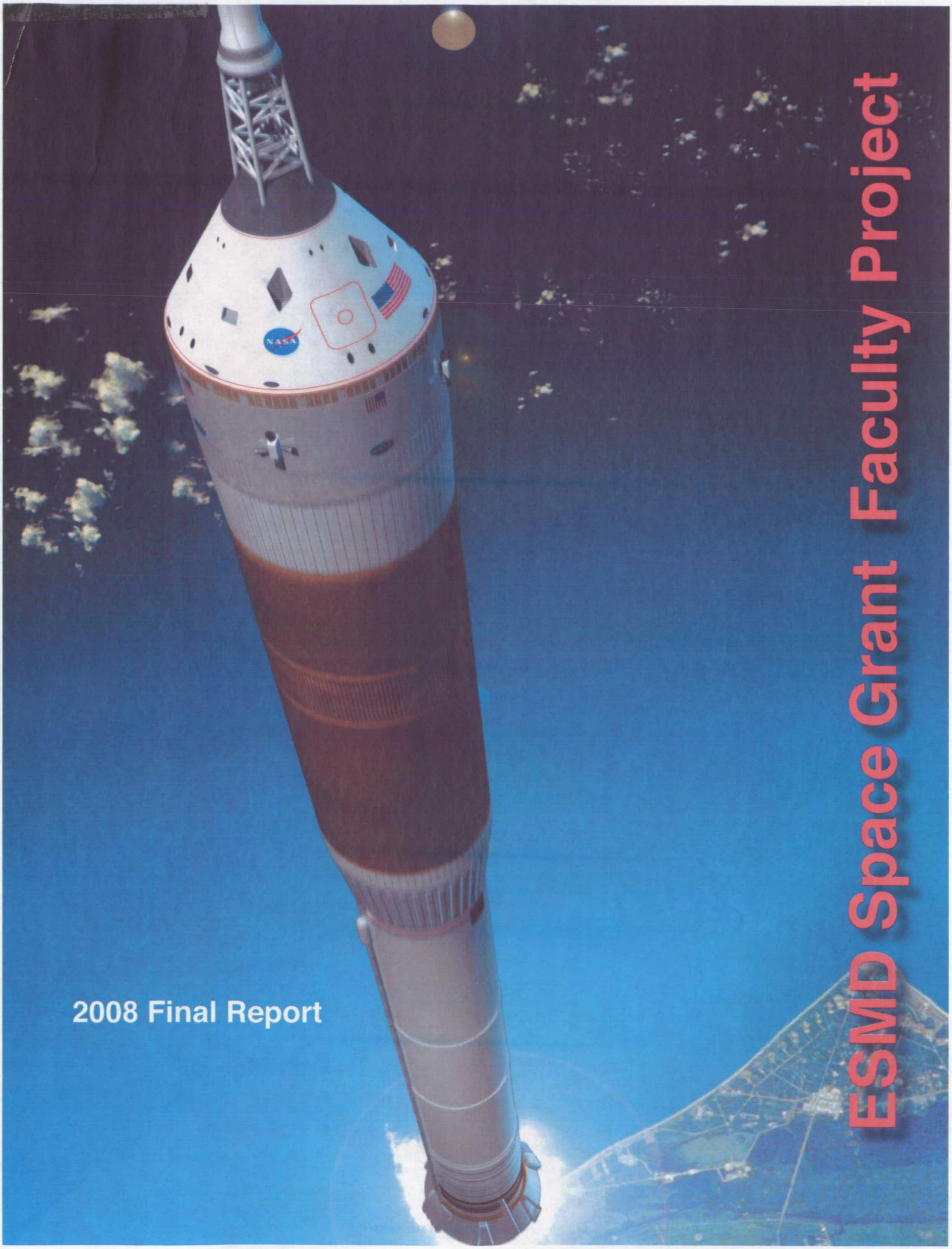
ESMD Space Grant Faculty Project
2008 Final Report

2008 ESMD Space Grant Faculty Project

Final Report
From
All NASA Centers

By

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“The Earth is the cradle of humankind, but one cannot live in the cradle forever.”
– Konstantin Tsiolkovsky, 1895

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EXECUTIVE SUMMARY

The strength of the Exploration Systems Mission Directorate ESMD Faculty Project lies in its ability to meet National Aeronautics Space Administration ***NASA's Strategic Educational Outcome 1*** by developing a sustainable and long-term integration of student involvement at academic institutions with all NASA Centers. This outcome is achieved by a three-fold approach: 1) by collecting Senior Design projects pertaining to Constellation work performed at each of the ten NASA Centers, 2) by engaging students at Minority Serving Institutions in the art of systems engineering and systems design of technologies required for space exploration, and 3) by identifying potential internships at each Center relative to exploration that provide students who are supported by their institutional Space Grant to engage in on-going mission-level and explorative systems designs. The objectives of the ESMD Faculty Project are to:

1. Aid the Centers (both Education Offices and associated technical organizations) in providing relevant opportunities for the ESMD Space Grant Program to support student and faculty in Senior Design projects
2. Enable better matches between the ESMD work required and what the Space Grant Consortia can do to effectively contribute to NASA programs
3. Provide the Space Grant Consortia an opportunity to strengthen relations with the NASA Centers
4. Develop better collective understanding of the U.S. Space Exploration Policy by the Center, Space Grant, faculty, Education Office, and students
5. Enable Space Grant institution faculty to better prepare their students to meet current and future NASA needs
6. Enable the Center Education Offices to strengthen their ties to their technical organizations and Space Grant Consortia
7. Aid KSC in gaining a greater and more detailed understanding of each of the Center activities

Senior Design projects are intended to stimulate undergraduate students on current NASA activities related to lunar, Mars, and other planetary missions and to bring out innovative and novel ideas that can be used to complement those currently under development at respective NASA Centers. Additionally, such academic involvement would better the prospects for graduating seniors to pursue graduate studies and to seek careers in the space industry with a strong sense for systems engineering and understanding of design concepts. Internships, on the other hand, are intended to provide hands-on experience to students by engaging them in diverse state-of-the-art technology development, prototype bread-boarding, computer modeling and simulations, hardware and software testing, and other activities that provide students a strong perspective of NASA's vision and mission in enhancing the knowledge of Earth and space planetary sciences.

Ten faculty members, each from a Space Grant Consortium-affiliated university, worked at ten NASA Centers for five weeks between June 2 and July 3, 2008. The project objectives listed above were achieved. In addition to collecting data on Senior Design ideas and identifying possible internships that would benefit NASA/ESMD, the faculty fellows promoted and collected data when required for other ESMD-funded programs and helped the Center's Education Office, as needed.

NASA'S EDUCATIONAL OBJECTIVES

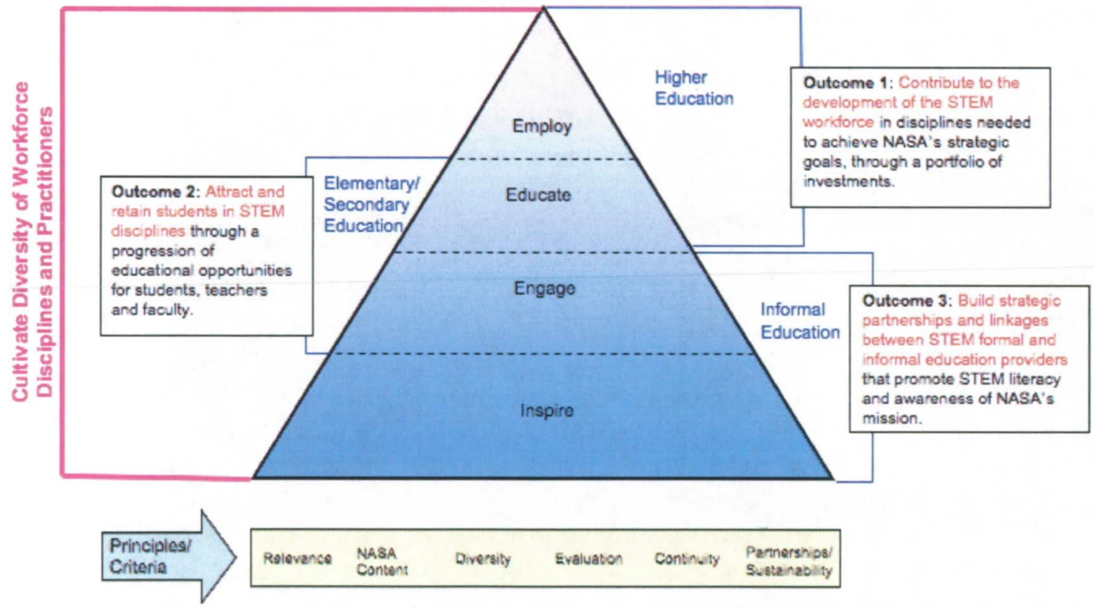
Three outcomes serve to align all agency education activities:

Outcome 1: Contribute to the development of the STEM workforce in disciplines needed to achieve NASA's strategic goals through a portfolio of investments.

Outcome 2: Attract and retain students in STEM disciplines through a progression of educational opportunities for students, teachers, and faculty.

Outcome 3: Build strategic partnerships and linkages between STEM formal and informal education providers that promote STEM literacy and awareness of NASA's mission.

NASA Education Strategic Framework



Description of the Four Categories of Involvement

Inspire–Activities focused on promoting awareness of NASA's mission among the public, primarily through informal education and outreach activities. This category is heavily supported by the outreach activities of other NASA organizations, such as the Office of Public Affairs. *Inspire* level efforts are broad, with the goal of reaching a large number of people, but are not limited to "in-person." This category forms the base of an education structure that becomes more focused at progressively higher levels of the framework "pyramid."".

Engage— Education activities that in some manner incorporate participant interaction with NASA content for the purpose of developing a deeper understanding. Participants are strategically identified and targeted.

Educate—Focused education support that promotes learning among targeted populations. Education activities focus on student learners, or pre- and in-service educators, and are designed to develop and/or enhance specific STEM knowledge and skills using NASA resources. *Educate* activities promote new knowledge acquisition and strengthen an individual's skills. NASA's elementary and secondary education efforts are supplementary to formal classroom instruction. NASA's higher education efforts may include development of specific university curricula in support of the NASA mission and student-built instruments.

Employ—Targeted development of individuals who prepare for employment in disciplines needed to achieve NASA's mission and strategic goals. Through internships, fellowships, and other professional training, individuals become participants in the U.S. Space Exploration Policy and NASA science and aeronautics research. At the apex, they have acquired sufficient mastery of knowledge for employment with NASA, academia, industry, or within STEM fields of teaching.

In 2006 NASA's ESMD partnered with the National Space Grant Consortia (SG) to create the ESMD SG Faculty Project. This Project is aligned with Outcome 1 of the NASA Education Strategic Framework: *Contribute to the development of the STEM workforce in disciplines needed to achieve NASA's strategic goals, through a portfolio of investments.* The Primary Outcome was identified as: *(Employ) Provide NASA competency building education and research opportunities for faculty, researchers, and post-doctoral fellows.*

The ESMD faculty project enables the above objectives to be achieved by providing faculty access to NASA centers and allowing faculty to act as liaisons between NASA and the academic community.

CONSTELLATION PROGRAM ASSIGNMENTS AT NASA CENTERS

The aim of the ESMD Faculty Project is to address future workforce needs of NASA's Constellation Program (Outcome 1).

Constellation Program

The structural model that most closely resembles the current mission is the Apollo "5-box" (shown in Figure 1) management structure and was selected because it worked effectively. These five organizational functions are comprised of program planning and control; test and verification; operations integration; systems engineering and integration; and safety, reliability and quality assurance. This was adapted and tailored to the Constellation Program's more evolutionary objectives.

Constellation is envisioned to have developmental aspects throughout its life cycle in that new developments to support the next mission will start in phases as current developments become operational. For instance, lunar outpost development will start after the low Earth orbit portions of the Program are operational. The adapted organizational structure is shown in Figure 1. Note that an advanced development function (Advanced Projects Office) has been added to the Apollo "5-box" structure. This organization houses research and development activities for "pre-projects" envisioned to support lunar missions and beyond. Organizations outside of NASA, such as international and commercial partners, could be involved in these later phases of the Program.

The Constellation Program was staffed with recognized leadership within the Agency (e.g., from the ISS Program, Space Shuttle Program, and Mission Operations Flight Director Office) and the contractor/DoD space community between November 2005 and March 2006, seeking project managers with demonstrated experience in executing projects and discipline area leaders able to assemble strong teams, articulate a clear vision of the task, and integrate horizontally and vertically.

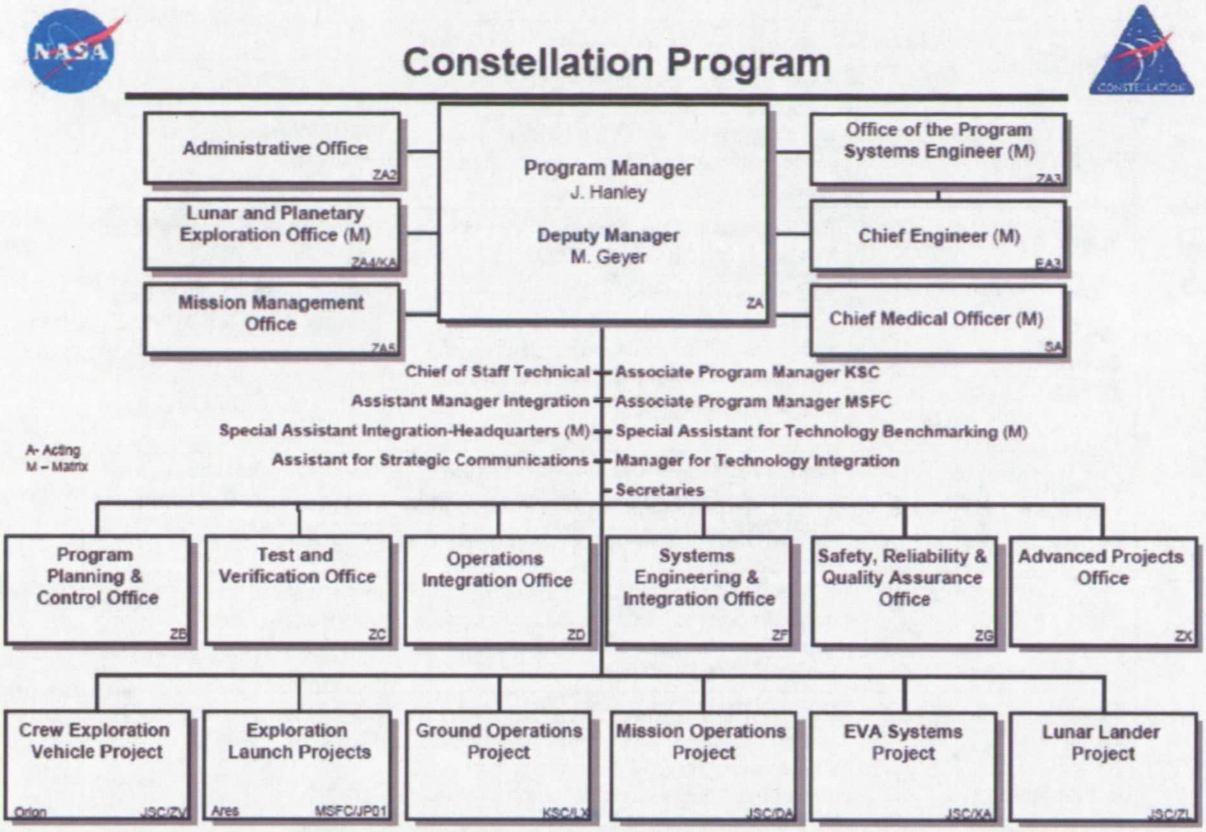


Figure 1: Constellation Organization Structure. Program Management (first row boxes); the Program Offices adapted from the Apollo 5-box structure (second row boxes); Project Offices (third row boxes).

Constellation Projects that comprise the Constellation Program are listed in the bottom row of Figure 1. Table 1 describes major responsibilities for each project in the development and operational phases of the Program.

It is known from Agency history that its success depends on a strong program leading strong projects. As soon as the program office was staffed, a process began of negotiating roles and responsibilities between the Program and projects. All recognized the importance of having a program office integrate project interfaces, as well as the importance of allowing projects maximum flexibility in managing their assigned element. However, a detailed examination of integration processes was necessary to truly understand and assign responsibilities. The program and project deputies conducted integration process decomposition in order to understand and agree upon ownership for each step in the integration processes. This understanding is paramount for implementation of hardware and software interface agreements and is a key element leading into the design definition phase.

Constellation Project	Lead NASA Center	Function	
		Developmental Phase	Operational Phase
Project Orion	JSC	Develop and test the Orion (CEV) spacecraft to transport crew to and from space.	Provide Orion spacecraft.
Project Ares	MSFC	Develop and test the Ares I (CLV) and Ares V (CaLV) launch vehicles.	Provide Ares launch vehicles.
Ground Operations Project	KSC	Perform ground processing and integrated testing of launch vehicles. Plan, construct and/or reconfigure integration, launch, and recovery services for Orion Crew Module, Ares I and Ares V.	Provide logistics and launch services. Provide post-landing and recovery services for the crew, Orion Crew Module, and spent Ares Solid Rocket Boosters.
Mission Operations Project	JSC	Configure, test, plan, and operate facilities, systems, and procedures. Plan missions and flight operations.	Train crew, flight controllers, and support staff. Coordinate crew operations during missions.
Lunar Lander Project	JSC	Develop and test the Lunar Lander to transport crew to and from the lunar surface and to provide a habitable volume for initial lunar missions.	Provide Lunar Lander.
Extravehicular Activities (EVA) Systems Project	JSC	Develop EVA systems (spacesuits, tools, and servicing and support equipment) to support crew survival during launch, atmospheric entries, landing, abort scenarios, and outside the space vehicle and on the lunar surface.	Provide spacesuits and tools.
Future Projects	To be deter-mined	Develop systems for future applications including Lunar Surface Systems (equipment and systems for crew operation on the lunar surface) and systems for future human exploration activities.	Provide future systems as needed.

Table 1: Constellation Project Descriptions

The Constellation Program has been formulated, and must execute, during continuous operations of the space shuttle (through 2010) and ISS.

Moreover, NASA must be prepared to make best use of the expertise resident in the space shuttle workforce, when it becomes available as that program phases out. Constellation has developed a phased development program in anticipation of this workforce availability.

The Program Office workforce is comprised of engineers, scientists, and administrative personnel and was sized utilizing experience from past programs as well as guidance on availability of key personnel to support three human spaceflight programs at the Johnson Space Center. The initial size estimate was based on previous human spaceflight programs and was set at approximately 8% of the total program content. After the Program System Requirements Review, there was sufficient experience in the office to attempt a reduction in the budget to only approximately 6.5% of the total Program content. This was based on expected workload and products and a better understanding of the Program integration responsibilities. The Program team continues to track risks incurred with this funding level and to reprioritize work as needed to meet the Program milestones.

The projects are staffed by leveraging expertise across the Agency. Project work assignments at the 10 NASA Centers (and the White Sands Test Facility/White Sands Missile Range) are described in Figure 2.

It is recognized that managing a team distributed to this extent is a daunting challenge; indeed it is only now possible with current communications technology that enables real-time electronic meetings, single-source record keeping, and maintenance of the requirements baseline in a single database accessible by all program elements. All members of the workforce must use the selected electronic tool suite in order to make this distributed team work.

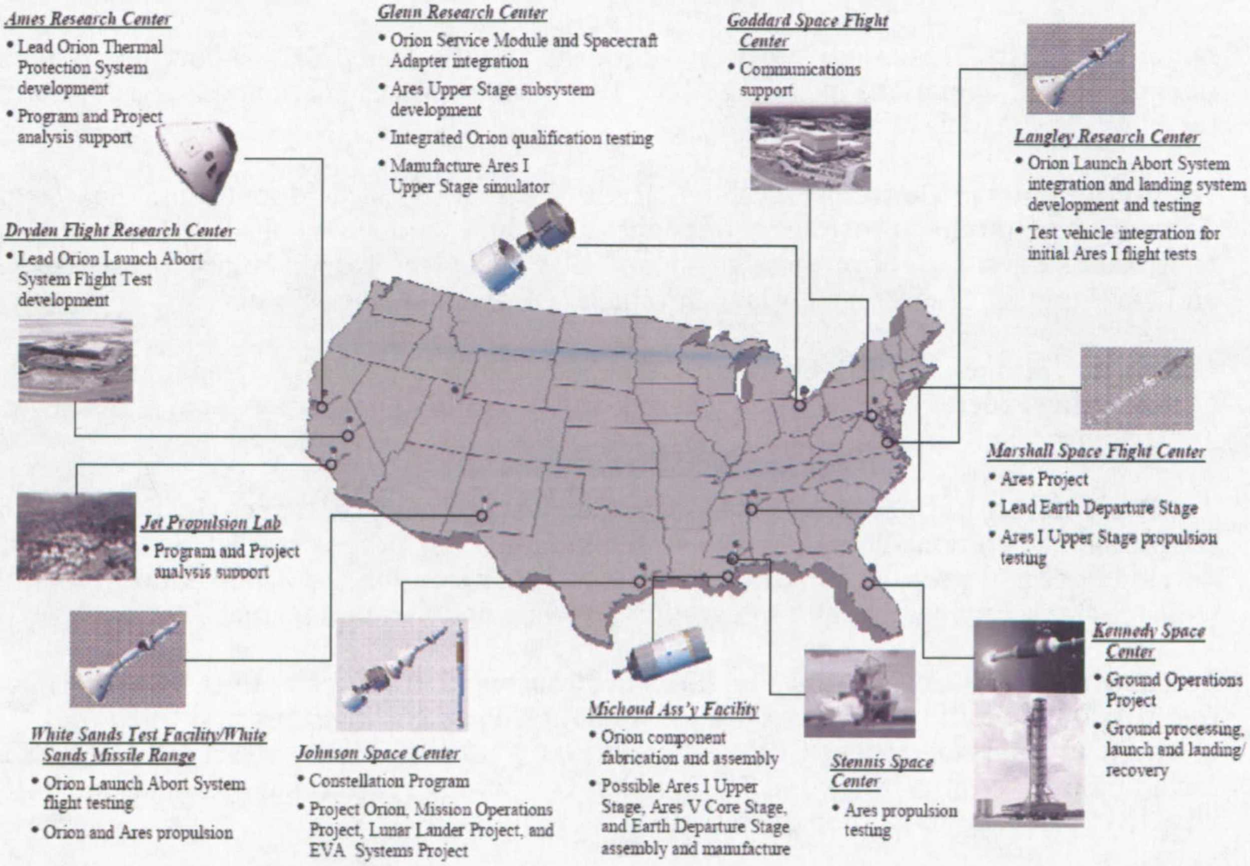


Figure 2: Constellation work assignments at NASA Centers

Constellation Project Assignments at NASA Centers

In June 2006, NASA announced Agency center responsibilities associated with the Constellation Program for robotic and human exploration of the Moon and Mars. The distribution of work across NASA's centers reflects the Agency's intention to productively use personnel, facilities and resources from across the Agency to accomplish the U.S. Space Exploration Policy.

In addition to the primary work assignments each Center will support the Moon and Mars surface systems conceptual designs. Constellation Center assignments are:

Ames Research Center, Moffett Field, Calif., leads the Crew Exploration Vehicle (CEV) Thermal Protection System Advanced Development Project. Ames is developing information systems to support the Constellation Program Safety, Reliability, and Quality Assurance Office.

Dryden Flight Research Center, Edwards, Calif., leads CEV Abort Flight Test integration and operations including Abort Test Booster procurement and integration with the Flight Test Article.

Glenn Research Center, Cleveland, leads the CEV Service Module and Spacecraft Adapter integration, providing oversight and independent analysis of the prime contractor's development of these segments. Glenn has lead responsibility for the design and development of several crew launch vehicle (CLV) upper stage systems.

Goddard Space Flight Center, Greenbelt, Md., provides co-leadership of the Constellation Program's System Engineering and Integration navigation team and software and avionics team.

Jet Propulsion Laboratory, Pasadena, Calif., leads a multi-center activity in support of the Mission Operations Project to plan systems engineering processes related to operations development and preparation. JPL provides co-leadership for the Constellation Program Office Systems Engineering and Integration Software and Avionics team.

Johnson Space Center, Houston, hosts the Constellation Program, the CEV Project and the Mission Operations Project. The Constellation Program manages and integrates the program and all projects. The CEV Project Office manages and integrates all CEV elements including prime contractor work. The Mission Operations Project manages and integrates all activities related to mission operations.

Kennedy Space Center, Fla., hosts the Ground Operations Project. The project manages all activities related to ground operations for the launch and landing sites, including ground processing, launch, and recovery systems.

Langley Research Center, Hampton, Va., leads Launch Abort System integration supporting the CEV Project, providing oversight and independent analysis of the CEV prime contractor's development of the system. Langley leads the Command Module Landing System Advanced Development Project for CEV. Langley provides vehicle integration and CEV test article module development for the CLV Advanced Development Flight Test-0.

Marshall Space Flight Center, Huntsville, Ala., hosts the Constellation Launch Vehicle projects. The projects are responsible for project management of all CLV and cargo launch vehicle related activities. Marshall provides the CLV first stage design, and is responsible for launch vehicle demonstration testing including the Advanced Development Flight Test-0.

Stennis Space Center, Miss., manages and integrates rocket propulsion testing for the CLV Project. Stennis leads sea-level development, certification, and acceptance testing for the upper stage engine, sea-level development testing for the upper stage main propulsion test article, and sea-level acceptance testing for the flight upper stage assembly.

The pilot testing of the ESMD Faculty Project began in 2007 with five faculty members, each assigned to two NASA Centers. The outcome of this pilot testing was very successful in that a large number of Senior Design topics and internships were identified.

SCOPE OF PROJECT

To enable the collection of Senior Design topics and identify potential areas for internships, four broad areas have been identified that describe the scope of the Project in terms of its breadth and depth. While there is overlap among the areas, the areas in general capture the essential components for space exploration. The ESMD areas and categories are:

Spacecraft: Guidance, navigation and control; Thermal protection; Electrical sources and systems; Software; Avionics; High-speed re-entry; Modeling and simulation; Interoperability/commonality; Advanced spacecraft materials; Crew/vehicle health monitoring; Life support systems.

Propulsion: Methods that utilize materials found on the Moon and Mars; On-orbit propellant storage; Approaches to soft-landing on planetary surfaces.

Lunar and Planetary Surface Systems: Precision landing software; In-situ resource utilization; Navigation systems; Extended surface operations (Habitats for human exploration of planetary systems); Robotic platforms; Novel approaches for planetary environmental analysis; Radiation protection for humans and machinery; Life support systems; Electrical power source and power transmission systems.

Ground operations: Pre-launch, launch, and post-launch mission operations, Command, control, and communications; Landing and recovery operations.

SUMMARY OF FACULTY PROJECTS AT ALL NASA CENTERS

Ames Research Center

Ames Research Center, located in the heart of California's Silicon Valley, is leading NASA's efforts to provide advanced, state-of-the-art technology for current and future NASA missions. It has played a major role in the ground-breaking Phoenix Mars mission in 2008.

Prof. Jiang Guo arrived at Ames on June 1st, 2008 and met with Brenda Collins, the Assistant Chief of Department of Education.

Starting on June 2nd and ending on July 2nd, Prof. Guo visited the Ames Exploration Technology Directorate, Aeronautics Directorate, Science Directorate and Project Management and Engineering Directorate. He identified a total of 40 new internship positions and 6 senior design projects. All the ESMD request forms for Senior Design projects and internship positions have been completed and properly signed.

Prof. Guo combined direct and indirect approaches to work on the ESMD Space Grant Faculty Project. He used a direct approach to confirm, verify, and update the existing intern positions collected for 2008 and used an indirect approach to collect new positions for 2009.

In the direct approach, Prof. Guo downloaded all the existing intern positions information from the PBMA database, which, when collected in 2007, was a total 21 internship positions and 4 senior design project positions. Then, he used the mentors' information in the forms to contact them directly. First, he sent emails to all the mentors to make appointments. Some mentors replied, but some didn't. Then, he made follow up phone calls to check for time availability. This was a very effective bottom-up approach because he didn't have to wait for anything. He met the mentors first, and then he met the chiefs through the mentors. In this way, he met all the existing mentors and confirmed, verified, and updated all the existing intern positions and Senior Design projects.

In order to collect more new intern positions and senior design projects at NASA Ames, he used an indirect approach. In this approach, with Brenda Collins' arrangement, Prof. Guo met Dr. Carol Russo, Deputy Director and James Clement, Associate Director of Exploration Technology Directorate. James Clement, the Associate Director, gave Prof. Guo a brief introduction on research and work at NASA Ames. Dr. Carol Russo, the Deputy Director, and Prof. Guo discussed how to expose the ESMD internship and senior design project program to chiefs and scientists in Exploration Technology Directorate. They also recommended that he visit ESMD-related research in the Aeronautics Directorate and Science Directorate.

In the indirect approach, Prof. Guo used a top-down method. He met the chiefs first, and then he met the new mentors with the chiefs' recommendations.

The Exploration Technology Directorate (Code T) is comprised of four separate and distinct research divisions:

The Intelligent Systems Division (Code TI). This division focuses on research and developing new technologies to employ new mission concepts and increase mission reliability and assurance while reducing mission costs.

The technical areas in this division are:

- Autonomous Systems & Robotics
- Collaborative & Assistant Systems
- Discovery & System Health
- Robust Software Engineering

Prof. Guo visited many chiefs, leads and scientists in this division and identified five new senior design projects. For ESMD research areas, two of them are Lunar and Planetary Surface Systems related, two of them are Ground Operations and Spacecraft related, and one of them is Lunar and Planetary Surface Systems, Propulsion, Ground Operations and Spacecraft related.

Thirteen new internship positions were identified in this division. ESMD related areas are shown in Table 1.

ESMD-Related Areas	Number of New Internship Positions in TI
Ground Operations	2
Ground Operations + Propulsion	3
Ground Operations + Propulsion + Spacecraft	1
Lunar and Planetary Surface Systems	5
All Areas	2
Total	13

Table 1. Internship positions and ESMD -related areas in TI Division at NASA Ames.

Human Systems Integration Division (Code TH). This division focuses on the new technologies of the perceptual and cognitive aspects of human performance. Their research and development are conducted on human-automation integration to support many NASA missions. The technical areas in this division are:

- Human Automation Integration Research
- Human Information Processing Research
- System Safety Research

Prof. Guo visited Division Chief Patricia Jones. She found an office with a printer for him. With her help, he visited many chiefs, leads and scientists in this division. Ten new internship positions in this division were identified. ESMD-related areas are shown in Table 2.

ESMD-Related Areas	Number of New Internship

	Positions in TH
Ground Operations	1
Spacecraft	2
Lunar and Planetary Surface Systems	7
Total	10

Table 2. Internship positions and ESMD-related areas in TH Division at NASA Ames.

NASA Advanced Supercomputing Division (Code TN). This division provides supercomputing environments for NASA-wide customers. They also conduct research on application development, simulation and modeling to various NASA missions. The technical areas in this division are:

- Advanced Architectures and Networks
- Computational Technologies
- NASA Mission Applications
- Supercomputing Operations

Prof. Guo visited Division Deputy Chief Dr. Bryan Biegel. With Dr. Bryan Biegel's help, he visited many chiefs, leads and scientists in this division. Ten new internship positions were identified in this division. Since this division provides super-computing capability to all the ten Centers, all the new internship positions are related to all four ESMD areas: Ground Operations, Propulsion, Spacecraft, Lunar and Planetary Surface Systems (Table 3).

