"

8. Program themes and project mission requirements were very clear
(1) Poor (4) Fair; 1 comment: "Pretty vague (i.e., what is permanent?) but that makes for more diversity". (5) Good (19) Very Good (16) Excellent (1) left blank with comment: "N/A-Advisor completed these steps for us".

9. Involvement in program reconfirmed my interest in science, engineering, and/or technology.
(0) Poor (0) Fair (4) Good (10) Very Good
(30) Excellent (2) Excellent "+"

10. Program encouraged/provided networking opportunities with faculty, NASA, and industry.
(0) Poor (0) Fair (3) Good (13) Very Good
(29) Excellent (1) Excellent "+"

11. Participation/quality of industry involvement
(0) Poor (1) Fair (4) Good (17) Very Good
(26) Excellent, with one comment "Excellent! Very accomplished & interesting individuals"

12. Participation/quality of NASA involvement
(0) Poor (0) Fair (3) Good (17) Very Good
(24) Excellent, with one comment "Pat Troutman is awesome!"

13. Information/Interaction provided by the featured guest speakers.
(0) Poor (0) Fair (1) Good (15) Very Good
(28) Excellent; (1) left blank (1) marked "Excellent + 10"

14. Interaction with other project faculty/students
(1) Poor (0) Fair (5) Good (18) Very Good
(22) Excellent

15. Knowledge/understanding gained of NASA and the aerospace industry
(0) Poor (0) Fair (6) Good (23) Very Good
(17) Excellent

RASC-AL PARTCIPANT EVALUATION RESULTS, cont'd

16. Poster sessions provided insight and interaction opportunities
(1) Poor (0) Fair (9) Good, with one comment "Not too many people came up; judges didn't ask many questions" (12) Very Good
(24) Excellent

17. Education outreach provides opportunity to share Science, Technology Engineering, and Math with students and community organizations.
(1) Poor w/ comment "opportunity was always there" (1) Fair (5) Good (19) Very Good
(19) Excellent (1) left blank

18. Logistical support in preparing for/attending the forum.
(2) Poor (3) Fair, with one comment "e-mails were unanswered at first" (6) Good (9) Very Good
(26) Excellent

19. Logistical support during the forum.
(0) Poor (1) Fair (2) Good (13) Very Good
(30) Excellent

20. Overall rating of the RASC-AL forum.
(0) Poor (0) Fair (1) Good (19) Very Good
(24) Excellent (1) marked both Very Good and Excellent (1) marked Excellent "++"

RASC-AL PARTICIPANT EVALUATION VERBATUM REMARKS

What did you like most about the design competition?

(36) of 46 evaluation participants responded to this question. If more than one person submitted the same response, this is noted at the end of the response.

- Interaction with industry and NASA professionals is very valuable (12 people gave this response)
- Opportunity to interact with other teams (8 people gave this response)
- Cocoa Beach was a nice location (7 people gave this response)
- Tour of Kennedy Space Center (5 people gave this response)
- The chance to see innovative ideas and thinking "outside the box" (5 people gave this response)
- Feedback from and interaction with judges (4 people gave this response)

RASC-AL PARTICIPANT EVALUATION VERBATUM REMARKS, con'td

What did you like most about the design competition?

- The beach outing (3 people gave this response)
- The variety and range of designs (2 people gave this response)
- Opportunity to present at a conference
- Discussions on how to improve projects
- I liked the conceptual design themes that were given as options for our design.
- The small size of forum and the high quality of the participants
- Being able to meet new people
- Adherence to schedule
- The engineering design process, especially the more detailed phase
- Opportunities for students to see what goes on at other universities. This generally raises standards at all participating universities
- Marcia Gibson
- Shuttle fly-by
- "Planting" members of steering committee at certain tables during dinner so students have a chance to meeting and interact with them.
- The independent drive to provide quality work for this project. On a different note, I really enjoyed the atmosphere because I have never been to anything like this. Furthermore, it solidified my interest in A.E. Thank you.
- Being exposed to the different colleges and universities and their different design approaches to a specific problem.
- I enjoyed the casual and technical atmosphere that enabled relaxed but detailed discussion
- The open atmosphere putting your ideas under fire is very eye-opening
- The questions posed were real life problems that we people have to think and solve in years to come, so the themes were excellent. The conducting committee did a wonderful job!
- I liked the overall management and the way the presentations were arranged with the relevant guest speakers' speeches.
- Presentation lengths and questions/answer periods.
- Volleyball tournament
- The fun/goofy awards.