ESMD-Related Areas	Number of New Internship Positions in TN
Lunar and Planetary Surface Systems Ground Operations + Propulsion + Spacecraft	10
Total	10

Table 3. Internship positions and ESMD-related areas in TN Division at NASA Ames.

Space Technology Division (Code TS). This division focuses on developing new technologies for materials, aerothermal simulation & modeling. The technical areas in this division are:

- Advanced Sensors, Materials, & Electronics
- Reacting Flow Environments
- Thermo-Physics Facilities
- Thermal Protection Materials & Systems

Prof. Guo visited Division Chief Charles Smith. By his recommendation, Prof. Guo visited David Hash, Deputy Chief and Senior Research Scientist, who is in charge of all the internship programs and Senior Design projects in this division. One new internship position was identified, which is related to ESMD Spacecraft area.

The Science Directorate (Code S) focuses on research and development products for the space community in astrobiology and related areas, including earth, space, and life science. Prof. Guo visited Space Biosciences Division and Space Science and Astrobiology Division.

Space Biosciences (SC). This division focuses on providing bioscience knowledge and developing new technologies and operations capability to extend human presence to support space exploration. The technical areas in this division are:

- Bioengineering
- Flight Systems Implementation
- Radiation & Space Biotechnologies

Prof. Guo visited Chief Dr. Mark Kliss. With his help, Prof. Guo identified four new internship positions. They are all Spacecraft and Lunar and Planetary Surface Systems-related ESMD internship positions. Currently, Dr. Kliss has three ESMD internship program funded students working in his branch.

The Aeronautics Directorate (Code A) focuses on developing new concepts and technologies for advanced airspace operations, aeronautics and aerospace systems. It also conducts research on analysis tools for these technologies and systems. Prof. Guo visited Aviation Systems Division.

Aviation Systems Division (Code AF): This division focuses on research and development of air traffic management and high-fidelity flight simulation. For air traffic management, they focus on "creating and testing concepts to allow for up to three times today's level of aircraft in the national airspace." The technical areas in this division are:

- Terminal Area ATM Research
- Automation Concepts Research
- Aviation Operation Systems Development
- Aerospace Simulation Operations
- Aerospace Operations Modeling
- Flight Deck Integration & Simulation Research

Prof. Guo visited Chief Dr. Jeffery Schroeder. By his recommendation, Prof. Guo visited Eric Mueller, Aerospace Engineer. Prof. Guo identified one new internship position with Ares-- related ESMD Spacecraft and Lunar and Planetary Surface Systems areas.

Prof. Guo also visited Deputy Chief Dr. Butler Hine, who is the Project Manager for the NASA Small Spacecraft Project at Project Management and Engineering Directorate at NASA Ames. One senior design project and one internship position have been identified. Both are related to the ESMD Spacecraft area.

During his tenure period as a NASA fellow, Prof. Guo also reviewed Auburn University's and Michigan Technological University's Senior Design Project Course materials and submitted review reports.

Dryden Flight Research Center

Stephen A Whitmore, Ph.D., Assistant Professor in the Mechanical and Aerospace Engineering Department at Utah State University began his ESMD Faculty Project tenure at NASA Dryden Flight Research Center on June 1, 2008. The main Dryden facility is located at Edwards AFB California, and is a tenant of the Air Force Flight Test Center (AFFTC). Currently Dryden is in the process of moving its science airplane operations to Palmdale California (50 miles away from the main facility), and will utilize 42 mothballed facilities at the USAF plant. Along with Stennis Space Center, Dryden is one of the smallest of the NASA center. Historically has been a flight operations center with the majority of work directed towards aeronautics and flight test. Dryden is primarily an "aero" center and the technical staff is to a large extent unfamiliar with the spaceflight "wing" of NASA.

Because of the small center size, and large flight-support work-load there is little discretionary time available amongst the technical staff at Dryden. Convincing the technical staff to support unfunded "ancillary" ESMD activities in all but a very cursory way was a "tough sell". During my investigations at DFRC I identified that the majority of Senior Design projects and internships identified for AY-2007/08 ESMD Faculty project were unsupported. In fact several of the identified POC's had no idea that this project even existed. Many of these tasks were closed. In all only one senior design topic and four internship opportunities were "rolled-over" and renewed from last year.

Dryden has the smallest center-related ESMD role within NASA. Officially, DFRC's primary role within the ESMD work breakdown is to lead the Orion CEV abort flight test integration and operations including abort test booster procurement and integration with the flight test article. There are two planned flights, a "capsule and tower only" pad abort test, PA-1. A flight test abort launch is also planned. In the Ascent-Abort (AA-1) test a full scale Orion capsule and abort tower will be launched to an altitude of approximately 50,000 ft. using a peacekeeper missile (SR-119) second stage. Beginning with Pad-Abort Tests the Launch Abort System (LAS) will be tested at the White Sands Missile Range, New Mexico, in late 2008 or early 2009. The purposes of PA- and AA- flights are to test the performance of the launch abort systems. Critical parameters include separation g-loading and "time-to-safe" after separation. This project is one of the largest flight tests programs ever undertaken at Dryden. Schedules are extremely compressed, and little latitude for schedule deviation is allowed.

An additional ESMD opportunity for Dryden emerged during my time at Dryden, that is, the development of a lunar landing training flight test vehicle. Dryden has been tasked to investigate feasible concepts by the Altair (Lander) office at Dryden. Dr. Whitmore's technical POC asked him to support this effort with some concept analysis. Dr. Whitmore "fleshed-out" a tethered lander concept where compressed nitrogen jets are used for 5/6-gravity offset and the "gravity-platform" is stabilized using momentum wheels. A gimbaled inner platform provides for maneuvering lift and gravity offset. Dr. Whitmore stayed an additional week at Dryden to present this concept to the JSC Lander (Altair) and Autonomous Landing and Hazard Avoidance (ALHAT) Offices.

The lander-related work directly resulted in two supported Senior Design topics and one internship opportunity. A final senior design topic to support Aero-Assist Options for Mars Surface Sensor Deployment was added and the POC time is supported by a previous project. A final internship opportunity was added to support a previously funded study for linear-motor launch assist.

Glenn Research Center

Professor Roger Radcliff visited the Glenn Research Center in Cleveland, Ohio, which is responsible for the following Constellation work tasks:

- Orion Service Module and Spacecraft Adapter Integration
- Ares Upper Stage Subsystem Development
- Integrated Orion Qualification Testing
- Manufacture Ares I Upper Stage Simulator

The University Affairs Officer prearranged visits with seven divisions. The schedule was

• Power and In-Space Propulsion	June 2,3,4
• Space Processes and Experiments	June 5,6,9
• Structures and Materials	June 10,11,12
• Communication	June 13,16,17
• Instrumentation and Controls	June 18,19
• Power and Avionics	June 23,24,25
• Mission and Mission Analysis	June 30, July 1

Days not dedicated to this schedule were reserved for meetings with interns, interfacing with PBMA, revisiting people, etc.

Many of the division/branch chiefs had only vague knowledge of why the faculty fellow was there. So, Prof. Radcliff's strategy was to let them know why he was there, meet with people who are currently on the database, and have the chiefs communicate to everyone else why he was there and encourage them to meet with him if they had any interest.

Prof. Radcliff found a wide range of interest for mentoring between divisions and branches. Most were lukewarm about adding work to their load, but were polite and accommodating. For example, he left the Space Processes and Experiments Division rotation with 16 oral commitments, but only four completed the submission process by COB July 3.

Overall, as of July 3rd, ten internships and two senior projects were posted with all information in hand. Thirteen other people committed to internships, but without revised descriptions or request forms. One new senior project was promised, but the POC could not provide the request form and journal papers by the end of the project.

Prof. Radcliff anticipates that he will receive new/revised descriptions from the people who didn't follow up before he left. He will have them fax the request forms to the KSC Education Office.

Goddard Space Flight Center

Professor Prabhakar Misra's five-week assignment at NASA Goddard Space Flight Center began on June 2 and ended on July 2, 2008. During this period, Dr. Misra focused on Constellation work at Goddard relating to the ESMD primary work assignment, areas of emphasis, potential rotations and competencies, which are summarized below.

Primary Work Assignment: Goddard provides co-leadership of the Constellation Program's System Engineering & Integration Navigation team and the Software & Avionics team.

Areas of Emphasis: For Constellation Program Systems Engineering, Goddard has responsibility for communications, tracking and support mechanisms for the CEV. These include Flight Performance, Navigation, Software & Avionics, Structures & Loads, and Communication System. In addition, Goddard supports Integration & Test for both the Lunar Reconnaissance Orbiter (LRO) and the Lunar Orbiter Laser Altimeter (LOLA). Other support to LOLA includes IP-based communications, Ground Operations, and Satellite Servicing. Besides the above areas, other Goddard areas of responsibility include the design of a Spacecraft to support a Lunar Mission, evaluation of the current strategy and provision of recommendations for the ESAS mission, and recommendations for instruments on SuitSat 2/3 that are in alignment with Exploration goals and objectives.

Potential Rotations: Lunar Reconnaissance Orbiter Project Office, Mechanical Systems Division, Instrument Systems & Technology Division, Information Systems Division, Mission Engineering & Systems Analysis Division, and the Solar System Exploration Division.

Competencies: Aerospace Engineer, Mechanical Engineer, Systems Engineer, and Electrical Engineer.

The primary networking approach was via telephone and e-mail in order to contact and set up individual appointments and to make presentations that provided an overview of the ESMD internship and senior design project efforts. These meetings and presentations were followed by e-mailing of the ESMD brochure and requests for project confirmation and/or new descriptions. The number of new confirmed internships (with approved & signed forms) totaled six, besides four continuing ones, yielding a total of ten potential internships at Goddard. The number of new confirmed Senior Design Projects (with approved & signed forms) at the Center is 3, together with five continuing ones, yielding a total of eight potential NASA-ESMD Senior Design efforts sponsored by Goddard. These project opportunities are summarized in the Appendix.

Professor Misra was also involved in other extracurricular activities and meetings with NASA mentors germane to the entire ESMD effort. On June 5, 2008, for instance, Dr. Misra attended a very informative seminar entitled "Organic Haze on Titan and the Early Earth" by Melissa G. Trainer of the University of Colorado at Boulder (3:30-4:30 pm, Goddard Bldg 2/Rm 8). In the course of conducting the ESMD Faculty Project, Professor Misra was involved in several activities that provided greater depth to the project through knowledge sharing with Center technical staff, and with students and their mentors in both formal and informal settings. For example, on June 11, 2008, Dr. Misra had an extensive meeting with Dave Everett, who is the Lunar Reconnaissance Orbiter (LRO) Mission

Systems Engineer. His current Senior Design Project "Design of a Spacecraft to Support a Lunar Mission: Shackleton Crater Reconnaissance Project" was implemented very successfully in conjunction with the University of Minnesota (Faculty Mentor: James Flaten with nine students registered for the Senior Design course). Excerpts from a thank-you letter written by the students to Dave Everett indicate how a hands-on NASA sponsor is crucial to the success of a Senior Design project: "For most of us, this was our first experience working with spacecraft. Your guidance has been crucial in developing our confidence for working on future projects. Without your help we surely would have wasted countless hours pursuing dead ends." On the same day (June 11, 2008), Dr. Misra visited the LRO and Hubble Space Telescope facility accompanied by Dave Everett. On another occasion, during the week of June 16, 2008, Stanford Ollendorf provided a brief summary of his Senior Design project involving the design of a Lunar Rover thermal control system utilizing a Loop Heat Pipe (LHP) that was built and tested by Louisiana Tech students (Faculty mentor: Hisham Hegab) with 98% realization of performance goals. Professor Misra met Jacqueline LeMoigne & her current ESMD student intern, Sean Brakken-Thal from Tacoma, Washington, on July 1, 2008 (10:30-11:30 am) & listened to a presentation by Sean relating to his research involving "Texture Analysis with Applications to Terrain Classification." Sean indicated an interest to apply for a similar ESMD internship for 2008-09, while he is enrolled as an undergraduate student in Aerospace Engineering at the University of Southern California starting Fall 2008.

Considerable time and effort was spent during the weeks of June 9 & June 16, 2008, reviewing and critiquing the Auburn and Michigan Technological University Senior Design courses, respectively.

Professor Misra had an informal and yet fruitful meeting with the University Affairs Officer, Vigdor Teplitz, on June 30, 2008, when Dr. Teplitz endorsed and signed the approved ESMD forms for the internships and Senior Design projects. Vigdor stressed that each ESMD student intern at Goddard should receive an additional $1,500 summer stipend (over and above the current $6,000) to cover increased costs relating to housing, local transportation, attendance at special events with other summer students at Goddard and administrative expenses. He indicated that to be competitive with approximately 170 summer interns at Goddard the ESMD stipend per summer intern should be $8,000 for the ten-week period. Dr. Misra also met Mablelene Burrell & Dillard Menchan in the Education Office (on 6/30/08) after his session with Vigdor Teplitz. Both Mablelene & Dillard inquired and requested updates about the ESMD internships & Senior Design projects at Goddard. Dillard was concerned that underrepresented minority students were not applying to the program in adequate numbers and stressed that NASA - in conjunction with university faculty - needs to publicize effectively the availability of these ESMD internship and Senior Design opportunities, with special attention focused on attracting minority students to the program. Professor Misra pointed out that Kennedy Space Center was considering providing a link to this program at each of the ten NASA Center websites via their education and outreach offices.

Jet Propulsion Laboratory

The five weeks of the ESMD Faculty Project was performed at NASA/Jet Propulsion Laboratory in Pasadena, California by Prof. Nadipuram (Ram) Prasad. The Constellation work at JPL is entirely oriented towards robotic missions for planetary exploration. The Center is focused on developing advanced robotic platforms with revolutionary technologies for imaging, guidance navigation and control, landing systems, and with capabilities for scientific exploration of Lunar, Mars, and other planetary systems.

The Center is committed to achieving successful robotic missions as a precursor to NASA's manned missions to the Moon, Mars, and beyond. As such, the number of projects that constitute JPL's work is enormous and would take considerably longer periods of time to capture the expanse of projects that JPL scientists and engineers are engaged in. The five-week assignment was too short to identify with greater specificity all the projects that one would hope for. A total of six Senior Design projects were collected and five possible internships were identified at JPL.

Senior Design projects include:
1. Robotic platform concepts for Lunar mining operations
2. Concepts for planetary and interplanetary transportation systems
3. Hierarchical control architectures for large-scale habitat monitoring
4. Human-machine interfaces that include gesture recognition by robots
5. Concepts for robotic construction machinery
6. Formation flight systems – navigation, guidance, and control

Internships include:
1. Processing and extraction of life supporting elements from surface and subsurface materials
2. Radiation protection and mitigating effects
3. Physics-based simulation modeling with 3-D graphics for modeling surface terrain suitable for crew training on manned missions
4. Sensor-based command execution
5. 360 degree environmental observation vision system

Commitment forms were distributed to each mentor so appropriate signatures can be obtained from their respective administrative chain-of-command.

Networking within JPL

In general, scientists and engineers responded quickly to inquiries and were very helpful in suggesting contacts in many areas and organizations. Unfortunately because of the very short duration of the Project, including the work schedule that most JPL'ers observe with alternate Fridays off, and the time of year when most individuals take time off for vacation, the networking was severely constrained. My host organization, Bio-Inspired Technology and Systems, Section 345 Flight Systems Avionics, provided office space with computer/Internet and telephone access during the five-week stay. Dr. Anil Thakoor, Group Supervisor, and Dr. Thomas Lu helped me tremendously in developing many contacts within the JPL system. Ms. Linda Rodgers was my primary contact at the JPL Education Office.

Project Reporting and Coordination

All ten faculty Fellows participated in weekly telephone conference calls and the VITs on June 10th. Weekly updates on the Project were shared and material uploaded on to PBMA. Discussions regarding the conduct of the Project were handled by email between all faculty members and Ms. Gloria Murphy, the Project Manager. Ms. Susan Sawyer, Mr. Richard Smith, and Ms. Zola Ingraham provided all the administrative support as and when needed.

Specific Issues and Concerns

Unlike any other NASA Center JPL is a prime NASA subcontractor and is operated by the California Institute of Technology. There is a university atmosphere which is conducive to visiting scholars and professors in information and knowledge sharing. However, this does not extend very well in terms of how engineers view their time commitments towards mentoring Senior Design projects.

Several JPL engineers and scientists do not favor mentoring Senior Design. It was almost unanimous at the presentation given on June 20th that past experience has shown very poor performance by student teams in achieving stated goals. Specific cases were cited wherein design teams changed their goals twice during the design claiming lack of technical know-how. This may be an indication in several cases of poor faculty direction/interaction with the student teams. Additionally, the oversight required by JPL mentors would be excessive in orienting the design teams towards practical outcomes that have any bearing with desired Center activities. As a senior design mentor one has to spend a significant amount of time reviewing the student designs prior to a design review in order to sign-off on the quality of senior design. This, according to several individuals, is not favorable as it almost invariably crosses ITAR/EAR regulations and intellectual property boundaries.

Almost all favor internships as there is more oversight and direction towards achieving the scientific and engineering goals. Students meet weekly with their mentor(s), discuss results, and focus on the desired objectives in a well-defined manner. Students learn to conduct research in a clear and systematic way. Several individuals indicated that all students who have served as interns performed admirably and many students were offered positions in their groups after graduation. Certainly this is a reflection of the measurable outcome, namely Outcome 1, as stated in the NASA Educational Strategy. Several individuals were hesitant in making a quick commitment due to potential programmatic changes and uncertainties in their projects.

There are many lessons learned from this summer fellowship that will be important for future ESMD educational efforts. Most significantly of course is the duration of the effort and collection of information pertaining to Constellation work. Five weeks (21 working days at JPL) is indeed too short for faculty to interact with Center personnel effectively. Considerable amount of this time is taken away by the inability to access internal resources immediately upon arrival at a NASA Center. In my own case, I received access to JPL's internal network on June 25th, five days before the end of the contract. It would be the responsibility of the Education Office to provide immediate access so work can be performed more effectively.

The letter signed by Mr. Scott Horowitz on June 2, 2006 suggesting Center staff to charge small amount of time spent on mentoring Senior Design to existing projects are more than 2 years old. Also, since Mr. Horowitz is no longer with NASA, this did not hold well with individuals at JPL towards charging their time for Senior Design projects.

Johnson Space Center

Johnson Space Center in Houston Texas hosts the Constellation Program as well as the Crew Exploration Vehicle Project and the Mission Operations Project. JSC still has Space Shuttle and International Space Station work, but these functions will decrease in emphasis over the next few years.

Johnson has the following directorates that are involved in Constellation work:

- Engineering (EA), including the following divisions: Systems Architecture and Integration, Aerospace and Flight Mechanics, Avionics Systems, Automation, Robotics, and Simulation, Energy Systems, Crew and Thermal Systems, and Structural Engineering.
- Astromaterials Research and Exploration Science (KA)
- White Sands Test Facility (RA)
- Space Life Science, including the following divisions: Space Medicine, Habitability and Environment Factors, and Human Adaptation and Countermeasures.

There were other directorates with pockets of Constellation work, but these were not consulted.

A five-week rotation barely allows one to touch the surface of the immense number of engineering and science projects at Johnson. As of July 3, 42 senior design projects and ten internship positions were submitted to the PBMA database and another eight senior design projects and ten internships were promised. Each participant was sent a thank you letter with a copy of the signed project/internship sheet, and a copy of the ESMD mentor flier.

The most useful way of obtaining projects at Johnson proved to be meetings organized by the directorate offices. For example, the Engineering Director asked each division chief to arrange a meeting with the faculty member to present project and intern ideas. The engineering directorate scheduled these meetings over the entire five weeks, but it would have been better to schedule them during the first two weeks and devote the last three weeks to collecting the forms and talking with more engineers. There was little turnover of NASA personnel between 2007 and 2008, so a list of interested contacts from 2007 was very helpful. A similar list from 2008 was created.

Other events at Johnson included tours of the old and new mission operations facilities, the simulator facility, the lunar and Martian landscapes ("Rock yard"), lunar habitats mock-ups, the Zero Gravity plane and lectures on "Moon 101."". Future faculty should make sure to visit the neutral buoyancy lab and lunar samples lab.

Kennedy Space Center

Kennedy Space Center in Florida serves as NASA's processing and launch center. In this role, Kennedy manages all activities related to ground operations for the launch and landing sites, including ground processing, launch, and recovery systems. Kennedy has served as the launch center for all of NASA's manned mission and for hundreds of unmanned expendable launch vehicles. For the Constellation Program, Kennedy will continue its role as NASA's processing and launch center. In addition to their primary work assignments, each NASA center will also support moon and Mars surface systems conceptual designs for the Constellation Program. Activities associated with these roles provided numerous opportunities for the identification of ESMD Space Grant Internship and Senior Design Projects during this summer fellowship assignment.

Ellen Lackey served as the ESMD Faculty Fellow at Kennedy. After completing orientation and a general tour with all of the summer interns on the first day, work on the ESMD Summer Project was begun. Arrangements for access to office space, a computer, telephone, and the Internet were very well organized at KSC, and there was no delay in getting started. Gloria Murphy, Susan Sawyer, Richard Smith, and Diane Ingraham provided excellent logistical support. The remainder of the first week was spent making contact with mentors and POC's from projects identified in 2007, researching topics from the 2007 list, identifying peer-reviewed papers for the 2007 senior design projects, and scheduling meetings.

Following initial contact via email, meetings were held with all available mentors and POC's for the projects that had been identified as part of the 2007 ESMD Space Grant Faculty Project, and most of the mentors and POC's indicated that their projects would be continued for the 2008-2009 school year. As a result of these meetings, the project descriptions for a number of these continuing projects were updated so that the expected outcomes and necessary skills were more clearly communicated. It is anticipated that these revised project descriptions will assist faculty and students in the selection of appropriate projects from the database.

With the assistance of Rich Smith and Gloria Murphy of the KSC XA-D Education Office, numerous meetings were scheduled with management of many of the directorates, branches, and programs. While all of the people who were contacted were very accommodating in meeting with Professor Lackey, the referrals by Rich and Gloria made them more receptive to spending time discussing this project. The intent of these meetings with the managers was to provide a broad understanding of the projects at KSC, introduce the ESMD Space Grant Internship and Senior Design Program, and identify potential contacts for new projects. These meetings were very beneficial in increasing Professor Lackey's understanding of NASA programs at Kennedy and expanding her ability to integrate topics related to the work of NASA into classes at her university. During the interviews, Professor Lackey had the opportunity to ask a number of the NASA management what skills that we as engineering educators should focus on to best prepare graduates with skills that meet NASA's needs. All agreed that in addition to general technical competence, communication skills were crucial. Also, the Engineering Directorate people mentioned specific skills including 3-D solid modeling, fluid mechanics, and modeling and simulation skills. These meetings were also beneficial in that Professor Lackey was able to make a number of contacts that lead to the development of new internship and senior design projects. During the weeks at Kennedy, she met with engineers from the Launch Services Program (VA), the Constellation Project Office (LX), Applied Technology (KT), the Launch Integration Office (MK), ISS and Spacecraft Processing Directorate (UB), Information Technology and Communications Services (IT), and the Engineering Directorate (NE). Due to scheduling availability of some of these people, meetings with some people could not be scheduled until her last day at Kennedy but generally, meetings were held throughout the entire time she was at Kennedy.

During the course of Dr. Lackey's discussions with the NASA engineers, a number of new senior design and internship projects were identified. As would be expected with the main role of KSC focusing on operations for launch and landing sites, most projects that were identified fell under the "Ground Operations" category of ESMD Areas of Research. During the discussions, it was apparent that the work of some groups was more conducive to internship and senior design projects than the work of some other groups. For example, the deadlines and quick turn-around times required in much of the design work being conducted for the Constellation Program were not conducive to the development of internship and senior design projects. However, discussions with people in these areas were still beneficial in that it increased Professor Lackey's understanding and awareness of these areas. Also, after she explained the ESMD Space Grant Project, a number of people who did not have projects appropriate for internships or senior design projects referred Professor Lackey to others who did have projects. In addition to the initial meetings that were facilitated by referrals by Rich Smith and Gloria Murphy, referrals by many of the people she spoke with and the arrangement of group meetings by some of the contacts so that Professor Lackey had the opportunity to discuss the ESMD Space Grant Project with a larger number of people were both very helpful in allowing her to contact a relatively large number of people in a short period of time. She was able to make presentations to groups with IT, UB, VA, and NE, and the ESMD Space Grant Project received support from management in these groups. For example, following a short presentation to a staff meeting of NE Division Directors, Roselle Hanson, Deputy Director, Engineering Directorate, sent out a KSC Action Item Tracking System (KAITS) Action requesting that projects from NE be submitted by July 15.

The relatively short time at Kennedy made the completion of all tasks during the project period from June 2- July 2 very difficult. This is not really a problem, but it should be realized that some additional time after the scheduled time will be necessary before everything is wrapped up. For example, for contacts that Professor Lackey first met with during the last couple of weeks that she was at Kennedy, the available turn-around time to get project submissions from them was very short. Having time between the end of the faculty fellow's time at the NASA center and the group meeting at Kennedy is definitely a good idea, and this interim time will at least help in finalizing the majority of the remaining project submissions.

In general, it was easier to identify internship projects than senior design projects. The long-term nature of the projects, the focus on general topic areas, the lack of direct oversight by the NASA contact, the uncertainty in the final product that would be delivered, and the need to avoid proprietary or ITAR limited material served to limit the interest in the senior design projects by many contacts. Some contacts expressed interest in senior design projects but did not have any topics they were working on that were appropriate for this type of project. Others expressed the need for students to have some exposure to the specific technical area at NASA before the students would be able to work on a senior design project related to topics in their area. In general, the people most receptive to the idea of senior design projects seemed to have had some background or experience in academia.

As of July 9, 2008, a total of eight new internship opportunities from Kennedy had been finalized and added to the PBMA database. The project descriptions of six other new internship opportunities have been approved by a NASA manager, and these new projects can be added to the database as soon as final contact information is received. Additionally, draft project descriptions for 8 new internship projects and four new senior design projects have been sent to the NASA POC's for approval, but responses related to these project descriptions had not been received by the time of the submission of this report. However, contact information was forwarded to these POC's so the projects could be finalized by the KSC Education Office if the projects are submitted following the end of the project time period. It is expected that some additional projects will be submitted as a result of a short presentation made at an NE staff meeting on June 25, 2008. Communications from a few of the people that Professor Lackey met with over the last few weeks she was at KSC indicated that they are preparing to submit a project via the KAITS sent out to the NE divisions/offices after this staff meeting concerning the identification of senior design and internship projects. The KAITS requested that they respond by July 15, so it is expected that some additional projects will be submitted through the end of the week ending July 18. As of July 9, 2008, signature forms had been received for about 1/3 of the projects. Mentors and POC's for all other projects have indicated that signature forms for the remaining projects will be submitted, and they were all given instructions to mail forms completed to Gloria Murphy (XA-D). The requirement for signature forms for submitted projects did slow the process somewhat, but the requirement for these signature forms is important and helps ensure that the mentors and POC's are committed to participation in this program.

A second focus of the faculty fellows was the review of materials for two senior design courses being developed so that faculty at schools without direct access to NASA contacts will be better prepared to utilize NASA-related course materials in a senior design course. Each faculty fellow reviewed course materials from Auburn University and Michigan Technological University and provided feedback to the authors of the course materials during the June 2 – July 2 timeframe. This is the beginning of the process to develop course packages for ESMD senior design courses. Each course package that was reviewed contained a good core of material for a senior design course. As these course packages continue to be revised and refined, they offer good potential to provide a foundation for faculty members who would like to incorporate NASA-related materials into their courses. These course packages also have the potential to serve as resources for classes other than dedicated senior design classes as faculty members could utilize portions of the course package materials in a variety of classes even if the entire course package is not adopted. Further refinement of the course package materials and wide notification of the availability of these materials will be critical for their utilization by faculty members.

A third task performed during this project related to obtaining feedback from the ESMD interns at Kennedy to ensure that the ESMD Space Grant Internship Program was meeting their needs and expectations. The opportunity to provide feedback to a third party other than the Kennedy Education Office or the mentor offered the students the opportunity to more freely express their thoughts. Interviews with the 7 ESMD Space Grant interns at Kennedy were scheduled during the time period of June 17 – July 1, 2008, and five interviews were completed. Two students did not keep the appointments that were made, and no time was available to reschedule these. The general consensus from the students who were interviewed was that they were having an excellent experience and that they would recommend this program to others. All said that they were working in areas generally related to their fields of study, and all were working on projects in the areas that they expected based on the description they received before beginning their internship. Positive aspects of the experience noted included interaction with their mentors, interaction with other students, opportunity for tours and seeing the STS-124 landing, and learning in conjunction with their project. All had received computer access and project assignments in a timely manner. The personal interaction with the mentors by the ESMD Faculty Fellows helps identify mentors who are really interested in providing a quality experience for the interns.

Langley Research Center

On June 6, 2008, Prof. Greg Selby began participation in the 2008 KSC ESMD Faculty Program, having been assigned to Langley Research Center, Hampton, Virginia. Approximately one month prior to arrival at Langley, security forms were received via email from the NASA Langley POC, Mr. Lloyd Evans. These forms were completed and emailed back to Mr. Evans about three weeks prior to June 6. As a result of completing the appropriate forms early, check-in (including badge issuance) was accomplished in 15 minutes or less. In addition, superb office space was assigned and available on the first workday. Also, a telephone, computer, and email account were immediately available. The Langley POC should be complimented on his effectiveness, especially in view of the problems other ESMD faculty members encountered at installation check-in.

Summary of Senior Design Projects

Ten senior design projects were identified during Summer 2007 and were listed in ESMD documentation as active projects. The present author reviewed the descriptions of these projects and based on his experience teaching a senior design projects course and advising senior design projects, was concerned that these projects were beyond the scope of typical senior design projects. The projects all required students to use specialized equipment at Langley to perform traditional research activities, as opposed to design activities. After conveying this information to Kennedy personnel, the present author initiated meetings with Langley POCs to review and revise, if possible, the projects listed. All ten of the aforesaid projects are to be deactivated and replaced by the fourteen projects listed below. The signed request forms were submitted to Kennedy personnel on Monday, July 14.

Summary of Internships

Eleven internships were identified during Summer 2007 and were listed in ESMD documentation as active projects. Of these 11 internships, three will be continued without change to the project description; four will be continued with a change to the project description, and four will be deactivated. Five new internships have been identified. The twelve active internships are identified below.

Overview of Meetings with Interns

- **Mr. Patrick Sims (Mentor: Dr. Narasimha Prasad)**

Mr. Sims' project concerns the differential absorption light detection and ranging instrumentation. This instrumentation allows for the detection and quantification of various atmospheric constituents. His summer project involves the development of the architecture for a novel DIAL system for ice detection. Specifically, he is presently researching possible light sources and detectors suitable for the design.
Mr. Sims indicated that the internship has allowed him to engage in hours of critical thinking. He also indicated that he has further developed his ability to search databases, books, and papers for relevant information concerning his topic. He stated that he has gained a technical understanding of laser remote sensing systems and their applications, especially pertaining to atmospheric constituents. He also has gained experience in initiating a new project from a basic idea.

Mr. Sims believes that his internship has permitted him to work at one of the most prestigious research centers in the world. He stated: "I have had the opportunity to see wind tunnels, hear erudite lectures from outstanding researchers, and interact with some of the top minds – students and professionals – in the country. This experience has been great."

- **Mr. Nathan Nasgovitz (Mentor: Mr. Stephen Cavanaugh)**

Mr. Nasgovitz's project concerns the design and production of a MATLAB program that seamlessly meshes three different static aerodynamic databases for the Ares I, CLV, for each of the three observed aerodynamic coefficients: normal force, axial force, and pitching moment. The seamless integration of the three databases will allow for better simulation models to be created and analyzed. Also, it will allow for a better footprint analysis of the first stage rocket, which is to be recovered.

According to Mr. Nasgovitz: "Each coefficient has three databases that represent different times in the flight of the Ares I rocket. The three databases comprise only about three seconds of flight time where the upper-stage section separates from the first-stage rocket. The first database represents stage separation when the two stages are very near each other. The second database represents wake effect data where the relative distance between the two stages is large, but the first stage is still in the wake of the upper stage rocket. The third database represents the first stage in the freestream where it isn't affected by the upper stage rocket."

Mr. Nasgovitz also related: "The databases are created by empirical wind tunnel testing from a variety of places and not all the data is exactly organized like the Aero Book Team would prefer, especially with relatively little data collected due to budget constraints. The program is designed to examine the different databases and prepare them for meshing by first filling the many data gaps via interpolation techniques. After each database is prepared, the data will be adjusted (if needed) to make sure the 5D databases fit together smoothly, i.e. there are no discontinuities in any dimension of the coefficients."

- **Mr. Nathan Elowe (Mentor: Mr. Peter Lillehei)**

The goal of Mr. Elowe's project is to improve existing composite materials mechanically and electrically by adding carbon nanotubes to them. In order to accomplish this, several samples are being tested with different amounts of nanotubes and different methods of fabrication. These tests are performed in a tensile microtester to determine the effect on the integrity of the samples. The behavior of the materials under stress is also being studied using a scanning electron microscope.

Mr. Elowe has indicated that his project has helped enhance his knowledge of topics in materials engineering, including the ability to create and analyze stress-strain diagrams and to calculate and predict moduli for each material. Mr. Elowe has also enhanced his research skills and has learned how to become more systematic in conducting research. New personal skills acquired by Mr. Elowe include the understanding of the electrical properties of nanomaterials and the ability to operate specialized laboratory equipment, such as the scanning electron microscope and the Raman spectroscope. Mr. Elowe suggests: "It has been very enlightening to explore professional research outside an academic laboratory environment."

General comments shared by Mr. Elowe include: "It has been very rewarding to work on a project with this cutting-edge technology – working on a project with a direct link to aerospace. Having a chance to contribute to this research – collecting my own data to add to the understanding of new concepts which will affect the development of new aerospace technologies – is probably the most rewarding benefit that I've received from this internship, thus far.

- **Mr. Travis Noffke (Mentor: Dr. Narasimha Prasad)**

Mr. Noffke was assigned tasks under the ASCENDS project. This is a project to place a LIDAR in earth orbit to detect global concentrations of CO_2. His work involves testing laser electronic control hardware for the project's optical system prototyping and further developing the system's overall architecture.

A few of Mr. Noffke's existing personal skills have been reinforced through participation in the ESMD internship. Of his previously developed skills, those that have been in use are his knowledge of electronics, basic thermodynamics, and professional software systems such as Microsoft Office, MATLAB, and other engineering programs.

Mr. Noffke reported that new personal skills have been acquired through his participation in the ESMD internship. He reported:

"Since the beginning of this internship, there has been a strong emphasis on networking. I have taken the opportunity to extend my communications, organizational, and leadership experiences along those more social lines. I have also furthered my electronics background by working with control electronics. This involves direct feedback systems in electronics and optics. As an engineer, the future work ahead of me is bound to include control theories including PID control and the like so I am glad to have the opportunity to learn about controls in a hands-on environment." Finally, other personal benefits that Mr. Noffke received and general comments are incorporated in his statement below.

"Working in a professional atmosphere goes such a long way to increase my personal motivation for furthering my education and setting higher standards for myself and others. I wish that these opportunities would be more available to students in the future. I would also like to see the ESMD program become more focused on the details of each project and make sure to organize/match mentors and students more effectively, in order to avoid too many students paired with a single mentor or to prevent students' projects (initially chosen) from falling through the "large holes of the bureaucracy."

Summary of Mentors' Perception of the ESMD Program

Questions posed to mentors were extracted from the 2007 ESMD Faculty Report and submitted to the present mentors. They were asked to rate their responses to the questions listed below according to the following scale:

5 = "Strongly Agree"

4 = "Agree"
3 = "Neutral"
2 = "Disagree"
1 = "Strongly Disagree"

The average response of the three mentors is placed in parenthesis after each question, as shown below.

1. Overall, the ESMD summer internship experience has met all of my expectations, thus far. (4.67)
2. I am satisfied with the quality of my ESMD intern(s), thus far. (4.67)
3. My intern(s) had appropriate technical knowledge and skills to pursue the assigned work. (4.67)
4. My intern(s) has(have) been available and approachable, thus far. (5.0)
5. I would recommend the ESMD internship/mentorship opportunity to my colleagues. (5.0)
6. I would like to work with ESMD interns again in the future. (5.0)
7. The ESMD internship activity could potentially help evaluate students for possible positions at Langley Research Center. (5.0)

Comments from the mentors regarded the need for increased programming relevant to the student interns – ESMD related technical programming. Also, there was a desire to have the students receive more assistance finding housing before arriving at the installation. One mentor expressed the need for assistance in arranging for phone and computer internet service for interns so that they would have these resources available to them upon arrival at Langley Research Center.

Overall, the mentors responded positively to all questions in the survey. There is strong support for the program at NASA Langley and the program is well-regarded by those professionals who are aware of it. However, there is still a need for increased exposure.

Overview of Meeting with Associate Director of Virginia Space Grant Consortium and Director, Office of Education

A meeting was held with Mr. Chris Carter, Associate Director of the Virginia Space Grant Consortium, and Dr. Roger Hathaway, Director, Office of Education. Mr. Carter and the present author share two principal concerns relevant to the Virginia Space Grant Consortium and other Space Grant Consortia, in general. First, there is concern that the internship opportunities are not attractive to graduate students because of the short-term nature of the internships. Graduate students would desire to continue the research conducted during the internships as the basis for a thesis or dissertation. However, as the present program is designed and executed, there is little opportunity for this continued interaction, although students at this level (graduate) possess advanced research skills that could benefit the mentors' research. A second area of concern is the decreased level of funding to Space Grant Consortia that is planned to be dispensed over the next year, which makes it difficult to sustain the present (Summer 2008) level of activity. There is also concern about sustaining continuity in the program beyond the next year (after Summer 2009), since no information is presently available about the planned longevity of the program. It is hoped that a long-term commitment to the present ESMD program by KSC will be announced.

Dr. Hathaway was concerned about the lack of opportunity for technical faculty to be involved in ESMD-related research during the summer (for example, an eight- to ten-week summer faculty research program is desirable). Such a summer faculty program would provide NASA researchers/mentors with additional human resources (at higher research skill levels), would provide additional role models for ESMD interns, and a voice for the ESMD programs on university campuses.

Prof. Selby's perception is that the opportunities for students to participate in senior design projects and internships need to be more effectively shared with the targeted university populations. The interns interviewed indicated that the information about the ESMD programs was not provided to them by their home departments, but that they "discovered" the programs through searching for NASA-sponsored summer student programs. It was also determined that many NASA engineers and scientists are not aware of the opportunities available through the ESMD programs. Some of the potential mentors (projects were not chosen by mentees) were not clear about the details of the internships, even though they had previously volunteered their mentoring services. Therefore, it may be desirable for KSC ESMD personnel to review advertising and follow-up (with mentors and POCs) strategies.

Another concern of Prof Selby is the need for a uniform definition of "Senior Design Project" for both NASA personnel and ESMD faculty. This would result in projects being defined that are at the proper level of technical complexity and those that can be completed without requiring that the NASA POC's be continuously involved in the project as technical advisors.

Overall, the program is successful in the opinion of the interns and mentors involved. It is important that the general NASA community be informed of this success, which may motivate more NASA engineers and scientists to volunteer to participate as mentors and POCs.

Marshall Space Flight Center

The reviewer believes that having to sign a form and finding their supervisor and get her/him to sign slowed the process down considerably. But also believes that signing that form is important. For many people the ESMD-SG SDP and Internship Program is not a high priority and thus is low on the totem pole. When their boss tells them this is important there is much more attention paid and forms come in. Thus it would be good to reach the Department Chiefs that work on ESMD projects (before the faculty members reach the centers) announcing the program and its importance for the future of NASA workforce and asking for their help with getting a response (yes or no) and a commitment (if yes) from their workers. The fellow's highest success was when he briefed Jim Turner (Deputy for a Department) and two other managers about the program. There resulted seven new SDPs from that one meeting.

Prof. Wersinger spent too much time trying to get present POCs to respond. He finally got in touch with almost all of them but it took the full four weeks to get there. With hindsight, he should have spent one week doing that and the other three weeks contacting new people through meeting with the right people at the Department level. He had no clue about the organization from Department to Branch and was not sure what's in between yet. It would be good for the next batch of faculty working next year on the project to learn about the structure, get an organization chart and hit the right people at the right level. Adding a detailed review of the two Senior Design Courses was in the fellows view too much. Such documents, to be well reviewed would take at least three full days of work each (24 hours). They are equivalent to a large proposal (at least in page numbers). So together they take over a week doing nothing else. Less time means less a meaningful review.

Overall, this was a very interesting job in spite of the challenges. The fellow met many very interesting people and invited several to talk at his university. Auburn University has the largest engineering school in Alabama (6,000 engineering students out of 24,000). The fellow invited the Ares Program Manager, Stephen Cook and his Deputy for Propulsion (an Auburn graduate) to give a campus-wide presentation on the program to go to the Moon, Mars and Beyond. He also invited another researcher who works on photonic sails for satellite de-orbit to come to Auburn and talk to the students. These two may have an excellent impact on workforce development in Alabama.

Stennis Space Center

Being a NASA ESMD Summer Faculty Fellow at Stennis Space Center this summer has been one of the most enlightening and enriching experiences of my career. Overall this was a very enjoyable experience. Prof. Jonathan Lambright was able to interact with many talented NASA engineers and scientists as well as support staff. He was housed in the Engineering and Sciences Directorate and his technical point of contact was Dr. Harry Ryan. His strategy was to make contact with all of the individuals that were listed as points of contact in the internship list located in the PBMA database for the previous year. Stennis did not have any Senior Design projects in the PBMA database for last year.

Dr. Harry Ryan was very instrumental in leading Prof. Lambright to potential senior design project mentors. In all he made contact with approximately 20 engineers and scientists in seeking to develop new senior design projects and internship opportunities. Stennis is one of the smaller centers in terms of personnel and does not have as many scientists, engineers and technologists as the other centers but in terms of real engineering and cutting edge technology they are among the top. Many of the mentors were very busy and you definitely have to set up meetings ahead of time to talk with them. Some of them expressed concerns of time commitment during the actual projects. They wanted to be ensured that the projects will not take a considerable amount of time.

After talking with several contacts during the first week Prof. Lambright implemented a strategy that assisted in contacting the potential points of contact. He contacted all of the chiefs and leads within the directorate and asked them to recommend individuals within their group that would be good POC/mentor candidates. He thinks it works better if they get direction / recommendation from their leader. Although, a couple that were recommended by their lead did not respond. In addition, he came up with a sheet that shows sample projects from Stennis and other Centers. So as he met with them he showed them some of the project descriptions as well as reviewed the brochure with them.

During the summer appointment, two senior design courses were reviewed. One for Auburn University and the other for Michigan Technological University. Both courses were very well put together and showed that the authors invested much time in developing the course. The detailed reviews were uploaded into the PBMA database.

In addition to the normal duties of developing and confirming senior design projects and internship opportunities, he had the pleasure of watching a test for the main Space shuttle engine, a test for the RS-68 and took a tour of the NASA Michoud Facility where the external tank is assembled.

Making contact with the technical point of contact and possibly mentors prior to arriving to the center would be beneficial. Also, if one can gain access to one of the regularly scheduled department or division meetings to make a pitch then you may gain some advantage in pitching the idea of internship opportunities and senior design projects to a broader audience.

Prof. Lambright departed the Stennis Space Center on July 2nd thus completing his on-site mission as the 2008 NASA Summer Faculty Fellow at Stennis.

SENIOR DESIGN COURSE AND REVIEW

During the Fall of 2007 a competition was announced with the purpose of developing a Senior Design Course that can be implemented/taught at any institution in the U.S. The principal objective in this effort is to streamline the design process that students can be trained to follow. Auburn University and Michigan Technological University were selected to develop the required course material. Summaries of both the developer comments and the review by the ESMD Faculty Fellows are provided below.

A good Senior Design project under NASA sponsorship requires the following elements: (i) Clear delineation of top-level requirements and hierarchy for the space mission at hand within imposed constraints; (ii) Itemization of major phases, tasks and engineering specifications associated with the project, as well as reviews, within the context of a holistic approach and an overall timeline of milestones/Gantt Chart; (iii) Design expectations; (iv) Allocation of responsibilities to group members for specified activities and processes in order to realize the customer expectations & produce an integrated design; (v) Testing, validation and verification of design as proof of compliance with customer requirements; (vi) Simulation/demonstration & presentation of the implemented design; (vii) Detailed documentation with references (including websites).

Auburn University

Course Developer Comments

The approach taken here is influenced by the senior capstone design course in Mechanical Engineering at Auburn University. The course is taught over two semesters, two credit hours each semester. In the course developers senior design experience, the students' backgrounds are:

a) Completed manufacturing training in the shop.
b) Learned the design process from a sophomore/junior level prerequisite design course, using the text by Ullman "The Mechanical Design Process."
c) Completed most of their coursework for their major; thus are proficient in heat transfer, MATLAB, CAD using Solid Edge, machine component design, basic electrical engineering (i.e. what you expect from a senior-level mechanical engineer)
d) Had some exposure to FEA.

Faculty typically don't lecture; the course is meant to be a design project where the student teams exercise the design process, from mission statement to a working prototype. The project originates from an industrial sponsor who usually has significant involvement and financial commitment to the project's success, who also helps guide and evaluate the student team's work.

The course developers think of the handbook as a "flexible resource" for the instructor and the student, rather than a course with lecture topics (although it could be treated that way). It is meant to fill in the knowledge gaps which students and engineers - who have heretofore designed only earth-based products - will have when attempting to design a product for use on the moon. (The technical sponsor of the project, Rob Mueller of KSC, believes that knowledge of the lunar environment is particularly important for the designer.) So a purpose of the handbook is to make available that educational material needed to fill the knowledge gaps, and to be used at the instructors discretion and at the time of his/her choosing.

The course developers have also tried to minimize the theory, emphasize what a student needs to know to design, the tools they need, and present practical application examples. For example, trade studies and failure mode analysis are presented as simple techniques. System Engineering can be learned by following the example of Chapter 3, and is given as a step-by-step process in Chapter 2. Thermal control is presented using simple formulas. In Chapter 5 they show how the lunar environment can affect design. In Chapter 6 they point out the standards, references and some sources for purchasing space equipment.

Next semester they plan on lecturing on Systems Engineering for about 1-2 weeks, and then students will read the chapter on the lunar environment followed by 1-2 lectures, and then be given a short quiz. If a particular topic in the handbook is needed later for a particular design task, they will ask students to either read it on their own or they will present a short lecture. The instructors will also try to make the project multidisciplinary - they see a big need for computer engineering for C&DH and also electrical engineers for Power Systems.

ESMD Faculty Fellows' Comments

- This class approach of teaching the design process through a specific end-to-end example is far preferable to the alternative approach of teaching theoretical systems-engineering generalities, and then letting the students figure out what applies to their project. The "handbook" approach to the design is also preferred; where relevant technical information is grouped together into a compendium. Finally, the design review schedule is more realistic with only three or four external peer reviews during the entire project cycle. There are some deficiencies as to recommendations for class length, number of meeting hours per week, and size of the target design group. Some allowance for providing the students with *hard technical* lectures relevant to the design has been buffered into the project. These technical sections are, however, incomplete. There are no defined objectives as to what will constitute a "design realization" as required by Accreditation Board for Engineering and Technology (ABET) standards. There needs to be extensive sections on prototyping, fabrication, testing, and evaluation added.
- Overall, the document is very complete in terms of information provided but lacking in guidance on how to proceed practically. It shows examples but does not provide specific recommendations. This is a question of philosophy and this is where input from KSC would be important. What is expected from this document? What is it to provide and how will it be used?
- Overall, the design course prepared by Auburn University is excellent. It is oriented towards a specific design and provides a step-by-step guide to the design of lunar excavators. Certainly, the design stages provided by the authors are very clear in its presentation. The course material however lacks the general aspects of design and towards a unified approach to design. In the reviewer's opinion the material must show students what the design process entails and how to give "form" to the design.

- The documentation of a model Senior Design project is a very ambitious task. In order to attain maximum usefulness, the documentation must target the average engineering student. It is the reviewer's perception that the cognitive level of the present documentation is consistent with an above-average student. An attempt to create a document that the average engineering student will be able to independently comprehend must include information, examples, and sample calculations that will be viewed as superfluous by the above-average student and insufficient by the below-average student. The approach that will be successful must mirror that adopted by writers of engineering textbooks – the style must motivate the student to read and the document must be thorough. Thoroughness should not be sacrificed at the expense of conciseness.
- The information presented in these chapters is important to include in this course; however, these chapters would be clearer if the organization and some of the content of these chapters were modified. As presently presented, these chapters do not flow as well as the chapters that follow. Also, as presently written, the application of the SE process in the context of a senior design project is not clear. After presenting a significant amount of SE information, the general message at the end of Chapter 2 seems to communicate that the SE design approach is not appropriate for use in student design projects. After giving a clearer overview of the SE process, a better message to communicate in this chapter would seem to be how to selectively apply the SE tools to a design process with a limited scope like a student design project. The Cubesat example in Chapter 3 needs to be more clearly tied to the course content. In general, if one of the goals of this course is to introduce the students to the use of Systems Engineering in the context of a NASA project, discussions throughout the course content should incorporate this and not just the first few chapters with a standalone overview discussion of SE. As a resource for both students and faculty at other schools who use this course materials, examples of expected content and NASA formats used for CDR's, etc. would be beneficial. At least a general reference to general design considerations such as safety, human factors, economic considerations, etc should be addressed somewhere in the introductory chapters. Discussion of the consideration related to interfacing the excavator to the rover could be expanded in the context of SE. The reviewer believes that this is only briefly mentioned in the CAD chapter, and SE is not mentioned there.
- The course material is rich in describing the structured process of the systems engineering process, methods and tools required for an effective product design. The authors do well to point out that despite the inhospitable environment, the moon does have many *in situ* resources to build and sustain a lunar base: such as availability of sunlight as a source for thermal power and conversion to electrical power; processing of regolith (lunar dirt) to extract oxygen, hydrogen and metals, and use of regolith for building roads, landing pads and habitats. Soil excavation on the moon can yield various oxide minerals of Cr, Ti, Al, Fe and Mg, along with silicates. In principle, the notion of In Situ Resource Utilization (ISRU) capitalizes on utilizing resources from the moon to sustain a lunar base: e.g., solar energy from solar collectors and cells; operation of a closed-cycle heat engine by exploiting the temperature difference (from shadow to sunlight); vacuum atmosphere for scientific experimentation; material processing using low gravity; and recycling of earth materials (such as reuse of propellants, rocket canisters for habitats, trash for polymers, etc.). The reviewer likes the illustration (Fig. 3) showing the excavation blade and soil body because it indicates the important variables needed to model and analyze soil excavation in a lunar setting. The document needs to be better organized. Rigorous testing needs to

be built into the design process for the components & subsystems. Safety issues need to be discussed under failure and risk management. Evaluation metrics for student evaluation and assessment need to be clearly delineated for the duration of the course. Division of labor at the outset of the course is key and needs to be spelled out. Clear guidelines on deliverables should be provided at the outset of the course. A sample Senior Design Project that earned an A in a previous year, or link to a good website (e.g. http://www.aem.umn.edu/teaching/design/spring2007/Home.html) should be provided for review by students, so that they are aware of expectations for NASA-sponsored Senior Design. The simulation relating to the pickup, lifting & dropping a rock (without dropping the rock on the way up) is shown only for a very brief duration (t = 0 through 5 secs); a discussion about actual time-scales involved and simulation over longer intervals is needed. There is a brief passing mention about attaching the excavator to a rover (in Chapter 8); it needs to be an integral part of the computer-aided design, as also effects of regolith on the force needed by the shovel to excavate and the incorporation of actuators for prescribed motions. Finite Element Analysis would add rigor to the modeling.

- If the authors can give a whole project as an example, it would be very helpful, in case they already had experience of senior project(s) with NASA and finished a senior project. This can be used as a case study. It would be better to give a check list to include all the documents, deliverables or milestones need to prepare when senior projects finish. Also, it would be better to add something about Project Management, including: project monitoring, tracking and cost and schedule estimation
- The biggest concern one reviewer had been that it was a multidisciplinary approach. In short, it should be a multidisciplinary team approach. The benefits would be tremendous to all of the other disciplines that have a hand in the design and development process of the project. Pull in the EE's, Comp E's IE's, Marketing, Finance, etc. The reviewer believes a multidisciplinary team will bring excitement, needed expertise, a more realistic real project world learning experience, and a better overall project environment to the table. The students learn about concurrent engineering, this is an opportune time for them to put it in practice.

Michigan Technological University

Course Developer Comments

The author took a non-standard focus with this course; one that the author thinks will result in a more useful and replicable product for NASA and the ESMD education mission.

The author developed a universal Capstone Design curriculum that stresses the structured process, methods, and tools of product design and includes the issues of systems integration that are often left out of even the best Senior Design courses. While students will work on a particular project, the curriculum will not be tied to only that project or to only space-related projects. The design process that is taught is borrowed heavily from NASA's current and proposed processes, and from existing high-risk, low-cost industrial stage-gate processes. Such integration allows for the use of a variety of project in the class. In addition, the author has chosen to tie the book to a single text since it seems that some teaching Capstone Design are not necessarily in the Design field. In doing so, the author borrowed heavily from the existing year-long Senior Design course at Michigan Tech. The Module 00 contains information intended for the course instructor (some of which could also be used in a first day lecture) that might assist in orienting you to this course.

The materials being reviewed are intended as a first public draft. There are some issues in them that we know of – not all material is properly cited yet, some formatting changes from slide to slide or module to module, some figures are not scanned clear enough, and we need more space related examples. However, the overall structure of the course, the design process to be used, and the content of the lectures is set. Please feel free to comment on any mistakes seen, no matter how trivial they may seem. When producing such a large package (roughly 43MB of data), it is difficult to catch all of these yourself.

In particular and in addition to the typical review, the author would like for you as a group to use your space-related design expertise to improve this course. Please alert the author to inconsistencies in this process, short comings of the NASA phase-gate process, missing tools that are key to any NASA project. The author is rather unfamiliar with NASA design projects. In addition, if the reviewers know of examples of tools, deliverables, or reviews that would serve the students well, please either attach them or point me to them. The author is counting on this review to significantly "beef up" the space-related content of the course. Lastly, please take a second look at Module 00 when you are done with the others to make sure that the information is sufficient for someone teaching a Capstone Design course.

The reviewers' feedback is very important to the future of this course. The author has chosen to send .pdfs of the files to make incorporation of comments easier

- Some allowance for providing the students with *hard technical* lectures Overall, it is an EXCELLENT Senior Design Course. The slides are very well structured, organized and complete, almost all aspects are included. The only concern is how NASA projects can be integrated into this senior design course.
- Without a doubt, the course material prepared by Michigan Tech is outstanding. The material is certainly oriented towards a general Senior Design approach. The material is extremely well organized and provides students the step-by-step systems engineering concepts which guide them towards successful designs. The topics are focused on educating students in understanding the intricate details of what design entails. The reviewer has been teaching Senior Design at New Mexico State University for the past 12 years and has prepared extensive documentation which students use in their design projects. The Capstone Design material developed by Michigan Tech is definitely more extensive than what we have developed and very much in line with how the course must be taught. It is quite enlightening to see many similarities in our approaches to teaching the Senior Design course. The design course is structured so any student group will find the material to be general enough to understand the design process and apply the design concepts to their own projects.
- This is an excellent senior design capstone course. It is clear that a lot of thought, information and analysis were poured into the development of the course. The biggest concern is that of a multidisciplinary approach. This is the same concern that the reviewer has with the Auburn course. The design process should be a multidisciplinary team approach. The benefits are tremendous to all of the other disciplines that have a hand in the design and development process. The presentation format is excellent. This is great for lecturing and presenting in the classroom or lab.
- This class as presented is a very good introduction to Systems Engineering, and is presented almost at a graduate level of complexity. However, in the reviewer's experience students, especially undergraduate students work better by example and need to get to a defined problem very quickly in order to realize a working piece of hardware in a 1-year time frame. This class would be far more effective if a single design subject were selected and then used to illustrate the systems engineering concepts presented throughout the class notes. Finally the example needs to be NASA relevant to attract enthusiastic mentorship involvement from the NASA technical rank-and-file. Perhaps this class would be best served by a twice a week meeting in which the systems engineering lectures are presented first, followed by a follow up class-session where students work with faculty to apply these concepts to the actual design. Additionally, one must realize that in a year-long senior design class, students are often not equipped with the technical tools necessary to attach the engineering of the design relevant to the design must be made.
- Either the material is for the instructor experienced in design or it is not. The reviewer's perception after reading the notes is that it is assumed that the instructor is familiar with design. Even so, in order for the material to be of maximum value, my opinion is that the .ppt file should be accompanied by an expanded narrative with appropriate additional explanatory/clarifying/illustrative information. It is also the reviewer's opinion that there is too much material for a typical senior design course. It would be desirable for the authors to identify for the instructor the material that is considered primary and secondary. The reviewer questions whether the author of this course has surveyed engineering departments across the nation to determine their

format for their senior design courses. This information should dictate the format for the present course, if it is to be distributed nationally for maximum benefit.

- Reading carefully the Introduction, the reviewer comes to the conclusion that it is impossible to both teach all this material and have the students design, build and test an engineering contraption. There are no less than 13 reviews. Each review in my experience takes a week: there is preparation, a dry run, then the review itself, and finally a lessons learned phase and implementation of recommendations made, modifications, etc. A semester has about 14 weeks of useful work, thus more than half the time would be spent in reviews. How much time is there to actually do the work?
- This course is ambitious and needs to be redesigned and made more realistic. On the other hand, the content of the course is incredibly rich and complete. It should not be too difficult to weed out material and simplify the course. The reviewer would first of all reduce the amount of reviews. The model followed works for a complex project such as NASA missions. Such a model is overkill for a student project in my opinion. There is too little time spent doing the hands-on team-work. That latter part is very time consuming but rich in practical experience. Another element I found important is to meet in a non-class environment at least twice a week with the students to insure that the overall direction and progress are satisfactory. The reviewer would also put the project description before setting up the teams since the teams and their composition will depend on what the project is. One meeting per week has proved to be too little in my experience. The reviewer recommends two meetings per week for 30 min. each to manage the project and make sure it is on track. A semester is short and a wasted week can be a disaster. The reviewer also wonder if the teaching of the material is possible at the rate of one class per week. This looks more like a two-year course, but I may be wrong. Difficult to say as the syllabus has not yet been written. On a positive note, the reviewer will be eager to read again this course in detail and work with the authors on applying some of its ideas in my own CubeSat project. There is a lot of excellent work that went into this course design.
- The content presented in the PowerPoint slides provides very good coverage of the general topics to be addressed in a capstone senior design class. The information is well-organized. The range of topics covered is good, and ABET requirements for capstone design are addressed. Based on the indicated course development title of "A Curriculum Package for High-Risk, Low-Cost Product Design and Systems Integration Using Small Spacecraft Projects," The reviewer would expect more specific information related to this specified course topic. While thorough coverage of general capstone design course topics is provided in the course materials, it seems that very little information is included that differentiates this course material from course material that would be applicable for any capstone design class. To assist instructors in the use of this course material for the indicated course topic of the application of the systems engineering process to the design of low cost, high risk space-related projects, the reviewer would suggest inclusion of specific course topics to illustrate the application of the design process to this type of project. For example, the criteria that differentiate "high-risk" projects from the design projects typically encountered by students should be included in the course material. Information related to the development and evaluation of risk management plans should be included. Also, since this project is NASA-related, it would be good to briefly introduce students to the types of design projects conducted by NASA ranging from manned missions to exploratory probes and to show the students where the concept of high-risk, low-cost small spacecraft addressed in this design course fits into the overall landscape. With the addition of slides and teacher's handbook information to

cover additional topics such as those mentioned in the previous bullet, the material will be appropriate for a course targeted toward "High-Risk, Low-Cost Product Design and Systems Integration Using Small Spacecraft Projects." The design process stages where integration is addressed are noted in the PowerPoint slides, but the concept of systems integration should be more fully defined and illustrated since, as indicated in the Cover Letter accompanying the course materials, systems integration issues are often not covered in traditional senior design courses and students typically have little exposure to this concept. A variety of NASA-related case studies or examples would be available for use as illustrations of the systems integration concept. While many tables and requirements from the *NASA System Engineering Handbook* are referenced, the inclusion of design examples, preferably related to high-risk, low-cost designs or even general space-related designs, to illustrate these concepts would be beneficial for student understanding and interest. Although a large number of space-related references are listed in the "Additional References" section, it seems that very little information from any of these sources is incorporated into the course materials. The incorporation of some examples from these references would help differentiate the course material developed for this ESMD project from a generic capstone design course, would illustrate the application of the systems engineering and integration issues addressed in the course materials, and would help generate interest by the students. After using an example from one of the sources, the professor could direct the students to the reference article for additional information. This would help tie the space-related information listed in the "Additional References" section to the course content more. Also, the grouping of the "Additional References" by topic area would be helpful since capstone design classes at many schools de-emphasize lecturing in favor of an inductive learning approach. If the "Additional References" were grouped by topic area, the course materials could be more easily utilized by a professor teaching a capstone design course with minimal lecturing. The course materials available for review at this time include PowerPoint slides that will be very useful for an instructor and could easily be adopted by an instructor for use in a capstone design course. I am interested to see the additional material in the teacher's handbook that was indicated to be included in the final course materials. The inclusion of additional background information in the teacher's handbook will provide the foundation to allow instructors to easily adopt this course material and incorporate it into a senior design course.

LESSONS LEARNED AND RECOMMENDATIONS

Lessons Learned

- The various Centers' Education Offices must inform all Center personnel associated with technical projects/management regarding the appointment of the ESMD Fellows and their scheduled visits. The purpose of the visits must be clearly conveyed.

- Internet access must be prearranged so all Fellows have timely access to Center's internet resources upon arrival at their assigned Center. This will enable access to internal library resources and more efficient collection of information on projects. It will also make the discussion of topics with potential mentors easier in a well-informed manner.

- Time was a compelling problem for everyone with some form of reorganization within Centers going on. This has been somewhat stressful to scientists and engineers and potentially contributed to the lack of commitment by potential senior design mentors.

- Potential NASA mentors were concerned that their current work might not have funding when the internships/senior projects would begin.