RASC-AL PARTICIPANT EVALUATION VERBATUM REMARKS, con'td

What did you like least about the design competition?

(30) of 46 evaluation participants responded to this question. . If more than one person submitted the same response, this is noted at the end of the response.

- Lack of free time during forum (6 people commented on this):
  - Breaks between sessions were too short;
  - little free time ;
  - looong days;
  - more free time to enjoy the beach; duration and lengthy occupation of afternoon timeslot)
  - Schedule of presentations; evening presentations would be preferred to allow for free time during the day.
- Breakfast was not substantial (4 people commented on this; would prefer a hot breakfast, including eggs & bacon, hot cereal, etc.)
- Guidelines unclear or confusing (6 people commented on this):
  - Submission of written and oral reports was badly mishandled and should be via e-mail or other online system rather than delivery of a hard copy.
  - Submission of written and oral reports was badly mishandled and should be via e-mail or other online system rather than delivery of a hard copy.
  - The requirements were sometimes not clear or confusing. Outreach was not listed as far as we saw as a judging criteria; the presentation due date of May 27 we thought was for the final version of the presentation.
  - Guidelines/requirements for the paper and presentation were a little vague in the beginning
  - The lack of editing in the presentation for "quick fixes" at the time of the presentation. This would have allowed for better performance also. Sending a physical copy was very inefficient as a submission. In today's modern technology an e-mail with the submission should suffice.
  - Website description and organization. The website often had contradictions and did not fully communicate the competitive goals and scope.

RASC-AL PARTICIPANT EVALUATION VERBATUM REMARKS, cont'd

What did you like least about the design competition?

- Paper length (2 people commented on this):
  - I understand it but it was very difficult to scale down our report to the 15 page limit. I felt we had to leave out a lot of good info. But I don't blame the judges for not wanting to read 100 pages of paper for each paper.
  - The 15 page limit for the paper, some subjects are very in depth. Competitors are also very quick to shoot down weaker projects, which is lame, because they're just trying to rack up participation points.
- Lack of scientific judges. (2 people commented on this)
  - There should be at least one judge who comes from a science background. The competition in its statement says it's not just about engineering but also science and technology
- No lunar science presented
- I felt that manned space flight was over represented while robotic exploration was not. I would have liked to see representatives from JPL (for example) as well in order to broaden the scope of the steering committee and industry representatives.
- I raised my hand a few times for questions, but did not have a chance to ask my questions.
- Some of the presentations were excellent. Innovative, thorough, high-quality projects that I felt I learned from. However, some were not quite as glowing. I enjoyed all of RASC-AL, but if I have to pick something that was my least favorite, I'd say it was listening to a couple of the less glowing student presentations. Felt like a long 30 minutes sometimes.
- Not enough revolutionary ideas. The R in RASC-AL. More credit should be given for radical concepts.
- There were many similar designs in the form of habitat modules and manned/unmanned rovers and hoppers. This may be due to the RASC-AL objects. Would have liked to see more variety.
- Some projects, or some parts of them, which are not related with aerospace engineering.
- Most projects are gathered around one topic: Lunar Settlement. However, there are other topics to study which are more related to aerospace engineering.
- Forum room not that comfortable; not too competitive
- Poster area was not well organized
- Poster session could have been better—longer with better layout
- Checks going to Faculty members—should go to "donor" accounts in their academic departments to avoid overhead. May be different at each school.
- Individual delivery of participation awards.
- Some of the activities during the conference (i.e. the NASA cheer and the hokey-pokey) do not befit a putatively professional gathering.

RASC-AL PARTICIPANT EVALUATION VERBATUM REMARKS, cont'd

- Everything was great!