- A hands-on NASA mentor is crucial to the success of a Senior Design project that would be useful for NASA-related programs. One of the student groups working on a senior design project stated: "For most of us, this was our first experience working with spacecraft. Your (NASA mentor's) guidance has been crucial in developing our confidence for working on future projects. Without your help we surely would have wasted countless hours pursuing dead ends." Such responses reinforce the value of the ESMD Faculty Project.

Recommendations

- The Center's Education Office should provide the Fellows pertinent organizational and contact information to facilitate meeting arrangements with NASA personnel in a timely manner. It would be good for the faculty working on the project to learn about the Center structure, receive an organization chart so that they have knowledge of the directorates' chiefs, leads, engineers, and scientists.

- For successful implementation of Senior Design courses, there should be a financial incentive for faculty provided by the institutional Space Grant. Merely providing small amounts that cover the design costs may not play out favorably, since the faculty must invest a substantial amount of time in direction and oversight. With a full load of teaching, there may not be sufficient time for faculty to engage students at the level of direction needed. The equivalent of 4-5 weeks of summer support would at a minimum entice faculty toward engaging seriously in the design process and in achieving a positive outcome.

- A five-week rotation barely allows one to touch the surface of the immense number of engineering and science projects at the NASA Centers. The fellowship time period needs to be extended to at least 6-8 weeks, if possible. This will enable more than one meeting with potential mentors and establish a level of trust and common understanding of the purpose and the mutual benefits of the program.

- It is suggested that in the future, the technical directorates will schedule meetings with potential mentors during the initial weeks of the fellowship to allow the faculty fellow to devote the larger portion of the fellowship period for discussing senior design projects and internships.

- The role of faculty is to ensure that Senior Design projects comply with ABET requirements. In this context, uniform expectations should be developed for Senior Design Projects for the benefit of the NASA POC. This would result in projects being defined at the proper level of technical complexity and those that can be completed without requiring that the NASA POC's be continuously involved in the project as technical advisors.

- If possible, just prior to the arrival of the faculty Fellow, supervisors and department chiefs at the NASA Centers can disseminate in their organizational meetings the ESMD Space Grant program objectives and its importance for the future of NASA workforce.

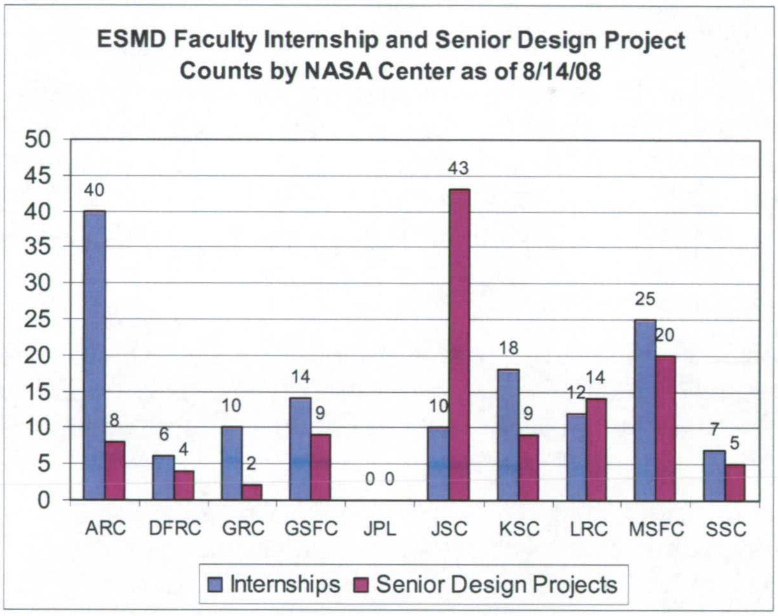
- It is recommended that NASA develop specific guidelines for allowing supervisors and potential mentors to charge their time against an appropriate account for the ESMD Space Grant senior design and internship program.

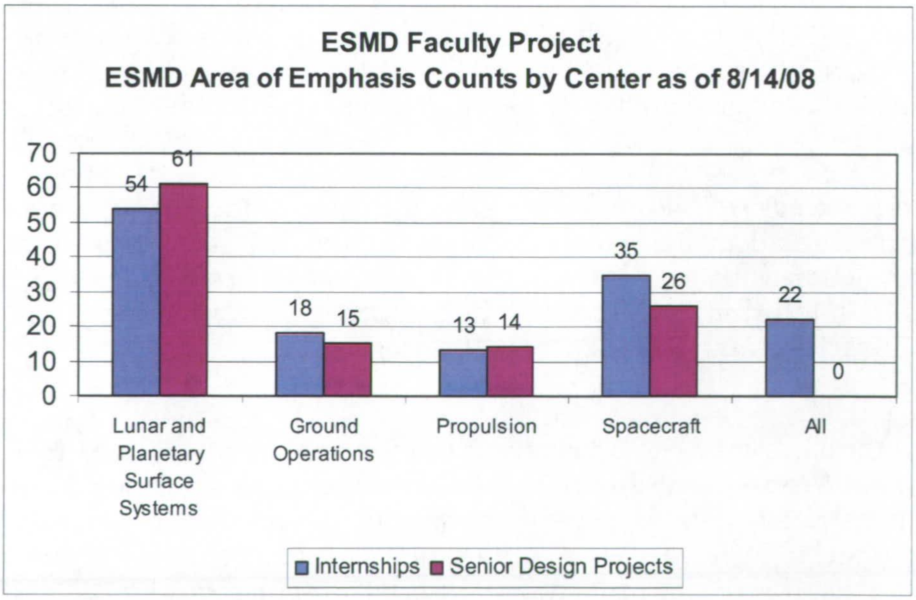
- NASA ESMD summer interns should receive an increased summer stipend above the current support to cover increased costs relating to housing, local transportation, and attendance at special events with other summer students.

- There is concern that underrepresented minority students were not applying to the program in adequate numbers. It is recommended that Space Grant Consortia - in conjunction with university faculty - publicize effectively the availability of these ESMD internship and Senior Design opportunities, with special attention focused on attracting minority students to the program.

- The thrust of the ESMD Faculty Project should be maintained towards enhancing NASA's ***Strategic Educational Outcome 1***. As the 2008 Faculty Project has demonstrated there is a need for faculty to closely interact with NASA Center personnel to identify relevant exploration topics and to develop senior design course materials. It is recommended that the 2009 Summer Faculty Fellowship be awarded to faculty fellows who can glean ideas relating to exploration and bring back to their respective institutions information that could be used to improve their curricula.

- Faculty Fellows seeking Senior Design ideas should fruitfully collaborate with industry partners, so that the design effort is of mutual interest to both industry and NASA. This will help facilitate interaction between the industry technical expert and the university faculty teaching the senior design course, which will reduce the time required from the NASA POC. Future Faculty Fellows could spend a portion of their assigned time at an industry partner in the vicinity of a NASA Center.





CONCLUSIONS

The Constellation Program is the medium by which we will maintain a presence in low Earth orbit, return to the moon for further exploration and develop procedures for Mars exploration. The foundation for its presence and success is built by the many individuals that have given of their time, talent and even lives to help propel the mission and objectives of NASA. The Exploration Systems Mission Directorate (ESMD) Faculty Fellows Program is a direct contributor to the success of directorate and Constellation Program objectives. It is through programs such as the ESMD Space Grant program that students are inspired and challenged to achieve the technological heights that will propel us to meet the goals and objectives of ESMD and the Constellation Program. It is through ESMD Space Grant programs that future NASA scientists, engineers, and mathematicians begin to dream of taking America to newer heights of space exploration. The ESMD Space Grant program is to be commended for taking the initiative to develop and implement programs that help solidify the mission of NASA.

The 2008 ESMD Space Grant Summer Faculty Fellows Program proved to be very successful. With the concerted efforts of the Kennedy Space Center educational staff, the ten current university Faculty Fellows, and the previous Faculty Fellows from the program, a total of 250 (TBD) potential internship opportunities and 150 (TBD) Senior Design project opportunities for participating Space Grant university students were identified. In-situ placement of Faculty Fellows at the NASA field Centers is essential; this allowed personal interactions with NASA scientists and engineers and established a better understanding of the NASA culture.

The Faculty Fellows are pleased that the ESMD Space Grant program is taking interest in developing the Senior Design courses at the university level. These courses are needed to help develop the NASA engineers and scientists of the very near future. It has been a pleasure to be part of the evaluation process to help ensure that these courses are developed in such a way that the students' educational objectives are maximized. Ultimately, with NASA-related content used as projects in the course, students will be exposed to space exploration concepts and issues while still in college. This will help to produce NASA engineers and scientists that are knowledgeable of space exploration.

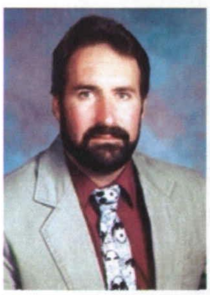
With the development of internships, senior design projects, and senior design capstone courses, NASA's ESMD Space Grant Project is making great strides at helping to develop talented engineers and scientists that will continue our exploration into space.

FACULTY BIOGRAPHIES

Jiang Guo

Dr. Jiang Guo is an Associate Professor of Computer Science at California State University Los Angeles. Before he joined California State University Los Angeles in 2002, Dr. Guo had been an Assistant Professor of Computer Science of California State University Bakersfield for two years. Before that, he had been a Research Associate of US National Research Council for three years from 1998 to 2000. Dr. Guo received his B.S., M.S., and Ph.D. degrees of Computer Science respectively in 1989, 1992, and 1996. Then, Dr. Guo spent a year and a half as a post-doctor with the Institute of Software at Chinese Academy of Sciences. Dr. Guo's research areas include software engineering, software reengineering, web-based systems and software system interoperability. Dr. Guo is the author of over 60 papers on computer science and software engineering deriving from his research. He got the best paper award of SEKE1999. He is the reviewer for Journal Information Sciences of Elsevier. He also was the Co-Chair of the Program Committee of IEEE ECBS'2000. He has served as the program committee member for more than 50 conferences. Dr. Guo was awarded outstanding professor commendations two years in a row in 2005 and 2006 in the College of Engineering, Computer Science and Technology of California State University Los Angeles.

Stephen A. Whitmore



Dr. Stephen A. Whitmore is an assistant professor of mechanical and aerospace engineering at Utah State University (USU) in Logan, Utah. He joined USU after 25 years working as a civil servant for the National Aeronautics and Space Administration. Dr. Whitmore attended undergraduate school at the University of Illinois, Urbana IL, where he graduated with a BS in Aerospace Engineering (1979). He attended graduate school at the University of California, Los Angeles CA, where he received MS, engineer, and doctoral degrees in Aerospace Engineering. He has published over 70 technical monographs including NASA technical memoranda and technical reports, conference papers, book chapters and peer-reviewed journal publications. He has 3 patents and has received multiple national awards. Dr. Whitmore's recent research focus at USU is on the development of interactive simulations for space launch, aerocapture, reentry, and on-orbit payload deployment. These simulations are applicable for a wide variety of conditions including launch, endo-atmospheric flight, and in-space operations. These tools have been developed in lieu of more standard industry tools as a cost and time saving measure, and include options for pitch profile optimization. Specific applications of these tools include lunar-return lifting reentry vehicles, with an emphasis of developing high-precision low-dispersion footprint techniques for lifting aero-capture and aero assist. Dr. Whitmore is director of the Chimaera Hybrid Rocketry program at USU. Recently (May 2008) the USU senior design team that was lead by Dr. Whitmore won the NASA-sponsored University Student Launch

Initiative (USLI) Competition at Huntsville Alabama. The rocket used a closed loop energy management system to deploy drag devices to modulate the rocket energy to achieve precisely 5280 ft altitude above the local ground level, a primary objective of the USLI competition. Experience gained with the Chimaera rocket program has recently spun off a series of research topics focusing on the characterization and modeling of medium-scale experimental hybrid rocket motors. Dr. Whitmore teaches classes in compressible fluids, propulsion systems, and mechanical measurements at USU. Dr. Whitmore is an Associate Fellow of the American Institute of Aeronautics and Astronautics (AIAA), has served as a member of the AIAA Space Systems Technical Committee.

Roger Radcliff

Dr. Roger Radcliff is a Professor of Electrical Engineering and Computer Science at Ohio University. He earned a B.S., M.S., and Ph.D. in electrical engineering at West Virginia University. His teaching and research are in the areas of computational electromagnetics, propagation, scattering, and applied electromagnetics for avionics applications. His research has been funded by agencies such as the National Science Foundation, NASA, the Federal Aviation Administration, and the National Security Agency. He has more than 25 peer-refereed journal articles and numerous conference publications and has a wide range of experience in university administration.

Prabhakar Misra

Dr. Prabhakar Misra is a Professor of Physics and Head of the *Laser Spectroscopy Laboratory* in the Department of Physics & Astronomy at Howard University, Washington, D.C. He earned his M.S. (Physics, 1981) degree from Carnegie Mellon University, Pittsburgh, PA, and his Ph.D. (Physics, 1986) from The Ohio State University, Columbus, OH. In 1999, he received a two-year NASA Administrator's Fellowship Program award; he spent a year (1999-2000) at the Laser & Electro-Optics Branch of the Goddard Space Flight Center, Greenbelt, MD, and the second year (2000-2001) at The National Academy of Sciences in Washington, DC. In 2004, Prof. Misra was awarded the Fulbright Scholar award. He spent the 2004-05 year as a Visiting Professor & Fulbright Scholar in the Department of Chemical Sciences at the Tata Institute of Fundamental Research in Mumbai, India. Dr. Misra's research expertise is in the area of Experimental Laser Spectroscopy of free radicals, stable molecules and ions in a supersonic jet expansion and in discharge plasmas. In 2007 he was selected to be a NASA Exploration Systems Mission Directorate (ESMD) faculty fellow at Langley Research Center & the Goddard Space Flight Center; and in 2008 he was again an ESMD Faculty Fellow at Goddard Space Flight Center. He is the author or co-author of over 140 research monographs, proceedings, abstracts and refereed journal publications, a technical report for The National Academy of Sciences, and the co-editor of a book titled *UV Spectroscopy and Ultraviolet Lasers*

(Marcel Dekker, NY, 2002). He is a member of the American Physical Society, the Optical Society of America, the New York Academy of Sciences, Sigma Xi, a life member of the Fulbright Association, and a *Fellow* of the American Society for Laser Medicine & Surgery.

Nadipuram R. Prasad

Dr. Nadipuram (Ram) R. Prasad is a tenured full-time Associate Professor in the Klipsch School of Electrical and Computer Engineering Department at New Mexico State University. He earned the S.M degree from MIT in 1971 and worked for several years in the electric power industry. He returned to academia in 1986 earning the M.S and Ph.D. in 1988 and 1989, respectively from New Mexico State University. He is the Director of the Rio Grande Institute for Soft Computing (*RioSoft*) at New Mexico State University and *Rio*RoboLab a NASA Ames funded Advanced Robotics Laboratory. In August 2001, he was awarded a NASA faculty fellowship under the NASA Administrator's Fellowship Program to spend one year at the NASA/Jet Propulsion Laboratory. During this fellowship Dr. Prasad worked with the Bio-Inspired Technologies and Systems Group where he was involved in several state-of-the-art technology developments for applications within Department of Defense, NASA Earth Sciences, and the US Department of Agriculture. He is a Senior Research Fellow for SPAWAR Systems Center of the Office of Naval Research. Dr. Prasad's research interests are in neural networks, fuzzy logic based systems, and evolutionary computation platforms. Dr. Prasad has authored and co-authored over 150 research publications in journals and conference proceedings, and is the co-author of two books on fuzzy and neural control.

James Conrad

Dr. James Conrad is an associate professor of Electrical and Computer Engineering at the University of North Carolina at Charlotte. He received his bachelor's degree in computer science from the University of Illinois, Urbana, and his master's and doctorate degrees in computer engineering from North Carolina State University. He has served as an assistant professor at the University of Arkansas and as an instructor at North Carolina State University. He has also worked at IBM in Research Triangle Park, North Carolina, and Houston, Texas; at Ericsson/Sony Ericsson in Research Triangle Park, North Carolina; and at BPM Technology in Greenville, South Carolina. Dr. Conrad is a Senior Member of the IEEE and a Certified Project Management Professional (PMP). He is also a member of Sigma Xi, Eta Kappa Nu, the Project Management Institute, the American Society of Engineering Education and the IEEE Computer Society. He is the author of numerous books, book chapters, journal articles, and conference papers in the areas of robotics, parallel processing, artificial intelligence, and engineering education.

Ellen Lackey

Dr. Ellen Lackey is an associate professor of mechanical engineering at the University of Mississippi (UM), and she has taught courses in the areas of materials science, failure analysis, manufacturing, introduction to engineering, and design. She has been involved with composite materials research for the past sixteen years. During this time, she has conducted projects related to mechanical and physical property characterization of polymeric composites, microscopy, and development of composite manufacturing techniques.

Gregory V. Selby

Dr. Gregory V. Selby is a Professor of Mechanical Engineering at Old Dominion University in Norfolk, Virginia. He received B. S. degrees in Aerospace Engineering (1971) and Psychology (1990) from the University of Virginia and Old Dominion University, respectively. He also received M.S. (1979) and Ph.D. degrees from the University of Delaware. Dr. Selby has taught the following courses: Introduction to Engineering, Statics, Engineering Mathematics, Fluid Mechanics, Heat and Mass Transfer, Thermodynamics, Gas Dynamics, Conduction Heat Transfer, Advanced Fluid Mechanics, and Boundary-Layer Theory. His research involves computational and experimental fluid mechanics with primary emphasis on flow control.

Jonathan P. Lambright

Dr. Jonathan Lambright is an Associate Professor in the department of Engineering and Technology at Savannah State University. He teaches courses for the Georgia Tech Regional Engineering Program at Savannah State and is heavily involved in engineering education research. He obtained a B.S. in Mechanical Engineering from North Carolina A & T State University in 1985. After working for 3 years as a Mechanical Engineer at the Department of Defense, he returned to graduate school at North Carolina A & T and received his M.S. in Mechanical Engineering in 1990 with a focus in Computer Aided Design and Manufacturing. He then attended the Georgia Institute of Technology's George W. Woodruff School of Mechanical Engineering and obtained his Ph.D. in Mechanical Engineering in 1996. While at Georgia Tech Jonathan focused his studies and research on design methodology and manufacturing automation. During the period between 1992 and 1996 Jonathan worked for the Lockheed Martin Aeronautical Systems Co. in Marietta GA. At Lockheed he worked on various research and development projects within the Advanced Design department. The research projects at Lockheed consisted of Computer Assisted Manufacturing Tools, Design Tools using Knowledge Based Systems and Advance Database applications. Between 1996 and 2002 he consulted with fortune 500 and other companies in areas of Enterprise Applications including Manufacturing Execution Systems and Customer Relation Management Systems.

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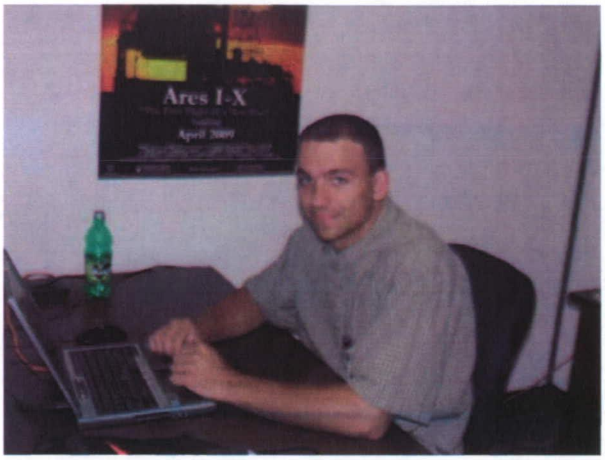
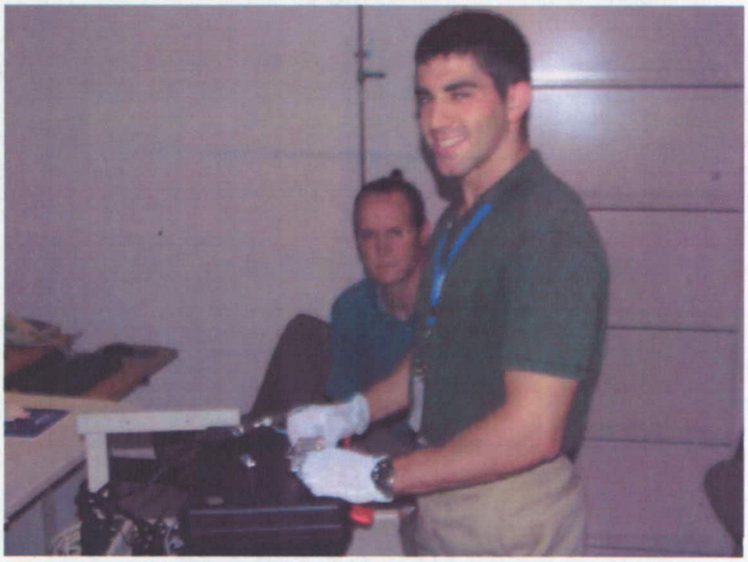
APPENDIX A



An ESMD intern at Langley Research Center shown working on designing and producing a MATLAB program that seamlessly meshes three different static aerodynamic databases for the Ares I.

Students preparing sounding rockets developed during a senior design class at Utah State University for launch at competition.

Louisiana Tech students insulating their senior design prototype of a loop heat pipe, a Goddard-sponsored project.



The project goal of this student's internship project conducted at Langley Research Center was to improve existing composite materials mechanically and electrically by adding carbon nanotubes to them.

ESMD interns at Kennedy Space Center were involved in building a test bed for lunar simulant and developing a percussive lunar excavator bucket.

Dr. Jacqueline LeMoigne at Goddard Space Flight Center with her 2008 ESMD student intern, Sean Brakken-Thal, from Tacoma, WA, discussing the project "Texture Analysis with Applications to Terrain Classification."

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APPENDIX B

Approved Center ESMD Internship Opportunities

This was the list on August 10, 2008. Please check the website for the most recent updates
http://education.ksc.nasa.gov/ESMDspacegrant/

NASA Center	Internship #	ESMD Area of Emphasis	Internship Description	Timeframe
ARC	ARC1-01-09-AN	Lunar & Planetary Surface Systems	LUNAR UTILITY ROBOTICS: The focus of this project is to develop 'utility' robots and procedures to automate lunar operations. Utility robots will perform: (1) tedious, highly repetitive, long-duration tasks that can be off-loaded from astronauts and (2) rapid response for addressing time-critical situations. Example tasks include: systematic site surveys, mobile camera platform, inspection, emergency response, site preparation, instrument deployment. This project involves software development in C++ under Linux and Java / Eclipse.	Spring, Summer, Fall
ARC	ARC1-02-09-AN	Lunar & Planetary Surface Systems	3D COMPUTER VISION: Since 1998, the NASA Ames Intelligent Robotics Group (IRG) has been developing stereo vision software to automatically build high-quality 3D terrain models from orbital images in a matter of hours (with minimal or no human intervention). The goal of this project is to adapt this software for use with the Mars Reconnaissance Orbiter, historic Apollo camera images, and cameras planned for the Lunar Reconnaissance Orbiter. This project involves software development in C++, focused on applied computer vision and 3D modeling.	Spring, Summer, Fall
ARC	ARC1-03-09-AN	Lunar & Planetary Surface Systems	REAL-TIME STEREO VISION FOR ROBOT NAVIGATION: The goal of this project is to take advantage of hardware-based stereo vision (GPU and FPGA acceleration) to enable very fast obstacle avoidance, navigation, and terrain modeling for mobile robots. This project involves computer vision theory, cross-platform software development (Linux and C++), and mobile robot testing.	Spring, Summer, Fall
ARC	ARC1-04-09-AN	Lunar & Planetary Surface Systems	ROBOT SYSTEM SOFTWARE: The NASA Ames Intelligent Robotics Group (IRG) operates mobile robots using a rich library of robot software. IRG is currently developing a new "service oriented" architecture to make it easier to integrate new hardware devices and algorithms. This project involves developing new robot software systems and requires strong knowledge/experience in C/C++ and distributed systems.	Spring, Summer, Fall
ARC	ARC1-05-09-AN	Lunar & Planetary Surface Systems	GIGAPAN: GigaPan is a robotic camera mount (http://gigapan.org) that enables capturing multi-gigapixel, explorable panoramas with most off-the-shelf digital cameras. These panoramas have many uses: scientific exploration (especially geology), inspection (structures, vehicles, etc.), site recon/characterization. This project will improve GigaPan in one (or more) of the following areas: user interface, cross-platform software, image mosaicking, and High-Dynamic Range imaging.	Spring, Summer, Fall

NASA Center	Internship #	ESMD Area of Emphasis	Internship Description	Timeframe
ARC	ARC1-08-09-AN	Lunar & Planetary Surface Systems	Robotic and Astronaut Activity Planning Project: This work will focus on supporing the planning of activities for the Mars Science Laboratory 2009 rover mission as well as the NASA Extreme Enviornments Mission Operations (NEEMO) underwared astronaut training lab. This project will provide applied experience working as part of a Human-Computer Interaction team at NASA. The work will include data collection and analysis for current NASA missions. Skills required to support this work include computer science.	Spring, Summer, Fall
ARC	ARC1-10-09-AN	Lunar & Planetary Surface Systems	Modeling Human Performance Physiology: Overall Research Goal: To develop and validate countermeasures to mitigate risks to neurobehavioral functions and enhance health, performance and safety of crews during extended duration spaceflight. To develop a real-time physiological model that will predict or classify individual and team performance. Skills: (preferred) 1. Some programming experience with Visual Basic, C/C++, Matlab. 2. Some familiarity with digital signal processing techniques, in particular human biomedical data (e.g., ECG, EEG). 3. Some experience with neural network based models	Spring, Summer, Fall
ARC	ARC1-11-09-AN	Lunar & Planetary Surface Systems	Monitoring and Correcting Hazardous Operator States: Overall Research Goal: To develop and validate countermeasures to mitigate risks to neurobehavioral functions and enhance health, performance and safety of crews during extended duration spaceflight. Objectives: 1. To study how humans adapt in space analog environments (e.g., isolation, confinement, and sustained operations), and to identify individual characteristics that best predict team performance; 2. To compare the effectiveness of selected countermeasures for mitigating performance impairments of individuals exposed to high-stress, high workload situations; 3. To develop non-intrusive, portable methods for self-detection and correction of adverse changes in physiological states, mood states, and cognitive, perceptual, and neuromotor function; 4. To develop a real-time physiological model that will predict or classify individual and team performance. Skills: (preferred) 1. Some familiarity with digital signal processing techniques, in particular human biomedical data (e.g., ECG, EEG). 2. MS Office, including Excel 3. Psychology, physiology	Spring, Summer, Fall
ARC	ARC2-06-09-AN	Ground Operations	3D MULTI-ROBOT USER INTERFACE: "Viz" is an interactive 3D user interface developed by the NASA Ames Intelligent Robotics Group (IRG). It allows mission operations teams to remotely control mobile robots and to study the data collected by the robots. This project will focus on improving Viz: adding command sequencing tools for multiple robots, incorporating speech and dialogue, adding predictive graphics (for time-delayed teleoperation). This project involves software development of multi-threaded Java applications, user interface design, and an understanding of 3D graphics.	Spring, Summer, Fall

NASA Center	Internship #	ESMD Area of Emphasis	Internship Description	Timeframe
ARC	ARC2-07-09-AN	Ground Operations	GROUND CONTROL SOFTWARE FOR LUNAR SURFACE OPERATION. The NASA Ames Intelligent Robotics Group (IRG) is developing a prototype ground control system to support lunar surface operations (e.g., science exploration) involving humans and robots. The goal of this project is to develop software systems including 2D/3D user interfaces, ground data servers, and group collaboration tools. This project involves programming in C++, Java, and/or scripting languages (Python, PERL, etc.).S:	Spring, Summer, Fall
ARC	ARC2-09-09-AN	Ground Operations	Risk Management for NASA's New Crewed Space Project: Orion and Ares will replace Space Shuttle as the new space vehicle to get astronauts, not only into orbit and to the Space Station, but also to the surface of the Moon within the next few years. This project will provide applied experience working as part of a Human-Computer Interaction team on risk assessment and management for NASA. The work will include data collection and analysis for current NASA missions. Skills required to support this work include computer science.	Spring, Summer, Fall
ARC	ARC4-12-09-AN	Spacecraft	Haptic Computer Interfaces for Space Applications: Engineering internship to work on programming, modeling, analysis, and calibration for computer controlled haptic interfaces.	Spring, Summer, Fall
ARC	ARC4-13-09-AN	Spacecraft	Human Performance During Launch Vibration: Engineering internship to work on programming, modeling, analysis, and calibration for computer controlled seat vibration simulator.	Spring, Summer, Fall
ARC	ARC5-14-09-AN	All	Advanced Visualization of Computational Physics Data: Advanced data analysis and visualization techniques for large-scale simulation data, hyper-dimensional data, real-time simulation data streams, and hyperwall environments. Example applications include computational fluid dynamics, structural dynamics, N-body systems, and computational chemistry. Skills required: computer graphics. Students will learn C++ and OpenGL programming in real world development. Strong math background is very helpful.	Spring, Summer, Fall
ARC	ARC5-15-09-AN	All	Programming Paradigms and Tools for Supercomputer Applications: Supercomputer application development programming paradigms and tools that significantly reduce the effort and technical challenge of converting a mathematical model or serial application code into a correct and efficient supercomputer app code. Internship: Study one advanced app dev programming paradigm by implementing it in a known benchmark (such as one of the NAS Parallel Benchmarks), or conduct a user study/survey to identify useful functionalities for parallel programming tools SDC: Compare app dev programming paradigms or develop new functionality or implementation techniques for a programming paradigm or tool	Spring, Summer, Fall

NASA Center	Internship #	ESMD Area of Emphasis	Internship Description	Timeframe
ARC	ARC5-16-09-AN	All	Supercomputer System Benchmarking, Performance Analysis, and Comparative Analysis: Characterize the performance of an application on two or more computer architectures and explain how architectural differences impact performance, or develop a website to store, access, and understand performance results; SDC: Compare benchmarking approaches or prototype new benchmarking functionality.	Spring, Summer, Fall
ARC	ARC5-17-09-AN	All	User Services: Supercomputer user environments with more intuitive, intelligent, and integrated interface to support supercomputing resources, services, and simulation data. Interns are expect to perform established user environment task or study one advanced user environment approach.	Spring, Summer, Fall
ARC	ARC5-18-09-AN	All	Advanced supercomputing architecture R&D: This project is to improve price-performance and/or programmability for NASA applications. Interns are expected to study one advanced architecture; and compare supercomputer architectures or prototype new architecture evaluation functionality.	Spring, Summer, Fall
ARC	ARC5-19-09-AN	All	Engineering for Managing the Infrastructure of Physical Plant: Design and develop engineering solutions for providing electrical and cooling resources for a large supercomputing facility, including significant changes to equipment, floorspace, electric power, and air/water cooling. Interns are expected to perform established facility tasks or study one advanced facility management approach.	Spring, Summer, Fall
ARC	ARC5-20-09-AN	All	Advanced Networking & Optimizing end-to-end Communications: Advanced networking software tools, techniques, and technologies, for improved bandwidth, latency, reliability, and administration of supercomputing interconnects, LANs, and WANs.	Spring, Summer, Fall
ARC	ARC5-21-09-AN	Lunar & Planetary Surface Systems	Data Collection for Exploration Mission Team Work Simulation: Exploration missions will involve distributed team collaboration and decision making, including space crews on the ISS or lunar surface and support personnel on earth. Interns will assist with data collection from laboratory and remote space analogue environments.	Spring, Summer, Fall
ARC	ARC5-22-09-AN	Lunar & Planetary Surface Systems	Data Analysis for Exploration Mission Team Work Simulation: Exploration missions will involve distributed team collaboration and decision making, including space crews on the ISS or lunar surface and support personnel on earth. Interns will assist with data analysis from laboratory and remote space analogue environments.	Spring, Summer, Fall
ARC	ARC5-23-09-AN	Lunar & Planetary Surface Systems	Lab Support for Exploration Mission Team Work Simulation: Exploration missions will involve distributed team collaboration and decision making, including space crews on the ISS or lunar surface and support personnel on earth. Interns will assist with software installation, Windows and Linux system management for PC and Laptops.	Spring, Summer, Fall

NASA Center	Internship #	ESMD Area of Emphasis	Internship Description	Timeframe
ARC	ARC5-24-09-AN	Spacecraft	Small Spacecraft - Mission Design: Small spacecraft show great promise for future NASA missions. Because of their nature, these spacecraft typically have very low margins in mass, power, and propulsion. In order to make these systems viable, NASA needs evaluate what is possible with innovative concepts for microspacecraft landers, rovers, and communications relays that could be used for very low cost robotic lunar precursor missions. This project focuses on innovative mission concepts for specific targets.	Spring, Summer, Fall
ARC	ARC5-25-09-AN	All	NASA Technology Database: Assist researchers in the determination of technology that affect ESMD mission using next generation of NASA Technology Database and explore approaches for improving NASA Technology Transfer meeting OMB Requirements Interns will help model aspects of the technology descriptions and maturity control and collect and analyze data as needed.	Spring, Summer, Fall
ARC	ARC5-26-09-AN	All	Infrastructure for Supercomputing Security Management: This project is to improve management tools for NASA supercomputing security. Interns are expected to study various security management tools and work to enhance their capability. This will involve prototyping of security management software services.	Spring, Summer, Fall
ARC	ARC5-27-09-AN	All	Spacecraft Handling Qualities Project: Assist researchers in the determination of factors that affect handling qualities for the next generation of NASA spacecraft and explore approaches for improving these handling qualities. Interns will help model aspects of the spacecraft control system, run experiments in the Vertical Motion Simulator, and collect and analyze data.	Spring, Summer, Fall
ARC	ARC5-28-09-AN	Lunar & Planetary Surface Systems	Information display formats for surface exploration space suits: Alternative system architectures and display formats will be analyzed to determine appropriate designs for space suit information displays to be used during planetary exploration. Analyses will be based on optical, biomechanical, perceptual and cognitive features of the systems displays and controls.	Spring, Summer, Fall
ARC	ARC5-29-09-AN	All	Database Development for Altair (Lunar Lander) Project: This project focuses on creation and development of a database for Altair (Lunar Lander). The work involves designing and developing user interfaces for system design engineers. Interns are expected to gather requirement, model interface, and develop prototypes and get users' feedback. Flex and Flash will be used.	Spring, Summer, Fall
ARC	ARC5-30-09-AN	All	Fault Detection, Diagnostics, and Response for Rocket Ares I: This project focuses on develop a fault detection, diagnostics and response system for the next generation of NASA rocket. Interns will help model aspects of the rocket monitoring, control system, develop experiments to be run in the simulator, and collect and analyze data.	Spring, Summer, Fall

NASA Center	Internship #	ESMD Area of Emphasis	Internship Description	Timeframe
ARC	ARC5-31-09	All	Exploration Life Support System - Air: NASA's Exploration Life Support program is charged with developing the advanced technologies and systems that support humans in extends space exploration. Advanced technology development areas required for future human missions includes: atmosphere revitalization, water recovery, waste processing and sensors. This project will focus on atmosphere revitalization.	Spring, Summer, Fall
ARC	ARC5-32-09	All	Exploration Life Support System - Waste Management: NASA's Exploration Life Support program is charged with developing the advanced technologies and systems that support humans in extends space exploration. Advanced technology development areas required for future human missions includes: atmosphere revitalization, water recovery, waste processing and sensors. This project will focus on waste management/resource recover.	Spring, Summer, Fall
ARC	ARC5-33-09-AN	All	Exploration Life Support System - Water Recovery: NASA's Exploration Life Support program is charged with developing the advanced technologies and systems that support humans in extends space exploration. Advanced technology development areas required for future human missions includes: atmosphere revitalization, water recovery, waste processing and sensors. This project will focus on water recovery.	Spring, Summer, Fall
ARC	ARC5-34-09-AN	All	Exploration Life Support System - Biosensors: NASA's Exploration Life Support program is charged with developing the advanced technologies and systems that support humans in extends space exploration. Advanced technology development areas required for future human missions includes: atmosphere revitalization, water recovery, waste processing and sensors. This project will focus on biosensors/biochemistry.	Spring, Summer, Fall
ARC	ARC5-35-09	All	CFD Applications - Grid Generation: Assist in development of CFD grid generation over complex aerodynamic shapes in support of aeronautic and space applications. Interns are expected to use existing software packages to generate grids for the purpose of creating aerodynamic databases.	Spring, Summer, Fall
ARC	ARC5-36-09-AN	All	CFD Applications - Result Analysis: Assist in development of CFD result generation over complex aerodynamic shapes in support of aeronautic and space applications. Interns are expected to use existing software packages to generate solutions for a wide variety of applications for the purpose of creating aerodynamic databases.	Spring, Summer, Fall
ARC	ARC5-37-09-AN	Spacecraft	Photonic or Electronic Hit Indicator: MMOD impact detector for Orion: Further advance a detector to determine the extent of MMOD damage to the Orion vehicle for its ISS and Lunar missions. This detector has a low false positive rate, uses minimal spacecraft resources and is based on a DoE system used to determine strikes on ballistic missile targets.	Spring, Summer, Fall

NASA Center	Internship #	ESMD Area of Emphasis	Internship Description	Timeframe
ARC	ARC5-38-09-AN	All	Prognostics for Complex Systems - Damage Propatation Modeling: The Prognostics Center of Excellence at NASA Ames Research Center is conducting research in systems health management. This involves the early assessment of abnormal conditions and damage as well as the estimation of "remaining life" of a component or subsystem. The goal is to research damage propagation mechanisms and to model damage using a physics-based approach for select application domains (e.g., power semiconductors, electro-mechanical actuators, composite structures, batteries, '). This project has a strong experimental component in the lab of the Prognostics Center of Excellence.	Spring, Summer, Fall
ARC	ARC5-39-09-AN	All	Prognostics for Complex Systems - Demonstration Testbed: The Prognostics Center of Excellence at NASA Ames Research Center is conducting research in systems health management. This involves the early assessment of abnormal conditions and damage as well as the estimation of "remaining life" of a component or subsystem. This project is a hands-on project. The goal is to implement damaged components into a testbed involving a real subsystem typically found in space application domains. The task includes data acquisition, controls, and data analysis.	Spring, Summer, Fall
ARC	ARC5-40-09-AN	All	Prognostics for Complex Systems: The Prognostics Center of Excellence at NASA Ames Research Center is conducting research in systems health management. This involves the early assessment of abnormal conditions and damage as well as the estimation of "remaining life" of a component or subsystem. The project involves both an experimental phase as well as analysis of data. The goal is to contribute to the understanding of how systems fail and how to predict failure. Prospective candidates should be comfortable in using algorithm prototyping languages like matlab.	Spring, Summer, Fall
DFRC	DFRC1-07-09-SU	Lunar & Planetary Surface Systems	Intern will work with NASA Mentor to model and develop dynamic-simulations for linear motor launch assist concepts.	Summer
DFRC	DFRC1-08-09-SU	Lunar & Planetary Surface Systems	Intern will work with NASA Mentor to develop interactive desktop lunar lander simulator that models the terminal phase of the lunar landing including the "gravity turn" and landing site selection. Intern will also aid in development of simulators of earth-based landing training vehicle, and perform flying quality comparisons to lunar landing simulation.	Summer
DFRC	DFRC4-01-09-AN	Spacecraft	Flight Abort Test Program	Spring, Summer, Fall
DFRC	DFRC4-02-09-AN	Spacecraft	Flight Abort Test Program	Spring, Summer, Fall
DFRC	DFRC4-05-09-AN	Spacecraft	Flight Abort Test Program - Systems Engineering	Spring, Summer, Fall

NASA Center	Internship #	ESMD Area of Emphasis	Internship Description	Timeframe
DFRC	DFRC4-06-09-AN	Spacecraft	Flight Abort Test Program - Project Planning and Control Analyst (includes Risk Management, Resources/Budgeting, Scheduling, Contracts and Public Affairs	Spring, Summer, Fall
GRC	GRC1-17-09-AN	Lunar & Planetary Surface Systems	Navigation for Lunar and Planetary Surface Systems: The student will develop performance analysis of lunar navigation systems in support of geo-locating systems for the planetaryEVA suit. The student will use and extend existing software tools that are part of the Space Navigation Computational Laboratory (SNCL). The student will employ Dilution-of-Precision (DoP), generalized DoP and full covariance-based techniques to analyze systems employing inertial, Earth-based and in-situ orbiting navigation resources for radiometric measurements.	Spring, Summer, Fall
GRC	GRC4-15-08-SU	Spacecraft	The student will be involved in the characterization of fuel/gas leak sensors and environmental chemical sensors, processing of data associated with these sensors, and other activities associated with the Chemical Sensors Team for CLV, CEV and ISRU. The student will be involved in measurement of the response of a variety of different types of gas sensors in range of temperatures and environments. These sensor types include diodes, electrochemical cells, and resistors. This work will include operation of a gas sensor testing system, compiling the resulting data, and some computer programming. The gas sensor testing system is computer controlled with the ability to flow several gases over a wide flow range. The student will operate this gas sensor testing system and use it to characterize samples. Other duties in support of the chemical sensor program will be performed as assigned. An Electrical Engineering major is preferred with programming knowledge.	Summer
GRC	GRC4-20-09-AN	Spacecraft	Advanced Combustion via Microgravity Experiments (ACME): Contribute to the design of a set of 4 experiments planned for the Combustion Integrated Rack on the International Space Station. Working with combustion scientists, study gas-fueled, non-premixed, laminar diffusion flames in 1D or 2D geometries. For example, investigate the effect of an electric field on chemiluminescent emission and flame stability. Develop and evaluate hardware and operational concepts through ground-based experiments in normal gravity and microgravity (via drop testing). Test the function and reliability of instruments and other hardware elements such as the burners and igniter.	Spring, Summer, Fall
GRC	GRC4-21-09-AN	Spacecraft	A spacecraft fire is one of major safety concerns for manned space crafts and lunar habitats. Student internship opportunities exist in the fire prevention area where flammability of materials is tested in normal gravity and in microgravity using the NASA Glenn Zero Gravity Facility. The normal gravity tests are geared toward either understanding the relevance of NASA's current material flammability screening test methods or simulating the reduced gravity environment through scaling laws.	Spring, Summer, Fall

NASA Center	Internship #	ESMD Area of Emphasis	Internship Description	Timeframe
GRC	GRC1-01-09-AN	Lunar & Planetary Surface Systems	GRC AW1: Excavation, Traction, and Material Flowability Measurements: Establish preparation recipes for lunar-equivalent soil using triaxial shear tests, penetration tests, and shear vane test. Use available wheel constructions to determine traction on lunar-equivalent soils under a matrix of operating conditions. Acquire excavator blades and measure the horizontal and vertical forces to dig in lunar-equivalent soil. Test validity/accuracy of traditional granular flow equations on lunar-equivalent soil seeking to identify the physics-based parameters that may be key to flow. All to develop test bins and validation tools for engineering design of surface systems.	Spring, Summer, Fall
GRC	GRC1-02-09-AN	Lunar & Planetary Surface Systems	GRC AW2: Finite Element, Mesh Free, and Discrete Element Modeling Calculation to reproduce simple measurements above (GRC AW1): Execute in a high performance computing environment at GRC. From this determine what particle parameters are needed to get responses equivalent to lunar soil. This is a building block for future more complicated simulations. All intended to develop modeling capacity that reduces lunar surface field testing during surface system design and build work in the future.	Spring, Summer, Fall
GRC	GRC1-07-09-AN	Lunar & Planetary Surface Systems	Description of General Research Work To Be Performed: Lunar dust is a major issue for materials and equipment used on the moon. Developing an understanding of the effect of dust on various materials used in space suits which will be exposed to lunar dust is necessary for up-coming missions. Baseline studies of space suit samples exposed to dust in the Apollo program using microscopy and other chemical analysis will be carried out based on availability. A selection of fabrics and other materials proposed to be used in advanced surface suits for up-coming missions will be exposed to lunar dust simulants, analyzed and compared to previous results.	Spring, Summer, Fall
GRC	GRC1-08-09-AN	Lunar & Planetary Surface Systems	Silica aerogels are attractive candidates for unique thermal, optical, catalytic, and chemical applications because of their low density and high mesoporosity. However, their inherent fragility has restricted their use to applications where they are not subject to load. Crosslinking silica aerogels with polymer significantly increases the strength of the aerogel with only a small effect on density or porosity. In addition, at very low densities, the aerogels crosslinked with a di-isocyanate are somewhat flexible. To enhance this property and make the monoliths more robust, synthesis of different formulations using more flexible linkages in the polymer backbone is proposed. Characterization and mechanical testing will be done on the monoliths produced and the properties will be optimized.	Spring, Summer, Fall

NASA Center	Internship #	ESMD Area of Emphasis	Internship Description	Timeframe
GRC	GRC1-09-09-AN	Lunar & Planetary Surface Systems	Mechanical systems for the next generation lunar rover are developed and tested. The Simulated Lunar OPEration (SLOPE) facility provides a test vehicle and environment of simulated lunar surface terrain including sloping section. Possible research topics are terramechanics (interactions between wheels and various terrains), drive train, and suspension. Interns will assist with design and fab of components and/or conducting experiments to validate performance.	Spring, Summer, Fall
GRC	GRC4-10-09-AN	Spacecraft	Development of Crew Injury Prediction Models for Orion: The design of Orion requires that NASA develop a high fidelity understanding of the human body's ability to withstand the landing forces generated by the vehicle during landing. Prediction of crew injuries during landing is critical to mission success and is a major design driver for the program. Currently the Brinkley model is used as the standard for crew injury predictions. This model is based primarily on empirical data and represents the human body analytically as a simple single degree-of-freedom oscillator in the spinal, side-to-side and chest in and out directions. The shortcoming of the Brinkley model is it is specifically designed for ejection seat injury predictions using a very specific seat arrangement and restraint system. The model is unable to assess the effects resulting from alternate seat designs, constraint systems, crew suits or helmets. Furthermore, the Brinkley model is based on limited test data and does not utilize the latest technology that is available from the automotive, aerospace or biomedical communities. More recently these industries have employed finite element technology to develop human body models to simulate human behavior during events such as automobile crashes. These models are able to predict full three dimensional human responses during an event such as a crash and airbag deployment are able to reliably predict the loading and deformations that occur within the human body. The Exploration System Mission Directorate (ESMD) is employing this technology for Orion and crew member injury predictions using the following approach; 1) leverage existing human body finite element modeling technology that has been developed for the automotive, aerospace and biomedical communities and further develop this modeling technology for application to Orion. 2) Collect and develop injury criteria applicable to Orion. 3) Enhance models to accommodate candidate seat designs, constraint systems, crew suits and helmets. 4) Integrate human body models into Orion landing scenarios and generate human body response. 5) Assess the human body model and generated response to accepted injury criteria as well as compare new human body model to currently used Brinkley model. Final products will be validated human body finite element models and associated injury criteria capable of modeling the crew members, crew seats, harness, crew suit and helmet and a validated set of injury criteria for Orion crew member injury predictions.	Spring, Summer, Fall

NASA Center	Internship #	ESMD Area of Emphasis	Internship Description	Timeframe
GSFC	GSFC1-03-08-AN	Lunar & Planetary Surface Systems	Lunar Terrain Categorization: Surface mission operational planning has been identified as one area of special interest within the Scientific Context of the Moon Exploration. Specifically, technologies that will enable scientists to perform terrain categorization, and in particular to detect, identify and characterize rocks, will be studied. Once lunar data is geo-registered & mosaiced to a common Lunar Geodetic Grid, these tools will assist scientists in determining general regions of interest, in performing precise targeting of specific types of samples, & in avoiding hazardous landing sites. Regions of interest will mainly be determined by understanding and characterizing potential lunar resources (minerals, ice, etc.) and their spatial distribution, their abundance, density, and distribution, relative to future missions and in-situ instruments that will be needed to perform additional detailed analyses. Rock identification will play an essential role in targeting specific samples, and rock location and distribution will be essential for selecting landing sites while avoiding hazards. Another importance tool in selecting landing sites will be accurately compute slopes and surface roughness parameters, from laser altimeter or stereo data, taking into account appropriate solar illumination models. Specifically, the work will focus on terrain classification and SAR data hazard analysis. Classification with methods such as shape analysis, textural analysis, mathematical morphology, & shading analysis, as well as both unsupervised clustering & supervised classification will be investigated and evaluated, and SAR Data Hazard Analysis will be used to generate hazard maps using methods such as texture and mathematical morphology.	Spring, Summer, Fall
	GSFC1-05-08-SU	Lunar & Planetary Surface Systems	Development of an Ytterbium (Yb)-fiber laser pumped Optical Parametric Oscillator (OPO) for an atmospheric methane measurement instrument.	Summer
GSFC	GSFC1-33-09-AN	Lunar & Planetary Surface Systems	Inverse Synthetic Aperture Radar (ISAR) for Interior Mapping of Asteroid: This project has a goal to develop hardware and software for low frequency wideband step frequency ISAR radar. Low frequency ISAR are used to image interior structure of an unknown target such as asteroid/comet and other planetary bodies. ISAR consists of three basic subsystems: (1) Base band signal generation and based ban I & Q data processing, (2) Analog RF front end, and (3) Antenna. Using either Xilnix/Altera FPGA board and Analog Devices' DDS chips entire base band operation will be programmed and implemented. The analog RF front end will be assembled from commercially available RF components. The data acquisition and processing will be implemented through FPGA. Development of data processing algorithm to form a 2-D image of interior portion of a target will also be part of this project.	Spring, Summer, Fall
GSFC	GSFC1-34-09-AN	Lunar & Planetary Surface Systems	Organic Compound Analysis of Mars Analogues: Gas chromatograph mass spectrometer analysis of Mars analogues.	Spring, Summer, Fall

NASA Center	Internship #	ESMD Area of Emphasis	Internship Description	Timeframe
GSFC	GSFC1-35-09-AN	Lunar & Planetary Surface Systems	Lunar Transverse Map Contest: Next year more than 3 billion dollars of new lunar data will start to flow in a torrent. We are designing an educational outreach effort setting up a competitive mission design by students for the most basic types of lunar robots.	Spring, Summer, Fall
GSFC	GSFC1-36-09-AN	Lunar & Planetary Surface Systems	Communications, Standards, & Technology Laboratory: The student intern will participate in the development & integration of technologies and systems into the GSFC Communications, Standards, & Technology Laboratory (CSTL). The CSTL is a facility capable of testing and demonstrating complete end-to-end mission communications scenarios from on board spacecraft computer systems through spacecraft busses and RF communications systems, ground station RF systems, terrestrial networking systems, to the mission control center. The work available ranges from software development to digital and RF hardware design. Current activities include demonstrations and development of Lunar Surface communications scenarios.	Spring, Summer, Fall
GSFC	GSFC1-39-09-AN	Lunar & Planetary Surface Systems	Dust Environmental Effects Particulate (DEEP) Chamber: The student intern will provide support in assembly and chamber operation for testing mechanisms and other spacecraft components in a lunar dust environment. Chamber internal designs will need to be accomplished for proper testing as well as complying with safety requirements.	Spring, Summer, Fall
GSFC	GSFC2-02-08-AN	Ground Operations	Embedded science data processing applications using high performance hybrid platforms: Work on a robotic path planning demonstration; R&D involving SAR and Hyper-spectral data processing; and robust software architecture that will help fly commercial processors reliably in a space-radiation environment. Students need to have C and/or VHDL experience, and combined hardware/software experience.	Spring, Summer, Fall
GSFC	GSFC2-06-08-SU	Ground Operations	Design and testing of a holographic optical filter; such narrow band optical filters are important in wavelength division multiplexed systems and very useful in optical communication systems.	Summer
GSFC	GSFC4-15-08-SU	Spacecraft	Structural Verification of the Lunar Reconnaissance Orbiter (LRO): The student intern will assist in the structural testing of the LRO spacecraft. These tests may include both vibration and acoustic tests. Pretest analysis will be performed and correlated to the test results.	Summer

NASA Center	Internship #	ESMD Area of Emphasis	Internship Description	Timeframe
GSFC	GSFC4-37-09-FA	Spacecraft	FPGA Implementation of a Motor/Actuator Controller Core: New flight instrument and spacecraft mechanism control electronics increase the challenges for higher performance and safety parameters as well as low development cost. A promising technology that can help achieve this is "System-On-a-Chip", or SOC, where many functions are integrated onto a single integrated circuit. By using a single device instead of many, printed circuit board size can be dramatically reduced, which translates into size and mass savings. Typically, a SOC is developed by coding and stimulating each of the functions in a hardware description language (HDL). Integrating those functions into a system, stimulating and synthesizing the integrated system for implementation on a field programmable gate array (FPGA). The ability to use these coded functions as "intellectual property cores" (IP cores) in multiple applications can significantly reduce development cost. However, one major obstacle to using SOC technology for many instruments is the lack of IP cores to perform motor and actuator control. This effort proposes to develop a motor/actuator control core (MACC) that will allow a complete instrument data system to be implemented on a single FPGA. This will allow the advantages of SOC architectures to be fully leveraged across a wide variety of upcoming instruments.	Fall
GSFC	GSFC4-38-09-AN	Spacecraft	Composite Material Lab - Hands on Internship - Multiple Programs: Multiple Composite Structure Programs.	Spring, Summer, Fall
GSFC	GSFC4-14-08-SU	Spacecraft	Communications, Standards, & Technology Laboratory: The student intern will participate in the development & integration of technologies and systems into the GSFC Communications, Standards, & Technology Laboratory (CSTL). The CSTL is a facility capable of testing and demonstrating complete end-to-end mission communications scenarios from onboard spacecraft computer systems through spacecraft busses and RF communications systems, ground station RF systems, terrestrial networking systems, to the mission control center. The work available ranges from software development to digital and RF hardware design.	Summer
GSFC	GSFC4-16-08-SU	Spacecraft	Development of a Motor/Actuator Controller Core for Flight Instrument & Spacecraft Mechanisms: Development of electronic circuits that will drive and control a precision mechanism actuator. Work will include fabrication of an electronic circuit and testing with a space flight actuator engineering unit to demonstrate all requirements can be achieved.	Fall

NASA Center	Internship #	ESMD Area of Emphasis	Internship Description	Timeframe
JSC	JSC1-01-08-6M	Lunar & Planetary Surface Systems	A student researcher is required to assist in the design and development of battery modules A student researcher is required to assist in the design and development of battery modules with polymer lithium-ion cells. The battery modules will be tested in ambient as well as vacuum environments for performance as well as safety. Lunar and planetary surface systems will require that they be exposed to extreme temperatures and testing will be performed at worst case hot and cold temperatures. Perform survey on polymer lithium-ion cells used in commercial, military and space applications. Study polymer cell electrode design configurations from different manufacturers. Survey of successful long-term operation and perform analysis that may relate cell design to long life.	Spring, Summer, Fall
JSC	JSC1-08-08-4M	Lunar & Planetary Surface Systems	A new project has been started in In-situ Resource Utilization for the moon. This project consists of a bioreactor that uses cyanobacteria to attack and corrode lunar soil in order to extract useful products (oxygen, iron, silicon) for use on the moon. It will use a unique bioreactor design in which fiber optics light pipes provide light energy to the cyanobacteria. The resulting biomass is recycled after removal of the desired resources. This project requires knowledge of general and molecular microbiology, general and analytical chemistry, basic biotechnology and engineering. Student needs experience with a Scanning Electron Microscope, and has knowledge of interactions between bacteria and minerals.	Spring, Summer, Fall
JSC	JSC4-09-08-AN	Spacecraft	Astronauts experience alterations in multiple physiological systems following their return to Earth due to adaptive responses that occur during exposure to the microgravity conditions of space flight. These changes may lead to disruption in the ability to ambulate and perform functional tasks during the initial reintroduction to a gravitational environment following a prolonged transit. These disturbances may cause decrement in performance of operational tasks immediately following landing on a planetary surface. Therefore, the goals of this interdisciplinary project are to: 1) Develop a set of functional tests for pre and postflight testing of astronauts; 2) determine the effects of short and long-duration space flight on functional performance and 3) map the relationship between changes in functional performance and the physiological alterations that occur as a result of exposure to space flight.	Spring, Summer, Fall
JSC	JSC1-18-08-AN	Lunar & Planetary Surface Systems	Student Intern will participate in the design of in-situ resource utilization oxygen production pilot plants. These plants will produce pure oxygen from lunar regolith (soil) to enable a sustainable lunar outpost.	Spring, Summer, Fall

NASA Center	Internship #	ESMD Area of Emphasis	Internship Description	Timeframe
JSC	JSC1-21-09-AN	Lunar & Planetary Surface Systems	Proton Exchange Membrane Fuel Cells: Fuel cells are likely to be key to lunar lander and lunar outpost operations. Key to developing lightweight and reliable fuel cell plants is the ability to manage reactants and water with no active pumps or other components. An intern would examine the technologies needed for passive reactant control, passive cooling, and water removal by wicking. Prototyping of one or many of these technologies is desirable.	Spring, Summer, Fall
JSC	JSC1-22-09-AN	Lunar & Planetary Surface Systems	In preparation for returning to the moon, a means must be developed to allow astronauts to practice performing tasks in a reduced gravity environment, and engineers to evaluate systems, such as space suits, used in the performance of these tasks. To these ends, the Active Response Gravity Offload System (ARGOS) is being developed. ARGOS will use electro-mechanical devices and sensors to compensate for the difference between earth and lunar gravity, while keeping the actuation point above the center of gravity during translations. Of interest to NASA is a control algorithm that will command the motors in response to the astronaut's movements with negligible lag time.	Spring, Summer, Fall
JSC	JSC1-23-09-AN	Spacecraft	This internship will be to implement ITU standard G.729 (CS-ACELP and G.722.2 (AMR-WB) speech compression codecs on FPGA target. These codecs are typically implemented on Digital Signal Processors (DSP). Constellation wants to implement the codecs on an FPGA so that redundant data-bus audio packet management, speech signal extraction and compression can happen on a single chip, minimizing mass, power and size requirements.	Spring, Summer, Fall
JSC	JSC4-12-08-SU	Spacecraft	Materials Science of Manned Spacecraft Radiation Shielding This internship will involve examining crew dose, materials dose, and avionics single event effects (SEE) environments and how it is affected by manned spacecraft radiation shielding. The intern will use the FLUKA (http://www.fluka.org/) ionizing radiation transport code to explore the effectiveness of various materials and materials combinations in attenuation of galactic cosmic ray and solar cosmic ray dose to the interior of relatively massive (compared to robotic vehicles) manned spacecraft. The objective here is to compare different materials in simple geometries so that materials effects on secondary particle production and stopping power can be determined and visualized directly with no complications from specific spacecraft configuration effects. Validation of the FLUKA tool against available space flight data and ground based accelerator data is an essential part of the project.	[Summer], [Fall]

NASA Center	Internship #	ESMD Area of Emphasis	Internship Description	Timeframe
JSC	JSC4-13-08-SU	Spacecraft	Geomagnetic Storms, Traveling Ionospheric Disturbances (TIDs), and Solar Cycle Effects on Neutral Atmosphere The objective of this internship is to evaluate existing (albeit cutting edge) tools used to predict the scale of the ISS attitude control or satellite drag anomalies expected as a result of geomagnetic storm events or as the upper atmosphere become immediately denser during geomagnetic storms and gradually denser as we approach the upcoming solar maximum, the magnitude and character of which is proving more difficult to predict than was the case for the last several solar maxima.	[Summer], [Fall]
JSC	JSC4-14-08-SU	Spacecraft	International Space Station as a Nano/Micro Satellite Base This effort is an evolution of the sounding rocket base (Wallops, White Sands, Poker Flats etc.) idea as suggested by the free launch services provided for micro satellite and nano satellites by ESA on the Arianne launcher and used extensively by Surrey Satellite customers. Specifically, the intern will need to provide a report with the following information: a) Feasibility - assessment of earth-to-orbit transportation opportunities to ISS in the post Shuttle era. b) Concept - multi-satellite carrier to attach to ISS externally and provide controlled mechanical deployment/launch over some range of vectors compatible with ISS safety (collision avoidance). c) Launch opportunities for satellite carrier assembly - Progress, Soyuz, ESA/ATV, JAXA/HTV, Commercial Carriers (COTS Program), Orion. d) Matching the concept to the agency road maps and science objectives/needs of, for example, the National Science Foundation, NASA Science Mission Directorate, and the National Oceanics and Atmospherics Administration.	[Summer], [Fall]
KSC	KSC1-07-08-AN	Lunar & Planetary Surface Systems	Interns will be involved in developing surface support equipment required to deploy and operate a Lunar Outpost. Examples include spacecraft servicing on the Lunar Surface, emplacement of Outpost assets & cargo and production & distribution of surface consumables such as Liquid Oxygen	Spring, Summer, Fall
KSC	KSC1-08-08-AN	Lunar & Planetary Surface Systems	Interns will work on In-Situ Resource Utilization (ISRU) technologies. Regolith Excavation is required for Oxygen Production and Lunar Outpost Construction. Technologies and mechatronic systems will be developed to syupport ISRU methods and goals.	Spring, Summer, Fall
KSC	KSC2-01-08-AN	Ground Operations	Advancing technologies that support Data Presentation & Visualization which is part of ESMD; KSC Lead Center for this initiative	Spring, Summer, Fall
KSC	KSC2-02-08-AN	Ground Operations	Improved discrete event simulation integration	Spring, Summer, Fall