Please provide any additional comments you have, including recommendations for improving the Forum and competition

(25) of 46 evaluation participants responded to this question. . If more than one person submitted the same response, this is noted at the end of the response.

- Organization/Guidelines:
    - Nearly every organizational aspect of the forum was run in a slipshod fashion with little or no attention paid to important details. The registration fee was first reported at $50 and then inexplicably changed to $350. The deadline for written report submission was set for 25 May, a federal holiday when no delivery services were operating. After an exchange of emails, we were told to have the material delivered on 27 May. However, the very next day (5/26) we received another email requesting the report as soon as possible. The deadline for oral report submission was listed as 6/1 on the website but then changed to 5/27 in a last-minute email. The lack of professionalism damages the credibility of the form. Such negligence is further demonstrated by the numerous errors of grammar and logic on this evaluation form and must be rectified for future forums
- I would like to see the competition held earlier in the summer since most students need to start internships/jobs by June. Also, hosting the competition over a weekend would be preferred so that if time needs to be taken off from work it would only be 3 days and not 5 days.
- Make colleges aware of RASC-AL; encourage more colleges to apply; make it more competitive
- Perhaps breaking up the presentations a bit more or differently. Overall, vast improvement over last year.
- Incorporate more members (judges) that have worked in projects with scientists. Have some more people into science (geology, astronomy, etc.) besides just engineers
- For next year tell what and how many of each category was done to try to encourage groups to branch out into other categories
- More interaction outside of Q/A between other project teams would be nice

RASC-AL PARTICIPANT EVALUATION VERBATUM REMARKS, cont'd

- On site Set-up comments:
  - Better preparation for the poster session (3 people commented on this):
    - To avoid issues that were brought up during the conference. Tell people not to plan on power being available or that they may need to print their poster on some type of backing board material
    - I wasn't happy about the placement of our Team during the Poster Session. We were down a hall and all by ourselves. There was very little traffic down our way. There was one judge that didn't visit our booth. I hope this didn't affect our overall grade
  - Maybe allow for beach time during afternoon, i.e. presentations in the morning, then again after dinner
    -
  - Look into better audio/visual
  - Set-up for first day was a bit inconvenient-no clicker to switch slides—overall—great experience!
- Scheduling comments:
  - Great schedule-keeping
  - An ice breaker the first night (or Sunday night) to promote student interaction could be nice. Maybe a science trivia night with random teams from different schools.
  - I liked having breakfast , lunch and dinner together that allowed interacting with students
  - Time to enjoy the beach during the day.
  - Waking up a little later would be nice
  - The opportunity to go out to eat one or two nights for dinner.

- Outstanding industry panel
- The stipends need to be larger for inter-university teams. We had three different schools involved with three advisors so the stipends did not come close to covering 7 people.
- Need to start a RASC-AL newsletter
- Need to start a RASC-AL alumni association—target for newsletter
- Design topic is too broad. I hope more narrow specification for design
- Have a couple of different sections to compete under and then an overall winner
- I found it interesting that there was such variety in the projects: very detailed design, trade studies, far-reaching & vague ideas. Is this what was hoped for?
- I support RASC-AL all the way; this is a great way to get students engaged in space and give them idea of what they may be doing if they choose to follow this path.

RASC-AL PARTICIPANT EVALUATION VERBATUM REMARKS, cont'd

- I'm really happy to see RASC-AL continue. I also like presentations from industry folks. This is a very important part of the Forum.
- This was a very organized form with little improvements needed. There was a good amount of time allotted for Q&A for the presentations and the guest speakers were nice to listen to.
- If we could have more graduate teams, I think that would be really good. The forum was great as for as the scheduling and conduct is concerned.
- Would have been helpful to know there was a dress code for KSC, so we cold plan what to pack. Maybe put that on the website in a prominent place?
- Let the girls know the shirts are men's polo's (2 people made this comment)
- A hot breakfast would be nice (2 people made this comment).
- Assigned seating at dinner to mix things up a bit.
- Shuttle fly-bys are a plus.
- Great volleyball tournament
- You guys did and do an awesome job.