NASA Center	Internship #	ESMD Area of Emphasis	Internship Description	Timeframe
KSC	KSC2-17-09-AN	Ground Operations	Development of a simulation tool to assist planning, scheduling and integrating the KSC ground processing tasks involved in preparing the ISS Orbital Replacement Units and payloads that will be launched on Visiting Vehicles. These vehicles include Japan's HTV, to be launched from Tanegashima, Japan; ESA's ATV to be launched from Kourou, French Guiana; CEV/Orion to be launched from KSC; and commercial vehicles to be launched from a TBD site. Appropriate for -- Industral Engineering or Computer Science/Engineering. Specialized Skills Required -- Experience with simulation tools beneficial but not required.	Spring, Summer, Fall
KSC	KSC2-18-09-AN	Ground Operations	Life Cycle Costs for Automating Spacecraft Processing Functions For this project, a model/tool to be used in forecasting lifecycle costs for different systems/operations will be developed. This may include cost/benefit analysis for automating certain spacecraft processing functions such as fueling and pressurization, versus performing these functions manually. Appropriate for any engineering discipline. Specialized Skills Required - Industrial Engineering field of specialization helpful but not required	Spring, Summer, Fall
KSC	KSC2-19-09-AN	Ground Operations	Electronic Work Control and Work Authorization Applicability at KSC This project will involve a survey of KSC operations and an assessment of the applicability of electronic work control (Work Authorization Documents) systems in use in the aerospace industry and especially at KSC for a recommendation of a system or type of system. Appropriate for any engineering discipline. Specialized Skills Required - Industrial Engineering field of specialization helpful but not required	Spring, Summer, Fall
KSC	KSC2-20-09-AN	All	International Space Station (ISS) Strategic Outreach to Gen Y Capitalizing on the global characteristic of the ISS, this project will develop communication strategies and tools for disseminating information about ISS milestones, accomplishments, and missions to the Gen Y audience in order to help them assume their role as active participants and stakeholders in NASA's goals. See "NASA Gen Y PowerPoint presentation" available on various public web sites for example reference information. Appropriate for - any engineering discipline Communication skills needed	Spring, Summer, Fall
KSC	KSC2-21-09-AN	Ground Operations	Space Station Processing Facility Operations and Maintenance Cost Evaluation This project will compare the Operations and Maintenance costs of the Space Station Processing Facility (SSPF) to the O&M costs of a similar building in industry. The intern will analyze other models of operation and opportunities for improvement to facilitate continued usage of the SSPF asset for Constellation.	Spring, Summer, Fall
KSC	KSC2-22-09-AN	Ground Operations	Knowledge Management Strategy Evaluation for the Transition from ISS to Spacecraft Processing This project will involve an analysis of current knowledge management practices within International Space Station (ISS) flight system processing. Benchmarking and analysis of other best practices will be conducted. Proposal of a strategy for transitioning from current infrastructure to a recommended future state will be developed.	Spring, Summer, Fall

NASA Center	Internship #	ESMD Area of Emphasis	Internship Description	Timeframe
KSC	KSC2-23-09-AN	Ground Operations	Initial Logistics Supportability in a Lunar Environment During this project, the intern will determine initial composition of spares based on lunar concept of operations, optimize packaging configuration, and identify maintenance scenarios based on potential failure modes and tools required. Industrial Engineering with logistics operations knowledge preferred	Spring, Summer, Fall
KSC	KSC2-25-09-AN	Ground Operations	This project will involve using the IRIS software package utilized by the Launch Services Program to design telemetry screens for the various vehicles and their ground systems used by NASA when launching unmanned payloads. These telemetry screens will provide vital measurements to systems engineers in an organized manner for both ground testing and launch activities and may also provide calculations and graphical representations of incoming data measurements. The creation of these screens will require the student to develop basic knowledge of ground testing and operation of multiple launch vehicle systems.	Spring, Summer, Fall
KSC	KSC2-26-09-AN	Ground Operations	During this project, the intern will assist the Launch Command and Control Systems (LCS) Hardware Group in Hardware Configuration Item (HWCI) electromagnetic interference (EMC) testing. This effort includes the development of susceptibility failure criteria and related requirements for all applicable LCS HWCI's.	Spring, Summer, Fall
KSC	KSC1-05-08-AN	Lunar & Planetary Surface Systems	Perform experiments to improve our understanding of the physics of the erosion of lunar/martian soil beneath a rocket exhaust plume, the processes of cratering and scour-hole formation in the soil, the aerodynamic forces upon the blowing particulates and larger ejecta, their trajectories, and the damage they may cause upon impact with spaceflight hardware.	Spring, Summer, Fall
KSC	KSC1-06-08-AN	Lunar & Planetary Surface Systems	Developing techniques to numerically simulate the blowing of soil and/or cratering beneath the engines of lunar and martian landers, validating the simulations by comparison with the Apollo landing videos, Surveyor III damage, Mars imagery, and terrestrial experiment data, and using the simulations in trade studies to determine how to develop landing zones that will control the blast effects and protect both the landing vehicle and the lunar/martian outpost	Spring, Summer, Fall
KSC	KSC1-09-08-AN	Lunar & Planetary Surface Systems	These tasks support the Exploration Life Support Project of ESMD. They are: Water Recovery Systems (WRS) Element by characterization of the microbial communities in water processed and stored for CEV; Waste Management Systems (WMS) Element by characterization of the microbial communities in solid waste solid waste compacting, storage and safing development for CEV; Habitation Element by developing efficient, high quality lighting systems for CEV, LSAM, and surface systems, including the use of LED and direct solar light capture systems with acceptable spectrum for human vision; Air Revtalization Element (ARS) by testing (COTS) polymer adsorbents for filtering trace contaminants found in cabin air; and developing a hypobaric test capability for assessing environmental and chemical sensors / detectors for CEV and Lunar landing applications.	Spring, Summer, Fall

NASA Center	Internship #	ESMD Area of Emphasis	Internship Description	Timeframe
KSC	KSC2-03-08-AN	Ground Operations	Evaluate and improve the usability and human factors of simulation tools	Spring, Summer, Fall
KSC	KSC2-04-08-AN	Ground Operations	Innovative uses of ESMD's Distributed Observer Network (DON) for education & other NASA purposes (KSC POC to interface w/Snr Pjt Team)	Spring, Summer, Fall
LaRC	LRC1-17-09-AN	Lunar & Planetary Surface Systems	Development of Mid-IR Laser-Based Differential Absorption Lidar (DIAL) for Water Vapor Detection: Student will be involved in developing the capability (modeling and simulation) of sensing water vapor on Mars and in other planetary atmospheres using lidars. (There could be some test experiments provided students have requisite training in using lasers that include laser safety training and eye exams.)	Spring, Summer, Fall
LaRC	LRC1-18-09-AN	Lunar & Planetary Surface Systems	Design, Modeling, and Performance Simulation of Lidar Systems for Sensing Trace Gases: Lidars for sensing water vapor, ice, and several atmospheric trace gases are being investigated. Student will develop computer models for evaluating the merits of several lidar techniques for optimum system development. (There could be some test experiments provided students have requisite training in using lasers that includes laser safety training and eye exams.)	Spring, Summer, Fall
LaRC	LRC1-19-09-SU	Lunar & Planetary Surface Systems	Development of Space Exploration Interactive Software: The primary objective of this project is to develop interactive online software to compare space exploration with other exploration efforts throughout history. The modules/options would include transportation, survival in harsh environments, human needs, desirable locations for settlements (and why), the importance of water in exploration, and other topics unique to all exploration efforts. The software would provide a repository of images of maps that NASA has developed in planning for future missions.	Summer
LaRC	LRC2-10-08-SU	Ground Operations	Integrated Diagnostic and Prognostic Aeroservoelastic Methods for Adaptive Control System: The purpose of this project is to develop integrated diagnostic and prognostic aeroservoelastic methods to generate static and dynamic load constraints due to structural damage and upset conditions for adaptive control system. The focus will be on the following: damage characterization and residual strength; rapid modeling and analysis methods; dynamic impact simulation; and probabilistic methods.	Summer
LaRC	LRC4-06-08-SU	Spacecraft	Analysis of Dynamic Stability Experimental Data in Support of Project Orion and Planetary Entry Capsules: Dynamic stability data from various sources will be compared to better understand the strengths and weaknesses of different test techniques and facilities. This analysis will help identify the best facility to obtain data for different blunt body configurations and applications. The comparisons will also be used to quantify uncertainties on the measured aerodynamic coefficients and the sources of error in each facility.	Summer

NASA Center	Internship #	ESMD Area of Emphasis	Internship Description	Timeframe
LaRC	LRC4-08-08-SU	Spacecraft	Nanomaterials Characterization for Aerospace Applications: Characterization and imaging of carbon nanotube networks in materials using Atomic Force Microscopy (AFM)	Summer
LaRC	LRC4-16-09-AN	Spacecraft	Assessment of Uncertainty Quantification and Modern Design of Experiments (MDOE) for Impact Dynamics Applications: This work is important in the context of the Orion Landing System development application and has potential for future spacecraft and lunar-lander work. This work integrates two specialized areas - impact dynamics and uncertainty quantification (using probabilistic analysis). Impact dynamics is based on an understanding of the nonlinear, transient-dynamic behavior of structures. The quantification and propagation of a number of uncertainties will require the knowledge of probabilistic analysis. MDOE can be used to minimize or control some uncertainties. A graduate student would be best suited for this work. The student's effort will be in the application of probabilistic analysis for uncertainty quantification to an impact dynamics problem. In order to most effectively work on the project, the student should have knowledge in either nonlinear, transient-dynamic structures or probabilistic analysis. In addition, experience with finite-element modeling and signal processing would be helpful.	Spring, Summer, Fall
LaRC	LRC4-20-09-AN	Spacecraft	Development of an ARES I Aerodynamic Database: The ARES I database will be derived from separate wind tunnel, CFD, and engineering code datasets. The work involves the integration of these separate items into a single database with routines being developed in MATLAB.	Spring, Summer, Fall
LaRC	LRC1-01-08-AN	Lunar & Planetary Surface Systems	Algorithm Development for Robotics Applications Using LABVIEW: This project involves the development of algorithms relating to autonomous mobility and navigation based on stereo, omni-directional, and thermal imagers. The intern should be interested in robotic systems and well-versed in computer programming.	Spring, Summer, Fall
LaRC	LRC1-03-08-SU	Spacecraft	Distance Learning Modules for Tribal Schools: Participants will work with NASA Digital Learning staff to design and test distance learning modules intended for delivery via videoconferencing to Tribal schools. Specific desirable skills will support digital media production, research activities, and technical/media writing. Proficiency with PowerPoint, Photo Shop; and/or video editing software is recommended. Content for modules will be associated with lunar and planetary surface systems, propulsion, and spacecraft.	Summer
LaRC	LRC1-04-08-AN	Lunar & Planetary Surface Systems	Design and Integration of a Robotic Platform for Science Instrument Testing: This project involves the development of software to support the operation of a robotic platform with application to the testing and deployment of science instruments. The tasks to be implemented include: image registration, behavioral robotic intelligence, and user interfaces for robot guidance and supervision. Ideal candidates for participation will be familiar with kinematics, machine pattern recognition, computer programming, and guidance and control.	Spring, Summer, Fall

NASA Center	Internship #	ESMD Area of Emphasis	Internship Description	Timeframe
LaRC	LRC4-09-08-SU	Spacecraft	Resonant Difference Frequency Atomic Force Ultrasonic Microscopy (RDF-AFUM): The RDF-AFUM technique employs an ultrasonic wave launched from the bottom of a sample, while the cantilever of an atomic force microscope, driven at a frequency differing from the ultrasonic frequency by one of the contact resonance frequencies of the cantilever, engages the to surface of the sample. The associated signals are used to create images of nano-scale near-surface and subsurface features.	Summer
MSFC	MSFC1-02-08-AN	Lunar & Planetary Surface Systems	Educational test bed for surface mobility studies: The objective of this project is to develop and implement a testbed that may be used at a college or university for further research and technology development in surface mobility systems. During the summer the students will utilize commercial off-the shelf components e.g., radio controlled cars, computer to RC interface boxes, X-box controllers, PC computers and network cameras to develop a demonstration of automated way-point navigation. The network camera will be positioned over the area traversed by the RC car and image processing algorithms will be developed to determine the car's position and orientation that will be used in the closed loop control system. This position data will be used in place of GPS data and will allow the development of a small scale surface mobility simulator than can be implemented indoors. This system may be replicated back at the grantee's home institution and provide a low-cost test bed for further development in surface mobility related areas."	Spring, Summer, Fall
MSFC	MSFC1-03-08-AN	Lunar & Planetary Surface Systems	Radiation Effects on Electronics Modeling: Develop advanced models of the natural radiation environment to diagnose and predict the effects of Single Event Effects (SEEs) on modern electronic architectures.	Spring, Summer, Fall
MSFC	MSFC1-04-08-AN	Lunar & Planetary Surface Systems	Reconfigurable Computers: Provide reconfigurable computing capability, resulting in reduction of flight spares and risk reduction for limited circuit lifetimes.	Spring, Summer, Fall
MSFC	MSFC1-05-08-SU	Lunar & Planetary Surface Systems	Impact testing using a variety of projectiles simulating micrometeoroids, orbital and launch debris, and weather encounters (rain/hail) for testing and developing materials to ensure safer space exploration	Summer
MSFC	MSFC1-09-08-AN	Lunar & Planetary Surface Systems	Microwave/Millimeter Wave Nondestructive Evaluation (NDE) Lab support	Spring, Summer, Fall

NASA Center	Internship #	ESMD Area of Emphasis	Internship Description	Timeframe
MSFC	MSFC1-11-08-SU	Lunar & Planetary Surface Systems	With longer duration and distance space flights becoming necessary, the ability to predict and simulate space radiation exposure due to galactic cosmic rays (GCR) is crucial. These predictions are commonly used in space weather simulations as well as in radiation exposure and protection studies for microelectronics and astronauts. This study focuses on four of the most widely used GCR models where they will be benchmarked and validated against a database consisting of both light and heavy-ion GCR data. This work will provide a foundation for updating the Cosmic Ray Effects on MicroElectronics (CREME) 1996 model, an effort that is currently underway by the Cosmic Ray group at MSFC.	Summer
MSFC	MSFC1-15-08-SU	Lunar & Planetary Surface Systems	Modeling the space radiation environment	Summer
MSFC	MSFC1-19-08-AN	Lunar & Planetary Surface Systems	Fission Surface Power Component Testing and Development. Involves analysis, design and testing of technologies for possible use in a fission reactor to power a lunar base. Involves thermodynamics, heat transfer, fluid flow, mechanical design, and hands-on laboratory operations. Current technologies include liquid metal pumps, flowmeters and heat exchangers, thermal fuel rod simulators, liquid metal corrosion and natural convection flow.	Spring, Summer, Fall
MSFC	MSFC1-20-08-AN	Lunar & Planetary Surface Systems	Radioisotope Power Simulator Development and Testing. Involves analysis design and testing of thermal simulators of the General Purpose Heat Source module, a Plutonium radioisotope source used in NASA mission. Involves heat transfer, mechanical design and hands-on laboratory operations.	Spring, Summer, Fall
MSFC	MSFC1-36-08-AN	Lunar & Planetary Surface Systems	Fission Surface Power: Fission systems could potentially provide abundant power anywhere on the surface of the moon or Mars. The intern would perform experimental work related to the design and development of fission surface power (FSP) systems for potential use on the moon or Mars. Work at MSFC is focused on testing related to the reactor and shield. Work could include completing experiments related to pump performance, heat exchanger performance, shield performance, integrated system performance, thermal simulator development, or other topics. Work may also be done in collaboration with other NASA centers (e.g. GRC).	Spring, Summer, Fall
MSFC	MSFC1-46-08-AN	Lunar & Planetary Surface Systems	In Situ Fabrication & Repair / In Situ Resource Utilization / Dust Management Project: Student would assist NASA project team in developing and advancing technologies required for returning to the Moon, establishing a lunar outpost and eventually exploring Mars and beyond. Multiple research and technology areas are under investigation which could enable self-sufficiency on the Moon by learning to utilize in situ lunar resources. Technologies the team is maturing include methods for extracting oxygen and metals from the lunar regolith, rapid-prototyping/fabrication, non-destructive evaluation (NDE), and repair. In addition, opportunities exist for student participation in developing and characterizing lunar simulants, including dust simulants, which closely replicate the lunar regolith.	Spring, Summer, Fall

NASA Center	Internship #	ESMD Area of Emphasis	Internship Description	Timeframe
MSFC	MSFC3-38-08-AN	Propulsion	Turbomachinery: Manufacturing methods/alternatives to produce small impellers (~2 Kpsi). Improving surface finish for rapid prototype manufacturing, particularly for small parts	Spring, Summer, Fall
MSFC	MSFC3-42-08-AN	Propulsion	Development of general purpose electric solenoid valve controller with advanced diagnostic capabilities. Involves programming a Digital Signal Processor (DSP) with C++ language to create an "intelligent" controller which electrically senses the state of closure of the valve using a reference resonator loop and a real-time FFT algorithm. Also involves some simulation with "SPICE" circuit emulation software.	Spring, Summer, Fall
MSFC	MSFC4-18-08-AN	Spacecraft	Build a process which integrates both quantitative and qualitative safety, reliability and quality engineering in the life cycle of a launch vehicle (Ares I)	Spring, Summer, Fall
MSFC	MSFC4-41-08-AN	Spacecraft	Testing and development of Micrometeorite gun. Involves high voltage pulsed power, plasma, hypervelocity measurements, high speed imaging and diagnostics development for a facility for the study of micrometeorite impact. Specific areas of interest include the hypervelocity impact of small particles (10-150 um) with multi-layer cryogenic insulation samples at velocities of 20 km/sec. Diagnostics are needed for accurate size and speed measurements of these small hypervelocity particles.	Spring, Summer, Fall
MSFC	MSFC4-47-08-AN	Spacecraft	Development and application of structural/thermal analysis and design software tools. Applications to spaceflight hardware and conceptual systems. Includes further development of NASA X-TOOLSS (eXploration Toolset for Optimization Of Launch and Space Systems) software. Also applies to: Lunar and Planetary Surface Systems	Spring, Summer, Fall
MSFC	MSFC4-48-08-AN	Spacecraft	Thermal and structural analysis opportunities, including heat transfer, stress, fracture, fatigue, structural dynamics/loads, and vibroacoustics. Applications to spaceflight hardware and future lunar surface systems. Also applies to: Lunar and Planetary Surface Systems	Spring, Summer, Fall
MSFC	MSFC1-10-08-AY	Spacecraft	Development of technology and demonstrations in advanced RC applications to universal modular computing resources for future Space Flight infrastructure. Work currently underway combines various schemes of software and hardware interaction to demonstrate physical and functional RC concepts. The ultimate product is a flight-qualified universal computing resource for use throughout future vehicle and surface systems.	Spring, Summer, Fall
MSFC	MSFC1-17-08-SU	Lunar & Planetary Surface Systems	MSFC is developing a method to create lunar regolith simulants that will match the properties of the lunar surface. This process involves understanding the lunar components and how to quantify and reproduce them, and how they mix together on the Moon. Knowledge of mining, milling, mineralogy, geology, image analysis, statistics, physics, engineering, chemistry and many other skills all have significant roles in the overall project. Areas of activity are constantly evolving as progress is made by the dynamic team reaching across the United States and internationally	Summer

NASA Center	Internship #	ESMD Area of Emphasis	Internship Description	Timeframe
MSFC	MSFC3-14-08-SU	Propulsion	To further develop P-STAR, the first order modeling tool, by providing the capability to perform off-design analysis of liquid rocket engines, while improving performance, weight and cost predictions	Spring, Summer, Fall
MSFC	MSFC3-34-08-SU	Propulsion	Designing/modeling/testing various plasma device, like space thrusters and pulsed plasma micrometeorite guns. Tasks include design/fabrication/use of plasma experiments and diagnostics, circuit design and analysis, data analysis, performance modeling.	Summer
MSFC	MSFC3-35-08-SU	Propulsion	Designing and testing various flow components for use in a simulated nuclear reactor with application towards lunar and deep space power production. Specific work in design/build/test of liquid metal pumps and flow sensors that are compatible with the NaK (sodium-potassium eutectic) heat transfer fluid.	Summer
MSFC	MSFC3-39-08-AN	Propulsion	The work consists of development, design, and testing of valves, valve actuators, lines (tubing assemblies), ducts (piping and flex-joints), and fluid systems, for liquid propellant rocket engines and vehicle main propulsion systems. Some fundamental tasks performed in the design and development process include conceptual design, fluid flow analysis, fluid mechanics, stress analysis, material selection, manufacturing technique selection, computer aided design (CAD) modeling, engineering drawing (drafting) preparation, test plan development, test procedure development, and testing. The intern will work with a mentor or senior engineer on a component design, development, and/or test task relating to the Ares Vehicle Program.	Spring, Summer, Fall
MSFC	MSFC4-01-08-SU	Spacecraft	Support the development and testing of robotic test platforms that are being modified.	Spring, Summer, Fall
MSFC	MSFC4-08-08-SU	Spacecraft	The intern will study and understand project requirements, develop concepts, do detailed design using 3D CAD modeling, use analysis tools to optimize components, do drawings to document the design, produce rapid prototypes of parts, and support flight hardware fabrication and testing.	Summer
SSC	SSC3-03-09-AN	Propulsion	RFID Instrument Calibration Data Device. Design an RFID device to be placed on instrumentation and a read/write device so that a QA technician can easily check to see what the re-calibration date is, can set the new date and can interface this data with a computer system automatically.	Summer
SSC	SSC3-04-09-AN	Propulsion	Strain Gage Bonding Integrity Measurement Device. Design an intelligent Integrated System Health Management (ISHM) detector for strain gages which will use capacitive coupling techniques and computer intelligence to determine whether the gage is still properly bonded to the subject material. It is difficult to determine whether an anomaly is caused by an actual adverse event or simply by the strain gage losing integrity. This must be done in real time.	[Spring], [Fall]

NASA Center	Internship #	ESMD Area of Emphasis	Internship Description	Timeframe
SSC	SSC3-05-09-AN	Propulsion	Characterization of strain levels in U-shaped Convolutes on cryogenic expansion joints. Collecting and analyzing strain readings from U-shaped convolutes for clarifying instrumentation techniques in support of rocket propulsion testing. The strain characterization will also be compared to an ANSYS finite element model to further substantiate the results.	[Spring], [Fall]
SSC	SSC3-06-09-AN	Propulsion	Hardware-in-the-Loop Propulsion Test Systems Analytic Modeling. The goal of this project is to develop and validate the technology and processes for pre-test validation of facility readiness relative to hardware response, planned test sequence execution and system detection and response to off-nominal performance situations. SSC analytic models of test facility propellant systems will be integrated with test facility hardware control systems and hardware to provide test like environments that enable test facility operational checkout and readiness verification. This project requires a combination of ME and EE disciplines and includes both systems development with regard to system architecture development and integration as well as thermo/fluid systems modeling and analysis, focusing on faster than real-time execution that enables real time assessment of test operations.	Spring
SSC	SSC3-07-09-AN	Propulsion	Engine Test Altitude Simulation Test Stand Development. SSC has initiated construction of an engine test altitude test stand to support NASA's Ares 1 and Ares V upperstage, J-2X engine development. A sundry of unique technology and engineering design and analysis investigations/trades are needed. 1) Design investigations of pressure-fed chemical steam generator system (4800 lb/sec,500 psi steam ejector system), including structural loads analysis, temporal transient performance investigations, system robustness/margin requirement definition & assessment, propellant supply sizing validation, etc..	[Spring], [Fall]
SSC	SSC3-08-09-AN	Propulsion	Engine Test Altitude Simulation Test Stand Development. SSC has initiated construction of an engine test altitude test stand to support NASA's Ares 1 and Ares V upperstage, J-2X engine development. A sundry of unique technology and engineering design and analysis investigations/trades are needed. 2) Analytic model development and related investigations of altitude simulation diffuser performance	[Spring], [Fall]
SSC	SSC3-09-09-AN	Propulsion	Engine Test Altitude Simulation Test Stand Development. SSC has initiated construction of an engine test altitude test stand to support NASA's Ares 1 and Ares V upperstage, J-2X engine development. A sundry of unique technology and engineering design and analysis investigations/trades are needed. 3) A sundry of fluid flow and heat transfer technical issues	[Spring], [Fall]

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APPENDIX C

Approved ESMD Senior Design Project Opportunities

This was the list on August 10, 2008. Please check the website for the most recent updates
http://education.ksc.nasa.gov/ESMDspacegrant/

NASA Center	ESMD Related Area	Project Title	Senior Design Project Description
ARC	Spacecraft	Small Spacecraft	Small spacecraft show great promise for future NASA missions. Because of their nature, these spacecraft typically have very low margins in mass, power, and propulsion. In order to make these systems viable, NASA needs evaluate what is possible with innovative concepts for microspacecraft landers, rovers, and communications relays that could be used for very low cost robotic lunar precursor missions.
ARC	Lunar and Planetary Surface Systems	REAL-TIME VISION FOR VEHICLE NAVIGATION	REAL-TIME VISION FOR VEHICLE NAVIGATION .The goal of this project is to develop a real-time computer vision library to support vehicle navigation (mobile robots, lunar transport rovers, etc). The library will allow vehicle control system developers to quickly assess the nearby environment, e.g., to determine if a particular arc is collision-free over a specified distance. This library will take advantage of real-time performance provided by a hardware-based stereo vision system (Tyzx G2 camera) and include methods for processing 3D point clouds, generating grid-based occupancy/obstacle maps, and evaluating drive arcs. This project will involve computer vision theory, cross-platform software development, and testing on a mobile robot.
ARC	Lunar and Planetary Surface Systems	NON-PREHENSILE MOBILE MANIPULATION	NON-PREHENSILE MOBILE MANIPULATION The goal of this project is to design non-prehensile robot manipulation devices for lunar site operations, such as cable running, leveling/grading, and rock clearing. A variety of approaches are possible including pushing, tapping, or rolling. These modes of manipulation require the robot to have some understanding of the physics of interacting with a part, particularly friction and contact. In addition, robotic systems should take advantage of different strategies for manipulation, such as picking up a part by pushing it against a fixed obstacle. This project involves electrical and mechanical engineering and some embedded system (e.g., microcontroller) programming.

NASA Center	ESMD Related Area	Project Title	Senior Design Project Description
ARC	Lunar and Planetary Surface Systems	GEOCAM: A LOW-COST CAMERA FOR RAPID GEO-REFERENCED AERIAL MAPPING	GEOCAM: A LOW-COST CAMERA FOR RAPID GEO-REFERENCED AERIAL MAPPING The goal of this project is to develop the 'GeoCam', a camera system that can be used to rapidly map local areas from low-flying vehicles (small planes, lunar hoppers, etc). High-resolution digital imagery acquired from low-altitude flight can supplement wide-area coverage provided by orbiting cameras, particularly when surface features are best viewed up close or satellite task time is limited. The GeoCam will be designed to: attach easily/rapidly (while respecting operational regulations), provide high-precision pose estimates (position and pointing) for each captured image, and be as low-cost as possible. This project will involve trade studies (capture device, storage medium, etc.), mechatronic system engineering, and development of position estimation software.
ARC	Spacecraft	Photonic or Electronic Hit Indicator: MMOD impact detector for Orion	Further advance a detector to determine the extent of MMOD damage to the Orion vehicle for its ISS and Lunar missions. The detector has a low false positive rate, uses minimal spacecraft resources and is based on a DoE system used to determine strikes on ballistic missile targets.
ARC	Ground Operations	NASA Technology Database	Assist researchers in the determination of technology that affect ESMD mission using next generation of NASA Technology Database and explore approaches for improving NASA Technology Transfer meeting OMB Requirements. Senior design team will help model aspects of the technology descriptions and maturity control and collect and analyze data as needed.
ARC	Ground Operations	Prognostics for Complex Systems - Damage Propatation Modeling	The Prognostics Center of Excellence at NASA Ames Research Center is conducting research in systems health management. This involves the early assessment of abnormal conditions and damage as well as the estimation of "remaining life" of a component or subsystem. The goal is to research damage propagation mechanisms and to model damage using a physics-based approach for select application domains (e.g., power semiconductors, electro-mechanical actuators, composite structures, batteries,)
ARC	Ground Operations	Prognostics for Complex Systems	The Prognostics Center of Excellence at NASA Ames Research Center is conducting research in systems health management. This involves the early assessment of abnormal conditions and damage as well as the estimation of "remaining life" of a component or subsystem. The goal is to contribute towards the state of the art in uncertainty management which is a critical component of prognostics.
DFRC	Spacecraft	Dynamic soaring/Autonomous autopilot	Develop aerial platforms that exhibit autonomy and dynamic soaring capabilities

NASA Center	ESMD Related Area	Project Title	Senior Design Project Description
DFRC	Lunar and Planetary Surface Systems	Lunar Landing Training Vehicle	This project seeks senior design concepts for Lunar Landing Training Vehicles. The concepts must account for reduced lunar gravity, and allow the terminal stage of lunar descent to be flown either by remote pilot or autonomously. Platform should allow for both sensor evaluation and pilot training.
DFRC	Lunar and Planetary Surface Systems	Aero-Assist Options for Mars Surface Sensor Deployment	This project seeks senior design concepts for using aero-assist to deliver a constellation of small sensors to the surface of Mars. In this study the surface delivery of pico-sat sized sensors using ONLY aerodynamic deceleration will be addressed. Study should identify aero-shell geometry, required L/D ratios, mass fractions, launch options, and number and size of sensors deliverable to the Mars surface. Class of allowable ballistic coefficients for sensor packages, and required parachute/decelerator systems should be described.
DFRC	Propulsion	Propulsions Systems for Planetary Gravitational Simulator	This project seeks senior design concepts for propulsion or lift-system concepts for gravity offset for a Lunar Landing Training Vehicle (LLTV). Project should perform trades to evaluate the most effective and reliable methods for gravity offset. Potential methods include roto-craft, jet engines, small rocket systems, and cold-jet lift concepts. Issues to be addressed include scalable lift mass, reliability, onboard propellant mass fractions, and vehicle stability/handling qualities.
GRC	Lunar and Planetary Surface Systems	Extreme Environment Lander Design	The goal of this project is to develop a conceptual lander design capable of long-term operation under extreme environmental conditions. The design must provide sufficient power and environmental protection for a pre-selected set of scientific instruments. A 3D CAD model of the lander is required to provide thermal and stress analysis, as well as to determine packaging and overall system mass.
GRC	Propulsion	Mechanical Components for Cryogenic Tank	Cryogenic propellant tanks, such as those used for the Lunar Lander, are rather complex systems with many electro-mechanical components for fuel supply, thermal control, pressure control, and low gravity propellant gauging. The objective of this senior design project opportunity is to consider the operability and reliability of those mechanisms inside or connected to the tank where the operating temperature range is extremely large. Thermal expansion of mechanical components, materials to withstand thermal cycles, sizes and weights of the mechanisms are some of important considerations.
GSFC	Lunar and Planetary Surface Systems	Design of a Spacecraft to Support a Lunar Mission	Engineers would give the students a set of instruments and a lunar orbit and let them design the spacecraft to support the mission. This project would be suitable for a class where the student already knows something of designing spacecraft.

NASA Center	ESMD Related Area	Project Title	Senior Design Project Description
GSFC	Lunar and Planetary Surface Systems	Lunar Terrain Categorization	Lunar Terrain Categorization: Surface mission operational planning has been identified as one area of special interest within the Scientific Context of the Moon Exploration. Specifically, technologies that will enable scientists to perform terrain categorization, and in particular to detect, identify and characterize rocks, will be studied. Once lunar data is geo-registered & mosaiced to a common Lunar Geodetic Grid, these tools will assist scientists in determining general regions of interest, in performing precise targeting of specific types of samples, & in avoiding hazardous landing sites. Regions of interest will mainly be determined by understanding and characterizing potential lunar resources (minerals, ice, etc.) and their spatial distribution, their abundance, density, and distribution, relative to future missions and in-situ instruments that will be needed to perform additional detailed analyses. Rock identification will play an essential role in targeting specific samples, and rock location and distribution will be essential for selecting landing sites while avoiding hazards. Another importance tool in selecting landing sites will be accurately compute slopes and surface roughness parameters, from laser altimeter or stereo data, taking into account appropriate solar illumination models. Specifically, the work will focus on terrain classification and SAR data hazard analysis. Classification with methods such as shape analysis, textural analysis, mathematical morphology, & shading analysis, as well as both unsupervised clustering & supervised classification will be investigated and evaluated, and SAR Data Hazard Analysis will be used to generate hazard maps using methods such as texture and mathematical morphology.
GSFC	Lunar and Planetary Surface Systems	Thermal Ctrl Sys (TCS) for Lunar (or Mars) Rovers	For future rovers a robust, simple, lightweight thermal control system will be required. The conventional thermal architecture uses a pumped fluid loop and was used on Mars Pathfinder and Mars Exploration Rover (MER). An alternative system using a miniature loop heat pipe (LHP) system has been proposed, which is an order of magnitude lighter, less costly and has no moving parts. The students will be asked to perform trade studies on this and other possible solutions, taking into account weight, reliability, cost, ease of integration etc, as part of their approach. They will be asked to determine the environment and perform thermal analysis to show that temperature limits have not been exceeded during 1) interplanetary cruise 2) descent and landing 3) surface operations. Mechanical or CAD drawings will be developed to show how the system will be integrated into a typical rover concept, such as Pathfinder or MER as well as how the TCS interfaces with other supporting sub-systems such as Power and C&DH.

NASA Center	ESMD Related Area	Project Title	Senior Design Project Description
GSFC	Lunar and Planetary Surface Systems	Inverse Synthetic Aperture Radar (ISAR) for Interior Mapping of Asteroid	This project has a goal to develop hardware & software for low frequency wideband step frequency ISAR radar. Low frequency ISAR is used to image interior structure of an unknown target such as asteroid/comet and other planetary bodies. ISAR consists of 3 basic subsystems: (1) Base band signal generation and base band I & Q data processing, (2) Analog RF front end, and (3) Antenna. Using either Xlinx/Altera FPGA board and Analog Devices' DDS chips entire base band operation will be programmed and implemented. The analog RF front end will be assembled from commercially available RF components. The data acquisition and processing will be implemented through the FPGA. Development of data processing algorithm to form a 2-D image of interior portion of a target will also be part of this project.
GSFC	Lunar and Planetary Surface Systems	Lunar Transverse Map Contest	Next year more than 3 billion dollars of new lunar data will start to flow in a torrent. We would like to design an educational outreach effort setting up a competitive mission design by students for the most basic types of lunar robots.
GSFC	Lunar and Planetary Surface Systems	Communications, Standards, & Technology Laboratory	The student intern will participate in the development & integration of technologies and systems into the GSFC Communications, Standards, & Technology Laboratory (CSTL). The CSTL is a facility capable of testing and demonstrating complete end-to-end mission communications scenarios from onboard spacecraft computer systems, ground station RF systems, terrestrial networking systems, to the mission control center. The work available ranges from software development to digital and RF hardware design. Current activities include demonstrations and development of Lunar Surface communications scenarios.
GSFC	Ground Operations	Use of a Fabry-Perot interferometer for precise column carbon dioxide measurements and monitoring.	Use existing Fabry-Perot Interferometer to make daily-long term measurements of CO2 column; check calibration/stability of instrument and evaluate data.
GSFC	Ground Operations	Embedded science data processing applications using high-performance hybrid platforms	Work on a robotic path planning demonstration; R&D involving SAR and Hyper-spectral data processing; and robust software architecture that will help fly commercial processors reliably in a space-radiation environment. Students need to have C and/or VHDL experience, and combined hardware/software experience.
GSFC	Ground Operations	Use of a Fabry-Perot Interferometer for precise column carbon dioxide measurements and monitoring	Use existing Fabry-Perot Interferometer to make daily-long term measurements of CO2 column; check calibration/stability of instrument and evaluate data.

NASA Center	ESMD Related Area	Project Title	Senior Design Project Description
JSC	Lunar and Planetary Surface Systems	Remote Image System Acquisition (RISA) - Space Environment Monitoring	The RISA multispectral imager has been shown to be able to detect and monitor space radiation. Further study is required to determine the usefulness and potential of employing the RISA imager in this way. The ability to have a single instrument provide multiple functions is of interest to NASA given limit stowage and power available in the spacecraft environment. In addition, temperature monitoring, and other environmental characteristics shall be included in the RISA design to serve to both indicate the ambient environment and for sensor calibration.
JSC	Lunar and Planetary Surface Systems	Advanced Lunar Pressurized Rover (EC Priority #2)	Design of a 2-4 person rover for lunar exploration with both robotic manipulator capability and EVA capability. Rover would include minimum gas loss and low power EVA airlock and dust mitigation capabilities. CHALLENGE GOALS AND OBJECTIVES: The task would be to design a future lunar pressurized rover that can accommodate 2-4 crew members. This rover would be an element of a future planetary Lander. The goal would be to perform surface exploration by creatively designing the layout and the operation of the pressurized rover. The Advanced EVA Technology Group will provide information on concepts from previous studies. Small models of advanced airlocks for rovers that have been proposed could also be provided. High level design requirements for rovers and airlocks from NASA design standards would also be provided.
JSC	Lunar and Planetary Surface Systems	Lunar Lander EVA Crew and Small Cargo Lifting System (EC Pr #4)	Design of a system for routinely and safely transporting the EVA crew and small cargo up and down from the airlock to the surface and back, including innovative ladder designs and lifts. CHALLENGE GOALS AND OBJECTIVES: The task would be to design a future lunar lander EVA crew and small cargo lifting system. This EVA crew and small cargo lifting system would be an element of a future planetary lander. The goal would be to minimize the overall, mass and weight of a lunar lander crew and small cargo lifting system. The Advanced EVA Technology Group will provide information on the previous designs of crew ladders and some concepts from previous studies.
JSC	Lunar and Planetary Surface Systems	Hand-held magnetic lunar dust removal brush.	Since most of the lunar dust is magnetic, a brush with magnetic bristles could be designed to brush the space suit or any other items and the dust would be attracted to it. If the brush was electromagnetic or mechanical where the polarity could be changed, then the poles could be reversed and the dust would be repelled and dropped to the surface after use.
JSC	Lunar and Planetary Surface Systems	Peel-off space suit visor protective film	Since the space suit visor will be scratched and get dust after each EVA, design a peel-off film or coating that can periodically be removed so the astronaut can clearly see and not have scratches, especially during long duration missions.
JSC	Lunar and Planetary Surface Systems	Dust tolerant hand tools	Standard tools, such as ratchets, folding handles on tools, and extendable devices, such as tripods will be used during lunar assembly, maintenance, and science tasks. Design some typical tools, such as a folding handle or ratchet, that has mechanisms that are extremely robust and dust tolerant.

NASA Center	ESMD Related Area	Project Title	Senior Design Project Description
JSC	Lunar and Planetary Surface Systems	Design of a Wireless Sensor Scavenging Network	Design a wireless sensor energy scavenging network that provides communications to a base station (mobile or stationary) from an array of intelligent sensors nodes comprised of various transducers, sensors, RF transmitters/receivers and controllers with their own power source that does not require batteries to operate. The wireless network sensors obtain power from the environment (power harvesting) and would respond to an interrogation command from the base station to send their data acquisition data to the base station. The wireless sensor scavenging network is programmable for sending data on demand or periodically. In addition, the sensor network can be reconfigured to acquire different types of data from each sensor by the base station. This has applicability for the lunar and beyond outposts. Design includes what trades were made to arrive at the design and concept of operations.
JSC	Spacecraft	Microphone beamforming array estimation model	Develop a beamforming microphone array model and compare against an actual microphone array measured data. This model would help predict microphone array configuration performance. The model would be developed in MatLab that would help determine the theoretical lower bound of performance using the Cramer-Rao lower bound method. An actual microphone array is built and data gathered and compared against the theoretical model. This project has potential applicability in the Constellation program CEV, lunar lander, and EVA spacesuit where a crew-worn headset is not necessary.
JSC	Spacecraft	A Field Programmable Analog Array (FPAA) Voice Activated Switch (VOX)	Develop a VOX device through the use of FPAA devices. Investigate the feasibility of using FPAA for simplifying the attack and decay time adjustments of the VOX through the use of digital techniques. This has applicability in the constellation program for not only for the audio systems but also understanding FPAA technology in use for other constellation systems. A circuit will be developed and data gathered to understand the performance of the VOX circuit. A process for implementing FPAA circuits will also be written.
JSC	Lunar and Planetary Surface Systems	Remote Image System Acquisition (RISA) - Space Camera 4 (SC4) Development	The purpose of the RISA SC4 project is to produce a high quality / high reliability wireless multispectral imager designed specifically for the space environment. The imager will be used to monitor the health and status of the crew and vehicle while in space as well as on Lunar and Martian surfaces. The SC4 design will be based on the existing SC3 and SC2 imagers. The project includes the: *development of required functions in VHDL, * electronic circuit development, * testing of alternate sensors, * characterizing the performance of the system, and * design and build of proof-of-concept prototypes using flight equivalent parts.

NASA Center	ESMD Related Area	Project Title	Senior Design Project Description
JSC	Lunar and Planetary Surface Systems	Remote Image System Acquisition (RISA) - Multispectral Imaging, Optical System Development	The purpose of the RISA Multispectral Imaging project is to develop methods to use multispectral imaging for materials identification, locating vegetation, locating evidence of life, locating environments that will sustain life, atmospheric penetration, biomedical applications, astronomical imaging, and improving methods to identify properties of interest to the NASA mission to meet exploration objectives. Both optical and electrically tunable filters shall be employed for the multispectral imaging objectives. The optical design objectives will explore the use of liquid lenses and other methods to mitigate the effects of the space environment. Proof of concept prototypes will be designed and built. [Disciplines: Optical Engineering, Physics, Astronomy, Biomedical Engineering, Remote Sensing, Electrical Engineering, Software Engineering, Mechanical Engineering]
JSC	Lunar and Planetary Surface Systems	Lunar lander dust mat	Since there will much walking and preparation at the base of the lander/habitat ladder or stairs after an EVA, and prior to entering the airlock, design a lunar mat or surface so the astronauts are not walking constantly in the lunar dust. This may sound simple, but the requirements are: * light weight, * low volume when stowed, * easily deployed, * dust can be removed or falls between mesh. The crewmembers would prepare sample boxes, repair equipment, dust off on this mat or surface prior to entering the airlock.
JSC	Lunar and Planetary Surface Systems	Dust Tolerant EVA Compatible Connectors	In the dusty lunar environment, astronauts will be making and breaking various electrical and fluid connectors with their gloved hands. A goal is keep out dust when the electrical or fluid connector is exposed. Design an electrical or fluid connector for lunar exploration with EVA capability. The connector should include dust mitigation capabilities. CHALLENGE GOALS AND OBJECTIVES: The task would be to design an electrical or fluid connector for lunar exploration with EVA capability and keeps dust out. These connectors could be on the space suit for recharging the portable life support system or on lunar surface systems for assembly or maintenance. The goal would be to creatively design a connector that is easy to operate with a gloved hand while keeping dust out with minimum crew operations and complexity. The Advanced EVA Technology Group will provide information on concepts from previous studies.

NASA Center	ESMD Related Area	Project Title	Senior Design Project Description
JSC	Lunar and Planetary Surface Systems	Advanced EVA Airlock with Pressure Assisted Airlock Hatches and Dust Mitigation	Due to the expected large number of space walks that will be performed on the lunar surface, innovative designs for an airlock will be needed. Both the internal and external hatches shall be pressure assisted. The EVA airlock should also include minimum gas loss, low power, and dust mitigation capabilities. CHALLENGE GOALS AND OBJECTIVES: The task would be to design a minimum gas loss airlock with pressure assisted hatches that accommodate 2 astronauts. This airlock would be an element of a future planetary lander, habitat, or pressurized rover. The Advanced EVA Technology Group will provide information on concepts from previous studies. Small models of advanced airlocks that have been proposed could also be provided. High level design requirements for airlocks from NASA design standards would also be provided.
JSC	Lunar and Planetary Surface Systems	Producing Oxygen from Lunar Soil	America will send a new generation of explorers to the moon. Once on the moon, astronauts will stay in pressurized habitats. This project involves the design of in-situ resource utilization oxygen production pilot plants. These plants will produce pure oxygen from lunar regolith (soil) to enable a sustainable lunar outpost.
JSC	Lunar and Planetary Surface Systems	Proton Exchange Membrane Fuel Cells	Fuel cells are likely to be key to lunar lander and lunar outpost operations. Key to developing lightweight and reliable fuel cell plants is the ability to manage reactants and water with no active pumps or other components. This project would examine the technologies needed for passive reactant control, passive cooling, and water removal by wicking. Prototyping of one or many of these technologies is desirable.
JSC	Lunar and Planetary Surface Systems	Electric Propulsion Systems	In this project you will: * Investigate new forms of electric propulsion that can be used for future exploration objectives. Build prototypes of existing methods of electric propulsion and compare them to alternate methods developed under this effort. * Research recent breakthroughs in propulsion and develop quantitative results documenting their characteristics. * Develop new theories of advanced propulsions systems and build prototypes to test concepts.
JSC	Lunar and Planetary Surface Systems	Velcro Improvement or Replacement for Use on Space Suits and other Equipment in Dusty Lunar Environment	Velcro is currently used routinely to attach and removal thermal blankets, close flaps on soft goods containers, and attach and close various components on the space suit, such as the Thermal Micrometeorite Garment (TMG). In this dusty lunar environment, Velcro will allow fine lunar dust to migrate through the Velcro connection and adversely affect equipment. The design challenge would be to improve the current Velcro such as to not degrade its performance and to not allow dust to migrate through it or to design a totally new technology to replace Velcro, but its performance is just like Velcro. This Velcro -like attachment system would have the same requirements as Velcro, such as easily attaches and removes, is flexible and can be sewed to textiles, meets lunar temperature limits, attaches while misaligned, and does not allow dust to migrate through it.

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JSC	Lunar and Planetary Surface Systems	Wall Surfaces that Allow Condensation and Low-Energy Evaporation	One problem with enclosed living spaces is that sometimes surfaces will collect condensation due to a cold surface behind the wall. This water could promote the growth of plant or animal life (mold and bugs!). For this project, you are to investigate how you can design a 'wall system' that will trap any condensation that forms then evaporate it periodically (e.g... every six hours) actively using very little energy or passively when the adjacent air warms above dewpoint. The solution could be a new material, a sensor/heater system, or any other viable design that can be demonstrated on a small scale.
JSC	Lunar and Planetary Surface Systems	Freeze Back Radiator	How would you cool a lunar outpost on the rim of Shackleton Crater? There will be high heat loads when the outpost is occupied plus unoccupied periods of low activity and heat load. One heat rejection system option is a freeze-back radiator of reflux boilers. For this project you will investigate reflux boilers, assess scaling laws for the reduced lunar gravity, build a scaled reflux boiler using commonly available materials, and test its performance.
JSC	Lunar and Planetary Surface Systems	Vacuum Cleaner for Spacecraft Cabin Housekeeping for Lunar Surface Missions	Dust and particulate matter contamination of spacecraft cabin atmosphere and surfaces are challenges that must be overcome for lunar surface exploration. Particulate contamination originating from the external surface environment or from internal sources are both of concern. Development of process technologies and equipment to minimize the impacts of surface dust on crew health and equipment inside the habitable volume are sought. This project focuses on development of an advanced vacuum cleaner for removal of particulates from internal cabin surfaces and equipment, including space suit components, and for additional use as a portable atmospheric dust filter. This tool will have particular challenges based on the affects of gravity and the physical properties of lunar dust. Particulates may range from several millimeters into the sub-micron range, and operation of the vacuum must not contribute to atmospheric particulates. Atmospheric requirements include maintaining particulates in the range 0.5 microns to 100 microns below 0.2 mg/m3 and lunar dust contaminants of less than 10 micron size below 0.05 mg/m3. Candidate technology solutions should provide high efficiency, long-lived removal capacity, low noise, and minimized use of power and consumables. Novel methods for particulate removal and filter regeneration are encouraged, including electrostatic, magnetic, inertial and/or cyclonic separation and/or backwashing processes. Technologies must be tolerant to the abrasive effects of dust particles. Performance should be demonstrated with appropriate lunar dust analogs or simulants.

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JSC	Lunar and Planetary Surface Systems	Low Energy/Low Water Laundry Equipment for Space	For long-duration human exploration missions including a Lunar Outpost, the clothing system will be a large factor in mission cost. Currently clothing used in space is discarded and is a major source of trash. Clothes washing and drying is expected to be cost effective for mission durations of the order of three months or longer. Aqueous-based systems with extremely efficient water-use are desirable. Initial use will be for lunar surface missions, thus operation in a fractional gravity environment and ability to remove lunar dust will be required. Systems engineering approaches, including synergy with clothing made from advanced fabrics, use of novel detergents or alternative cleaning agents, and compatibility with physicochemical and/or biological regenerative water recovery systems must be considered. This project will involve the design and prototyping of a washing and drying system for re-use of clothing that minimizes requirements for mass, volume, energy, heat rejection, consumable supplies and crew involvement, while meeting toxicity, flammability, out gassing, and human factors requirements.
JSC	Lunar and Planetary Surface Systems	Advanced Clothing for Long Duration Human Exploration Missions	Currently clothing is not re-used in space. It is a bulky consumable of considerable mass that must be re-supplied, and once soiled, becomes a solid waste problem. Significant benefit may be realized from improvements to space clothing systems. Advancements in textiles, including high performance fibers, fabrics and materials treatments may benefit clothing systems for future human space exploration missions. Benefits may include reduced mass and volume for stowage of clean and used clothing, increased use life, safety for use in enriched oxygen atmospheres, and compatibility with low water and low energy laundering and drying systems, while meeting requirements for crew comfort. Properties of interest include mass, thickness, durability, strength, thermal conductivity, wicking, flammability, linting, off-gassing and antimicrobial characteristics. This project includes the investigation or new materials of changes to existing materials.
JSC	Lunar and Planetary Surface Systems	Active Response Gravity Offload System Control Algorithm Development	In preparation for returning to the moon, a means must be developed to allow astronauts to practice performing tasks in a reduced gravity environment, and engineers to evaluate systems, such as space suits, used in the performance of these tasks. To these ends, the Active Response Gravity Offload System (ARGOS) is being developed. ARGOS will use electro-mechanical devices and sensors to compensate for the difference between earth and lunar gravity, while keeping the actuation point above the center of gravity during translations. Of interest to NASA is a control algorithm that will command the motors in response to the astronaut's movements with negligible lag time.

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JSC	Lunar and Planetary Surface Systems	Active Response Gravity Offload System Gimbal Development	In preparation for returning to the moon, a means must be developed to allow astronauts to practice performing tasks in a reduced gravity environment, and engineers to evaluate systems, such as space suits, used in the performance of these tasks. To these ends, the Active Response Gravity Offload System (ARGOS) is being developed. ARGOS will use electro-mechanical devices and sensors to compensate for the difference between earth and lunar gravity, while keeping the actuation point above the center of gravity during translations. A key component of the system is the gimbal, which allows the astronaut to bend and turn while suspended from above. Of interest to NASA is a system that will remain aligned with the astronaut's center of gravity when bending forward or leaning both backwards and to the side.
JSC	Lunar and Planetary Surface Systems	Active Response Gravity Offload System Advanced Control Algorithm Development	In preparation for returning to the moon, a means must be developed to allow astronauts to practice performing tasks in a reduced gravity environment, and engineers to evaluate systems, such as space suits, used in the performance of these tasks. To these ends, the Active Response Gravity Offload System (ARGOS) is being developed. ARGOS will use electro-mechanical devices and sensors to compensate for the difference between earth and lunar gravity, while keeping the actuation point above the center of gravity during translations. Since mass constraints could result in lunar transport vehicle suspension systems that do not function in earth's gravity, it would be beneficial if ARGOS, or a similar system, could be used to perform "test drives" of development hardware. Of interest to NASA is a control algorithm that would allow multiple gravity compensation devices to work in tandem to support a large mobile system.

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JSC	Lunar and Planetary Surface Systems	Biotechnology System Development for Lunar Outpost in Situ Resource Utilization	This project seeks to develop and test an innovative biotechnology-based resource production system for future space exploration. This research will provide new opportunities for the in situ resource utilization (ISRU) enterprise for cleaner, safer, and more efficient production of oxygen, metals, fuels, and organics for lunar outpost needs. The objective is to develop a sustainable integrated system covering the whole life cycle of products to enhance human activity at the lunar outpost. We propose to develop and test a hybrid, geobiochemical, light-driven reactor to provide outpost resources. The process is based on our discovery that the extracellular products synthesized by litholitic cyanobacteria are able to dissolve (synonyms: leach, deteriorate, break down, weather) rocks; e.g., ilmenite, an analog of lunar glasses. In the initial phase, we will extend our current studies on biomining by litholitic cyanobacteria to characterize the biogeochemical dissolution (leaching, etc.) of lunar soils and minerals within the system 'microbes & rocks.' The major objective is to develop an effective biotechnological process to extract elements and compounds, including Fe, Ti, Al, Si, Mn, and O. We propose that this process will require less mass and energy for the extraction of elements and will work as a beneficial component of both ISRU and a life support system with lower environmental risk. The most critical feature of our project is to make extraterrestrial mining more compatible with oxygen, propellant and food production, and waste recycling to form an integrated bioindustrial system that would be the core of successful lunar outpost sustainability and growth. Such a synthesis of technological capability could decrease the demand for energy, transfer mass, and cost of future lunar settlements. Anticipated results on the ability of lunar rocks to host cyanobacteria may contribute to the NASA Planetary Protection Program and the NASA Astrobiology Program.

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JSC	Lunar and Planetary Surface Systems	Lunar and Martian Gravity Simulator Development for Long Duration Bed Rest Studies	The Flight Analogs / Bed Rest Research Project at the Johnson Space Center provides NASA with a ground based research platform to complement space research. By mimicking the conditions of weightlessness in the human body here on Earth, NASA can test and refine scientific theories and procedures on the ground before using these in space. Future space exploration will challenge NASA to answer many critical questions about how humans can live and work for extended missions away from Earth. The Flight Analogs Bed Rest Research Project is one way NASA will answer these questions and devise ways to ensure astronaut safety and productivity on extended missions. Looking forward to support the Vision of Space Exploration, the FAP has developed a Lunar Gravity Simulator which will add to the complement of ground analogs a device to simulate the forces encountered by astronauts on the lunar surface at the FAP facility. The LGS, which reclines a subject at 9.5 degrees of head up tilt, will be the primary method for studying the effects of Lunar Gravity on the human body here on Earth. The LGS will be used by subjects for 16 hours a day for up to 90 days in duration during the long term bed rest studies. The objective of this project will be to develop new and novel approaches for simulating Lunar and Martian gravity for the Flight Analogs Project. The simulators must be designed so that human test subjects are exposed to the forces encountered in Lunar and Martian gravity in the long axis of the body for 16 hours a day and up to a total duration of 90 days. It is desirable that the design will be able to simulate either gravity situation through adjustment on the simulator tilt. The simulators must be able to reside in a standard hospital room, and must meet human factors and safety considerations. It is preferred that the device can accommodate a seated and standing position for the subject with minimal effort for reconfiguration. See also: http://sk.jsc.nasa.gov/sk211/analogs.aspx
JSC	Lunar and Planetary Surface Systems	Lightweight Electric Vehicle Transmission	Vehicles used on the lunar surface will need electric motors. Since the lunar surface will have variable grades and variable masses (due to different payloads in the vehicle), a drive system with a transmission will be needed. A transmission made from steel will be too heavy, so a lightweight, yet reliable transmission is planned. This project includes the design and prototyping of such a transmission. It must be able to operate in the extreme lunar temperature conditions as well.

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JSC	Lunar and Planetary Surface Systems	High Voltage, High Current 3-Phase Motor Control with PID Control	Vehicles used on the lunar surface will need electric motors. Since the lunar surface will have variable grades and variable masses (due to different payloads in the vehicle), a drive system with a transmission will be needed. The center of this drive system is a 3-phase brushless DC motor. The motor is expected to use 350 volts and be driven with 30 Amps. The control of this motor (PID or similar closed-loop system) will need to ensure constant torque is delivered and constant velocity is maintained. The design challenges include using such a high voltage, circuit board design that support high currents, and maintaining control stability when the vehicle is decelerating. This project includes the design and prototyping of such a motor control system, including the motor and motor control board. It must be able to operate in the extreme lunar temperature conditions as well.
JSC	Lunar and Planetary Surface Systems	Cryogenic Component Checkout and Problem Resolution	In order for NASA to return to the moon there will be a reliance on cryogenic technologies for use with descent propulsion systems, crew breathing air, and fuel cell reactant storage. As part of it's initial development efforts of these systems NASA is interested in determining whether current off the shelf fluid components, not currently rated for use with cryogens, can be used in these extreme conditions and if not, what design changes need to be made in order to make them function in a cryogenic environment. The intent of this project will be to receive selected components from NASA's Johnson Space Center for testing with liquid nitrogen and or helium fluids and perform a number of checkout tests. If the component fails checkout testing NASA is interested in understanding what design changes should be made to improve its performance at cryogenic conditions. A comparison with current cryogenic-rated components would be useful.
JSC	Propulsion	Electric Propulsion Systems	The RISA multispectral imager has been shown to be able to detect and monitor space radiation. Further study is required to determine the usefulness and potential of employing the RISA imager in this way. The ability to have a single instrument provide multiple functions is of interest to NASA given limit stowage and power available in the spacecraft environment. In addition, temperature monitoring, and other environmental characteristics shall be included in the RISA design to serve to both indicate the ambient environment and for sensor calibration.
JSC	Spacecraft	Splash-down Space Capsule Cooling	How do you effectively cool the confined inside enclosure of a just-returned space capsule that is bobbing in the Pacific Ocean? One problem is that there is insufficient energy available in the capsule to run a vapor compression cycle to chill the environment. Can you use the ocean water to cool the air in the capsule? Remember, the temperature of the ocean water at the surface varies, since the capsule can land anywhere between 56 degrees North and 56 degrees South latitude. For this project you will need to investigate the typical ocean temperature, and then design an energy efficient system to use this ocean water to effectively cool the capsule air.

NASA Center	ESMD Related Area	Project Title	Senior Design Project Description
JSC	Spacecraft	Space Vehicle Transfer Tunnel Automated Mating Design	In the design of the next generation vehicles to be used during NASA's return to the Moon, there is a need to allow crew transfer between vehicles / modules in a pressurized, shirt sleeve environment. This type of transfer is called 'IVA (Inter-Vehicle Activity) Transfer'. Generically, this type of transfer is performed between any two connected or docked vehicles. The specific case under consideration in this project is the IVA transfer between a Lander Ascent Module (AM) and Airlock (AL). The current lander concept has the IVA transfer tunnel between the AM and the AL pre-mated at Earth launch. The AL remains behind on the Moon and the AM ascends to rendezvous with a vehicle in lunar orbit. The tunnel is pyrotechnically separated and retracted to allow for AM ascent without contact. During a nominal mission, this separation between the AM and AL can be easily managed, as timing is not highly critical. However, in the event of an abort, the tunnel must separate and provide clearance (via retraction) so that the AM does not contact any portion of the tunnel or AL. This retraction must happen very quickly to improve abort reliability. One way to avoid this complication is to fly the mission with the tunnel disconnected. This may provide for increased safety, but adds a serious complication that the tunnel must be mated and sealed in an automated manner once the vehicle lands on the moon. The tradeoff becomes added complexity for automated connection / sealing versus improved safety. This project focuses on the design and potentially fabrication of a mock-up IVA tunnel / connection mechanism and demonstration of the ability to create a pressure seal.
JSC	Spacecraft	Hydrogen Detection in a 100% Humidity Environment for Oxygen Generation Technologies	Key to any exploration effort will be generating oxygen for the crew. For example, the Oxygen Generator Assembly (OGA) on the International Space Station (ISS) generates oxygen by electrolysis of water. A current problem of this process is that the oxygen exits the OGA at ambient temperature and pressure, but at 100% relative humidity (RH) due to un-reacted water vapor. The by-product of the electrolysis process is hydrogen, which is very flammable. Normally, hydrogen is vented from the cabin environment, but there are several hydrogen sensors located in and around the OGA to check for hydrogen leaks. If the hydrogen sensor indicates anything other than nominal, the entire OGA is shut down. 'Other than nominal' has, in the past, meant moisture has condensed on the sensor, rather than hydrogen being detected. The design project would be to make this system halt from occurring. The recommended approach is three-fold: 1) attempt to heat the sensor slightly and/or thermally insulate it; 2) create a cold spot upstream of the sensor so that water vapor will deliberately condense away from the sensor and then the condensed water would need to be continuously wick away the water vapor (no gravity available!); and 3) then heat the air back to ambient temperature, resulting in a less-than-100% relative humidity exit stream. This will require applying fluid mechanics of two phase flow in zero gravity, steam thermodynamics, and heat transfer techniques and design. This project and resulting prototype would not need to involve 100% O2 or H2 to test the approach.

NASA Center	ESMD Related Area	Project Title	Senior Design Project Description
JSC	Spacecraft	Robust Miniature Lightweight Multifunction General Purpose Measurement Tool	In current and future space travel, electronics will play an important part. These electronics are increasingly complex. Occasionally, an electrical or electronics system will fail. In order to troubleshoot the problem, a single handheld instrument is needed. It should have the combined capabilities of a multi-meter, oscilloscope, protocol analyzer, network analyzer, spectrum analyzer, hand held computer, and technical reference database in a rugged, radiation tolerant, easy to use unit. This tool would be the Swiss Army Knife of the International Space Station, Crew Exploration Vehicle and Lunar Habitat Electrical and Electronics Installation and Test. Some capabilities include: * Unit should be easily used by an astronaut, with a user interface that can be used in bright sunlight, or dimly lit environment. * Use of high reliability universal front end electronics and virtual instrument interface coupled with field programmable analog arrays, and FPGA to maximize universality.
JSC	Spacecraft	Telemetry in Audio Compression CODEC	The Constellation Vehicle Orion will utilize the Internet Protocol (IP) for voice and data communications via the radio frequency links to the Mission Control Center (MCC) routing through Tracking and Data Relay Satellite (TDRSS). For redundancy and safety a 'dissimilar' audio link will communicate simultaneously with the ground via line-of-sight, during critical mission phases, i.e. launch and landing. This communications link will not be IP but will be digital with compressed audio. The audio speech compressor (Vocoder) will be Conjugate Structured Algebraic Code Excited Linear Predictor (CS-ACELP) as defined by ITU-T G.729. The IP data will be delayed due to the difference in path from the ground to the vehicle, i.e. one is line-of-sight the other via the TDRSS. This project will be to create the algorithms and prototype the system for this redundant audio link. It is the intent to deliver both audio communications simultaneously to the headsets of the onboard astronauts, without degradation in intelligibility cause by time delay echo. It is desired to encode a short duration, 10-20ms, sync. signal at the beginning of a ground based voice transmission allowing the line-of-sight speech data to be synchronized with the IP voice data, thus presenting the audio to the astronaut's headsets simultaneously. A method of reliably encoding sync. data in the G.729 encoder needs to be developed.
JSC	Spacecraft	Implement Codecs on FPGAs	This project will be to implement ITU standard G.729 (CS-ACELP) and G.722.2 (AMR-WB) speech compression codec's on FPGA target. These codec's are typically implemented on Digital Signal Processors (DSP). Constellation wants to implement the codec's on an FPGA so that redundant data-bus audio packet management, speech signal extraction and compression can happen on a single chip, minimizing mass, power and size requirements.

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JSC	Spacecraft	Development of a Multi-Functional Internal Configuration for a Lunar Lander	Given the pressurized volumetrics of a lunar lander module, develop the internal configuration for a human crew of four astronauts for 7 days. This module must provide for the habitability of the crew as well as the support functions necessary to accomplish the mission objectives. This project will have applicability to the Constellation Program. The project objective is to design this lunar lander module's functional areas (types required will be provided) in such a way that allows for singular or multi-task activities to occur. Constraints will also be provided (e.g., mass allotments).
JSC	Spacecraft	Verification Analyses in Support of the Second ISS Treadmill	NOTE: This is a one semester project that must be done in the Fall semester 2008. The International Space Station Program is planning to begin six man operations in mid 2009. The Treadmill is a critical countermeasure device required to maintain crew health while on-orbit and prepare them for return to Earth. To augment the needs of a six member crew, a second treadmill is required. The overall approach for the T2 project is to utilize as much existing NASA Program Hardware as possible and couple it with an existing, commercially available high reliability treadmill. The Treadmill and supporting subsystems (power, cooling, etc.) will be housed in an International Standard Payloads Rack (ISPR) and the vibration isolation system will be a modified Passive Rack Isolation System (PaRIS). The entire assembly is planned to be housed in the Node 2, and will then be moved to Node 3 upon its arrival to ISS. The targeted launch of the T2 system is currently ULF-2. Senior Design Project Description: Verification Analyses in Support of the Second ISS Treadmill The senior design project will consist of a grouping of 3 to 6 analyses (depending on complexity) required to verify the Second ISS Treadmill (T2) design meets the Engineering Specifications and/ or Environmental Compliance Requirements for the International Space Station. Treadmill Project will provide: 1. Description of the problems/analyses to be performed 2. All relevant data needed for analysis including: Relevant Treadmill Design Data and applicable test data results. Senior Design Team will provide: 1. Written analysis that clearly determines whether the design and/or test data provided meets the ISS requirement. 2. If design does not meet requirement, recommendation on test or design change to bring design into compliance with requirement.

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JSC	Spacecraft	Materials Science of Manned Spacecraft Radiation Shielding	This project will involve examining crew dose, materials dose, and avionics single event effects (SEE) environments and how it is affected by manned spacecraft radiation shielding. The project team will use the FLUKA (http://www.fluka.org/) ionizing radiation transport code to explore the effectiveness of various materials and materials combinations in attenuation of galactic cosmic ray and solar cosmic ray dose to the interior of relatively massive (compared to robotic vehicles) manned spacecraft. The objective here is to compare different materials in simple geometries so that materials effects on secondary particle production and stopping power can be determined and visualized directly with no complications from specific spacecraft configuration effects. Validation of the FLUKA tool against available space flight data and ground based accelerator data is an essential part of the project. Participants in this project should strongly consider a similar internship available at JSC during the Summer of 2009.
JSC	Spacecraft	Geomagnetic Storms, Traveling Ionospheric Disturbances (TIDs), and Solar Cycle Effects on Neutral Atmosphere	The objective of this project is to evaluate existing (albeit cutting edge) tools used to predict the scale of the ISS attitude control or satellite drag anomalies expected as a result of geomagnetic storm events or as the upper atmosphere become immediately denser during geomagnetic storms and gradually denser as we approach the upcoming solar maximum, the magnitude and character of which is proving more difficult to predict than was the case for the last several solar maxima. Participants in this project should strongly consider a similar internship available at JSC during the Summer of 2009.
JSC	Spacecraft	International Space Station as a Nano/Micro Satellite Base	This project is an evolution of the sounding rocket base (Wallops, White Sands, Poker Flats etc.) idea as suggested by the free launch services provided for micro satellite and nano satellites by ESA on the Arianne launcher and used extensively by Surrey Satellite customers. Specifically, the project team will need to provide a report with the following information: a) Feasibility - assessment of earth-to-orbit transportation opportunities to ISS in the post Shuttle era. b) Concept - multi-satellite carrier to attach to ISS externally and provide controlled mechanical deployment/launch over some range of vectors compatible with ISS safety (collision avoidance). c) Launch opportunities for satellite carrier assembly - Progress, Soyuz, ESA/ATV, JAXA/HTV, Commercial Carriers (COTS Program), Orion. d) Matching the concept to the agency road maps and science objectives/needs of, for example, the National Science Foundation, NASA Science Mission Directorate, and the National Oceanics and Atmospherics Administration. Participants in this project should strongly consider a similar internship available at JSC during the Summer of 2009.

NASA Center	ESMD Related Area	Project Title	Senior Design Project Description
KSC	Lunar and Planetary Surface Systems	Lunar Regolith Excavation O2 Prod/Outpost Emplace	The feedstock required for O2 production on the moon is Lunar Regolith (soil). 100 metric tones (MT) of Lunar Regolith will be required each year for Oxygen Production of 1 MT. In addition up to 2,000 MT of regolith excavation will be required per year in the initial stages of Outpost construction. This project will investigate concepts for Lunar Regolith excavation equipment and propose solutions in the form of completed designs and prototypes.
KSC	Lunar and Planetary Surface Systems	Lunar Operations Cryogenics Consumables Transfer	Oxygen that is produced on the moon must be transferred to the end user. In addition there will be residual propellants on the descent stage that can be scavenged and re-used as valuable commodities. This project will identify methods for cryogenics consumables transfer and appropriate dust tolerant interfaces.
KSC	Lunar and Planetary Surface Systems	Umbilicals and Quick Disconnect Couplings for Lunar Cryogenics Consumables Transfer	A Quick Disconnect (QD) Fluid Coupling that is dust tolerant and does not leak is required for transferring cryogenic and other liquid consumables on the moon.

NASA Center	ESMD Related Area	Project Title	Senior Design Project Description
KSC	Ground Operations	Universal Wireless Sensor	Recent developments in the availability of low cost, low power microcontrollers have underscored the amazing things one can do in integrated silicon in today's market. In particular, there is an ever increasing trend to integrate more peripheral's into modern microcontrollers including additional A/D channels, digital I/O, serial communication interfaces, analog comparators, and Pulse width modulation channels for analog outputs with prices starting at under $0.48 and averaging less than $5.00. As an example consider the device from ATMEL semi, the 8-bit RISC processor, ATMEGA168, with a single unit price of ~$4.00 Device Flash (Kbytes) EEPROM (Kbytes) SRAM (Bytes) F.max (MHz) Vcc (V) 16-bit Timers 8-bit Timer PWM (channels) RTC SPI UART TWI ISP 10-bit A/D (Channels) Analog Comparator ATmega168 16 0.5 1024 20 1.8-5.5 1 2 6 Yes 1+USART 1 Yes Yes 8 Yes This unit has (8) 10bit A-D channels, 6 analog output channels (PWM), has serial communication interface built in, and can operate from off the self alkaline batteries for weeks. This is in contrast to a typical programmable logic controller deployment with KSC's ground power system which involves over $10K in controller hardware for a very similar IO count. More recently, microcontroller vendors have begun to offer wireless communication chipsets that are designed for integration with their controller lines. While many of the products that will emerge have not made it to market yet, the simplicity of the hardware all but guarantees they will. However, the time constants in the R&D cycle as well as UL listing often delay products to market. This makes for an excellent opportunity to develop ahead of the private sector a wireless device suitable for KSC use that costs under $20.00 in materials and is fully functional in KSC ground applications. Proposed Requirements: I/O Capability: (1) Support Analog input with 10 bit or better resolution AND (1) digital sensor using I2C, TWI or other standard serial interfaces Sample Rate: Variable based in battery life requirements but be configurable from 1 sample/minute to 100kSamples/sec Power Requirements: Make use of controller sleep and standby modes to extend battery life to fullest extent Size: Limited to one 2"x4" single layer PCB Connectivity: Transmit wirelessly over Zigbee IEEE 802.15.4 and via USB to a laptop Data Storage: Support onboard data storage or remote poll via Zigbee. Cost: Under $20.00 BOM for 10k units Project Program: Microcontroller specific C Code Deliverables: (1.) (3) Demo units configured to demonstrate Zigbee's mesh networking capabilities with both digital and analog sensor inputs (2.) C code for entire project (3.) Development tools if not freeware (ATMEL development environment is totally free) (4.) PCB layout files so that the government can produce at its leisure from PCB express or other online builders.

NASA Center	ESMD Related Area	Project Title	Senior Design Project Description
KSC	Lunar and Planetary Surface Systems	Senior Biological Engineer	The goal of this senior design project is the design, integration, and evaluation of components, subsystems, and systems of a prototype habitat module. NASA could then validate and test concepts for the ultimate design of a 'Surface Habitat Module' to be used on the Moon or Mars. The focus will be on the design of components, subsystems, and systems to reduce resupply of life support elements (i.e., air, water, and food), and incrementally evolve and integrate current resupply methods and physical-chemical technologies with bioregenerative technologies. This project should emphasize the critical system selection criteria of minimum launch mass, efficient utilization of volume and power, and minimization of crew labor time and lifecycle costs. Depending on the desired scope of the senior design project, a sub-set of the design elements and requirements may be selected to reduce the scope of the project so that it would be suitable for a senior design project related to this topic. The POC for this project has agreed to be contacted prior to the start of the project for more specifics concerning current priority focus areas and recommendations concerning elements to include for a reduction of the project to a desired scope. This project is recommended for majors including mechanical engineering, biology, microbiology/bacteriology, agricultural engineering, and chemical engineering. The design elements to be considered include: structures, automation and mechanization (robotic manipulators), sensors, command/control and data handling, and power. The habitat subsystems will consist of plant-based food production and processing, integrated biological processors for liquid and solid waste streams, systems monitoring with steady state and predictive control, and mass transfer interfaces for each subsystem utilizing NASA standard human life support (food, air, water and waste) input/output streams. Reliability of the mechanical and biological elements should be considered in the component design, and elements selected should be adaptable for remote, automated/semi-automated operation. Each dynamic subsystem should be mechanized where possible and incorporate configurations that accommodate expansion and integration of the habitat life support system. Incremental infrastructure developments should be integrated into all system element designs. The system must be able to identify abnormal operations and reconfigure to normal operations without human intervention. The six requirements for the system elements are: 1. Automation/Mechanization - Should require less than 1 crew member hour per day to maintain (crew of 4 requires 4 hours/day) 2. Food, Water, and Oxygen Production - System should produce quantities of each element based on ISS crew requirements (crew of 4) for an extended mission (greater than 9 months) 3. In-Situ Resource Utilization - System shall reduce mission mass by making maximal use of available resources 4. Reliability - Elements should be designed to minimize single point failures 5. Fault Tolerance - Elements/System should maintain functionality through reconfiguration or by switching to a redundant backup 6. Modularity - Elements/System should be designed to interface with current life support technologies and allow for ease in upgrading, expansion, or repair The bioregenerative technologies for the plant production subsystem should support multiple crops with an emphasis on incremental expansion from fresh vegetable production to 50% caloric dietary production. Consideration should be given to the capability to photosynthetically revitalize the atmosphere

NASA Center	ESMD Related Area	Project Title	Senior Design Project Description
KSC	Ground Operations	Packetized Telemetry Converter	Utilizing reconfigurable logic devices, develop a system that accepts packetized telemetry (reference CCSDS 702.1-R-1, 714.0-B-1, 727.0-B-3 and 732.0.B-2) and outputs a PCM stream compatible with IRIG-106-05 Ch.4 for input to existing ground based telemetry processors. The intent of this project is to determine whether existing KSC telemetry processing devices can be utilized in the Constellation packet telemetry environment or if all the PCM based devices need to be replaced. The use of FPGA type devices provides the flexibility to update the translation routines without requiring hardware change-out.
KSC	Ground Operations	Habitat Design	The goal of this senior design project is the design, integration, and evaluation of components, subsystems, and systems of a prototype habitat module. NASA could then validate and test concepts for the ultimate design of a "Surface Habitat Module" to be used on the Moon or Mars. The focus will be on the design of components, subsystems, and systems to reduce resupply of life support elements (i.e., air, water, and food), and incrementally evolve and integrate current resupply methods and physical-chemical technologies with bioregenerative technologies. This project should emphasize the critical system selection criteria of minimum launch mass, efficient utilization of volume and power, human factors, habitation, cultural interaction, minimization of crew labor time, and lifecycle costs. This project is appropriate for human factors, any engineering major, anthropology, or psychology majors.
KSC	Ground Operations	Innovative uses of ESMD's Distributed Observer Network (DON) for education & other NASA purposes	Form a multidisplinary team to interface with KSC intern to test and evaluate other uses of DON and provide results in oral and written form. Various aspects of simulation usage including communication and teaming, human factors, use of simulation for educational purposes (k-12 through professional), and distributed teaming will be addressed. This project is appropriate for human factors, computer science, any engineering major, anthropology, psychology, graphical arts, or education majors.
KSC	Ground Operations	Simulation that Supports Synthesis	Analyze existing simulation tools and recommend tools and techniques to improve the usability of simulation tools. Various aspects of simulation usage including communication and teaming, human factors, and distributed teaming will be evaluated. This project is appropriate for human factors, computer science, any engineering major, anthropology, psychology, or graphical arts majors.
LaRC	Lunar and Planetary Surface Systems	Development of Lunar Technology Educational Display	The primary objective for this project is to develop an educational display and/or software to understand the challenges engineers face as they create technologies that will enable humans to live and work on the Moon. The display or software could include a simulation of the Small Pressurized Vehicle, which will help astronauts work on the Moon.

NASA Center	ESMD Related Area	Project Title	Senior Design Project Description
LaRC	Lunar and Planetary Surface Systems	Design of a Robot Operator/Controller	This project involves the design of an operator/controller for a robot arm. The user would define a visual image using a video camera and guide the end-effecter to the location of an object. A student team would undertake a feasibility study and design the controller interface and algorithms.
LaRC	Lunar and Planetary Surface Systems	Design of an End-Effecter for a Robot Arm	This project involves the design of an end-effecter for a robot arm. Tasks to be performed by the robot arm include: deployment of a science instrument/sensor, scooping, and gripping/moving material/items. Constraints include power, mass, and space considerations. The project also involves the determination of additional potential lunar functions for the end-effecter.
LaRC	Lunar and Planetary Surface Systems	Algorithm Development for Robot Guidance and Control	This project involves the development of algorithms which use various types of input data to accomplish autonomous robot guidance and control. The students will develop algorithms which process and merge data from various sources - video, laser range finders, gyro, GPS, etc. - in order to control a robotic device. An appropriate user interface will also be developed.
LaRC	Lunar and Planetary Surface Systems	Design, Modeling, and Performance Simulation of Lidar Systems for Sensing Trace Gases	Lidars for sensing water vapor, ice, and several atmospheric trace gases are being investigated. Students will develop computer models for evaluating the merits of several lidar techniques for optimum system development. There could be some test experiments, provided students have requisite training in using lasers that includes laser safety training and eye exams.
LaRC	Lunar and Planetary Surface Systems	Development of Mid-IR Laser-Based Differential Absorption Lidar (DIAL) for Water Vapor Detection	Students will be involved in developing the capability (modeling and simulation) of sensing water vapor on Mars and in other planetary atmospheres using lidars. (There could be some test experiments provided students have requisite training in using lasers that include laser safety training and eye exams.)
LaRC	Spacecraft	Development of Gravitational Acceleration Educational Display	The primary objective for this project is to develop an educational display and/or software comparing the gravitational acceleration of the ARES 1 rocket, including the Launch Abort System, to roller coasters, games of the winter Olympics, skate boards, and other games and sports that youth can relate to. The display could be a kiosk that would be used at museums, science centers, educational activities, and outreach events.
LaRC	Spacecraft	Development of Mars Lander Educational Display	The primary objective for this project is to develop an educational display and/or software emphasizing the challenges of entry, descent, and landing on Mars. The user would become the "engineer" and solve problems related to landing on a planet that has an atmosphere.

NASA Center	ESMD Related Area	Project Title	Senior Design Project Description
LaRC	Spacecraft	Design of Scaled Spacecraft and Test Apparatus to Enable Assessment of Water Landing for Orion-Type Vehicles	This work is important in the context of the development of the Orion Landing System and has potential for future spacecraft design. The focus of the undergraduate engineering design team will be the design and fabrication of a scaled capsule and testing apparatus for landing in water. The model of the Orion spacecraft should land in water with various combinations of horizontal and vertical velocities and impact attitudes in a parametric study. Measurements of interest will be tri-axial accelerations at the center of gravity and pressure variation on the heatshield.
LaRC	Spacecraft	Determination of the Chemical Composition of Nanomaterials for Aerospace Applications	This project involves the characterization of the chemical composition of nanomaterials for aerospace applications using energy (or wavelength) dispersive spectroscopy, x-ray diffraction, atomic absorption (or emission) spectroscopy, mass spectrometry, and/or nuclear magnetic resonance spectroscopy. The materials will be provided to the project team by the NASA POC. The overarching purpose of this and related projects is to understand the morphology and mechanical, electrical, magnetic, and chemical properties of the fabricated materials and then attempt to correlate those results to the modeled and observed nanoscale structures.
LaRC	Spacecraft	Determination of the Surface Conductivity of Nanomaterials for Aerospace Applications	This project involves the characterization of the surface conductivity of nanomaterials for aerospace applications using a four-point probe for mapping. The materials will be provided to the project team by the NASA POC. The overarching purpose of this and related projects is to understand the morphology and mechanical, electrical, magnetic, and chemical properties of the fabricated materials and then attempt to correlate those results to the modeled and observed nanoscale structures.
LaRC	Spacecraft	Determination of the Surface Energy of Nanomaterials for Aerospace Applications	This project involves the characterization of the surface energy of nanomaterials for aerospace applications using contact-angle goniometery. The materials will be provided to the project team by the NASA POC. The overarching purpose of this and related projects is to understand the morphology and mechanical, electrical, magnetic, and chemical properties of the fabricated materials and then attempt to correlate those results to the modeled and observed nanoscale structures.
LaRC	Spacecraft	Determination of the Surface Chemistry of Nanomaterials for Aerospace Applications	This project involves the characterization of the surface chemistry of nanomaterials for aerospace applications using x-ray photoelectron spectroscopy. The materials will be provided to the project team by the NASA POC. The overarching purpose of this and related projects is to understand the morphology and mechanical, electrical, magnetic, and chemical properties of the fabricated materials and then attempt to correlate those results to the modeled and observed nanoscale structures.

NASA Center	ESMD Related Area	Project Title	Senior Design Project Description
LaRC	Spacecraft	Determination of the Surface Roughness of Nanomaterials for Aerospace Applications	This project involves the characterization of the surface roughness of nanomaterials for aerospace applications using an atomic force microscope. The materials will be provided to the project team by the NASA POC. The overarching purpose of this and related projects is to understand the morphology and mechanical, electrical, magnetic, and chemical properties of the fabricated materials and then attempt to correlate those results to the modeled and observed nanoscale structures.
MSFC	Lunar and Planetary Surface Systems	Radiation Effects on Electronics Modeling	Develop advanced models of the natural radiation environment to diagnose and predict the effects of Single Event Effects (SEEs) on modern electronic architectures.
MSFC	Lunar and Planetary Surface Systems	Reconfigurable Computers	Provide reconfigurable computing capability, resulting in reduction of flight spares and risk reduction for limited circuit lifetimes.
MSFC	Lunar and Planetary Surface Systems	Integration of Surface Mobility Systems through Systems Engineering	Designing and building surface mobility mechatronics systems by multi-disciplinary teams. Not only the design of such systems but also the process of developing the entire system will be emphasized.
MSFC	Lunar and Planetary Surface Systems	Planetary Instrument Sample Collection Device	Marshall Space Flight Center has been developing a miniaturized Scanning Electron Microscope for in situ imaging and chemical mapping of samples for use on the Moon (as well as other planetary bodies.) This project would require the mechanical design and prototyping of a sample collection scheme that would take samples from the lunar surface and introduce them into a sample chamber for analysis. A fully automated sample collection device would allow for the instrument to be operated remotely from a rover. Some key considerations instrumental to this design are dust mitigation, selectable sample size, temperature fluctuations on the lunar surface, and compactness of design.
MSFC	Lunar and Planetary Surface Systems	NASA X-TOOLSS (eXploration Toolset for Optimization Of Launch and Space Systems)	Description: Use of the NASA X-TOOLSS software for design optimization of conceptual space systems. NASA X-TOOLSS is based on genetic and evolutionary algorithms, which have proven successful for global optimization of complex systems and for applications where unique and innovative designs are sought. An advantage of NASA X-TOOLSS and genetic/evolutionary optimization is that the design space is not limited to existing designs and approaches. Example applications of interest for NASA X-TOOLSS include habitats for the Moon and Mars, lunar surface mobility and power systems, lunar descent module and lander concepts, and thermal/structural design of small satellites and other spaceflight hardware.

NASA Center	ESMD Related Area	Project Title	Senior Design Project Description
MSFC	Lunar and Planetary Surface Systems	Development, characterization and Evaluation of Lunar Regolith and Simulants	
MSFC	Lunar and Planetary Surface Systems	Development of lunar composting capability	Composting of human food and other waste on the moon will be desirable, both from the standpoint of reuse of biochemicals (in support of longterm habitation) and in order to protect human health. While composting in lunar soil may be desirable, it may not be feasible. Lunar soil is, in contrast with most earth soils, completely mineral. More importantly, it is believed to be mechanically, and possibly chemically, hazardous to biological systems. Semester 1: Assess existing literature; identify sources of unpublished data and evaluate publication of recovered information. Characterize the risks and benefits of use of lunar soils for composting foodwastes, paper and cardboard, and sewage. Address each type of waste separately and in combination, as well as microbiological culture required. Develop design concepts for a composting system. Plan testing that addresses regolith simulators and effects of gravity; document in a test plan. Semester 2: Execute complete design based on concepts. Fabricate and assemble. Conduct testing defined in test plan and executes report.
MSFC	Lunar and Planetary Surface Systems	Lunar habitat situational awareness	In order to provide radiation shielding, thermal insulation, and impact protection, the covering of the lunar habitat will be very thick, likely including regolith. Physical windows in the habitat hull will be limited at best. Suggest schema and technologies to allow the crew to be kept informed (without constant human monitoring of the hemisphere around the habitat. System requirements would include, but not be limited to, planning and coordination of multiple ExtraVehicular Activities (EVA); habitat integrity monitoring; and recording of environmental events, such as meteoroid strikes or passages, and solar energetic events. The system should consist of internal controls and displays in the habitat and the external means to gather information. Multispectral data collected simultaneously (visible, IR, UV, and high energy) may be useful. Consider methods such as 'difference modeling' to extract crew-useful information from the collected data. Semester 1: Develop the concepts for the situational awareness system. Address cost, mass, and volume, as well as where the system components would be located both inside and outside the module. Describe the technologies to be used and note which are commercially available and which need further development. Semester 2: Prototype the system and demonstrate its capabilities. Propose further work.

NASA Center	ESMD Related Area	Project Title	Senior Design Project Description
MSFC	Lunar and Planetary Surface Systems	Design of Lunar Garage	NASA will need a garage facility to repair & maintain Lunar Roving Vehicles (LRVs) once we return to the moon. The garage could be pressurized for a shirt sleeve environment or unpressurized for a space suit environment or perhaps both (unpressurized for minimal maintenance, pressurized for more extensive repairs). Semester 1: Using the size of the Apollo LRV as a guide to the vehicle size to be accommodated, propose concepts for the garage using minimal launched mass as a major constraint. This might lead to an inflatable design, or one built from regolith in sand bags for example. Consider what tasks might need to be done on the LRV, based on the Apollo experience, and provide clearance in the garage for the work to be done by two crew. Plan evaluation activities and document in test plan. Semester 2: Construct & test the garage based on the overall design constraints formulated during the first semester.
MSFC	Lunar and Planetary Surface Systems	Partial Gravity Crew Interface Design	The microgravity experience has illustrated the need to accommodate the differences in human performance due to different gravity fields. NASA's short term interest is in 1/6 g for Lunar habitats, but is also in 1/3 g for Mars. Appropriate architectural design for habitats requires establishing partial Gravity Crew interface design principles such as the transition angles between ramps, stairs, stair ladders, and stairs. These are well established for 1 g, but are still unknown for 1/6 & 1/3 g. Semester 1: Propose methods to determine the transition angles for Lunar habitats. Document in test plan. Semester 2: Carry out the experiments and determine the transition angles for 1/6 g, and (time permitting) 1/3 g.
MSFC	Lunar and Planetary Surface Systems	Nuclear Fission Surface Power Design	This project will focus on the design and potential utilization of a 20/40 kWe Fission Surface Power System for use anywhere on the surface of the moon or Mars. The project will include performing a top level design of the Fission Surface Power System, including the reactor, shield, power conversion, power management and distribution, and radiator. Potential uses of the electrical or thermal energy from the reactor should be identified. Methods for emplacing and deploying the system should also be discussed. Emphasis should be on systems that minimize programmatic risk and utilize well proven technologies.
MSFC	Propulsion	Main Propulsion System and Turbomachinery Analysis by GFSSP (Generalized Fluid System Simulation Program)	GFSSP (Generalized Fluid System Simulation Program) is a finite volume based network analysis code developed at MSFC for analyzing chilldown, loading, stratification, pressurization, feed system, recirculation and fluid transients. It has also been extensively used for secondary flow analysis in turbo-pumps and many other applications that require coupled thermo-fluid analysis involving conjugate heat transfer. GFSSP has an user-friendly visual pre and post processor and a modular code structure with extensive documentation with example problems that make it ideally suitable for Senior Design Project.

NASA Center	ESMD Related Area	Project Title	Senior Design Project Description
MSFC	Spacecraft	Design for Reliability and Safety	Safety and Reliability is a top priority for NASA in the development of new launch systems. There is a need to define and develop a process that describes how to "design for reliability and safety". This is a system engineering design project that addresses all what needs to be done throughout all the phase of a program (quantitative and qualitative) to design highly reliable and safe launch systems. This includes identification of products, tools, approaches, etc. by program phase.
MSFC	Spacecraft	Optimized De-Orbit Propulsion Systems for Various Mass-Class Payloads	NASA classifies satellites as standard (>500 kg range), small (100-500 kg range), mini (10-100 kg range), and nano (less than 10 kg). Each size satellite has associated volume constraints which together define the launch mass and volume of the payload. All spacecraft programs are required to have a de-orbit plan for all satellites in Low Earth Orbit. This study will focus on determining the optimum de-orbit system for each of the satellite sizes. The de-orbit systems to be considered are: 1. solar sail, 2. chemical /liquid fuel thruster, 3. natural decay, 4. electro-dynamic tethers, 5. other. To normalize the study, start by considering all satellites at an altitude of 1000 km, in a circular orbit, and 28.5¢ª inclination. To start the study, assume the following masses: Standard = 500 kg Small = 250 kg Mini = 50 kg Nano = 5 kg The study should evolve into optimization over available trade space.
MSFC	Spacecraft	Remediation of environmental pollutants and contaminants through non-mechanical technologies	Current technologies for removal of toxic and hazardous materials from life-contact fluids (air, wastewater) include filters and chemical exchangers that must be discarded after use. The limitations on mass that can be carried on long-term missions to the moon and Mars will demand that regenerative capabilities be developed to remove biological materials, outgassed abiological compounds, and lunar dust from water and air. Semester 1: Develop concepts for remediation technologies that could be achieved within 15 years. Address regenerative abiological chemistries, nanotechnology, and biological or biochemical systems. Develop proposal for construction of one or more systems, including test plan. Semester 2: Develop system and conduct appropriate tests, based on test plan. Report results.
MSFC	Lunar and Planetary Surface Systems	Using Lunar materials and solar energy for Lunar Base self-reliance	Design a self-supporting system for the Lunar outpost using lunar materials and solar energy. The system can supply any necessity for the astronauts (water, oxygen, spare parts, food etc.)
MSFC	Propulsion	Liquid engine system performance modeling and Predictions	To further develop PSTAR, the first order modeling tool, by providing the capability to perform off-design analysis of liquid rocket engines, while improving performance, weight and cost predictions. There are up to 4 senior design projects available -- off design capability, performance improvements, weight model improvements and cost model improvements.

NASA Center	ESMD Related Area	Project Title	Senior Design Project Description
MSFC	Propulsion	Diagnostics for plasma propulsion systems	Plasma-based systems are typically applied to situations where very high gas velocities are required. As a space thruster, plasma-based devices expel their propellant at a much greater velocity than chemical rockets. Consequently, they require less propellant to complete a given mission, leaving more room on a spacecraft for hardware/consumables/instruments. Plasma based devices also find use in studies where the fast plasma can be used to accelerate small particles up to the speeds typical of in-space micrometeorites impacting a spacecraft or habitat. There is a need to have diagnostics that can measure the time-varying plasma properties in such devices to validate the present theoretical understanding and to serve as experimental benchmarks that can support the development of models. Senior project opportunities are available in designing and constructing robust, stand-alone diagnostic packages with plug-n-play capability for use with many pulsed plasma sources and in designing and fabricating experiments for evaluation of new diagnostic techniques.
MSFC	Propulsion	Liquid metal system components for nuclear surface power	There is presently an effort underway at MSFC to evaluate components that might be included in the design and eventual deployment of space and lunar-based nuclear reactor systems. The evaluation effort involves the use of a simulated nuclear reactor core (comprised of resistive heating elements) where pumped NaK (sodium-potassium eutectic) is used as the heat-transfer medium. In these systems there is significant need for improvement over present state-of-the-art component technology. This includes the need for lighter-weight, more efficient liquid metal pumps, more accurate flow rate measurement techniques, and capabilities to monitor the state of the liquid metal (liquid level, temperature, etc), especially in locations that are not easily accessible. Senior projects would aim at evaluating different strategies to improve technology over the present state-of-the-art through a combination of literature research, theoretical and numerical modeling, performance analysis, fabrication and testing.
MSFC	Propulsion	ROCETS (Rocket Engine Transient Simulation) Improvements	RTo improve the Rocket Engine Transient Simulation (ROCETS) tool by making the optimization scheme more robust, adding new design modules and improving existing modules
SSC	Propulsion	Stratification Rates of Nitrogen Contamination in Hydrogen	Determination of the diffusion rate constant and buoyancy force balance at small concentrations for nitrogen contamination in hydrogen. The project would be the experimental determination of the rate of stratification of gaseous nitrogen in a container of hydrogen by introducing a small fixed amount of nitrogen in into a volume of hydrogen (or possibly helium for safety) and monitoring the stratification process.

NASA Center	ESMD Related Area	Project Title	Senior Design Project Description
SSC	Propulsion	Determination of Circumferential Temperature Distribution	Determination of the circumferential heat leak through a vacuum jacketed pipe carrying cryogenic fluid. The project would be the experimental determination of the circumferential temperature distribution and heat leak under cryogenic conditions for a vacuum-jacketed pipe in a horizontal orientation. One of the primary goals of the investigation would be the separation of the external radiation component from the convective component of heat transfer producing the circumferential temperature variation with a partially filled inner tube.
SSC	Propulsion	Design of A Shell Tube Heat Exchanger	When discussing space travel (including satellite launches), there is and always has been a desire to lift as much payload as possible at the lowest cost possible. In fact, SSC has been asked to deliver 162 degree Rankine Liquid Oxygen (LOX) to support testing of X-33, J-2X Powerpack and recently SSME. This was accomplished by "bubbling" gaseous helium through the LOX storage vessel until the desired temperature was achieved. This "denser" propellant enabled the rockets to achieve better engine performance. Recently, a customer approached SSC with a desire to test with 150 degree Rankine LOX, which is outside of the capability of "bubbling". The customer described a shell tube heat exchanger type apparatus used in conjunction with Liquid Nitrogen to achieve temperatures as low as 145 degree Rankine in a previous project. This heat exchanger would not be available for our testing series. We need to design a shell tube heat exchanger (and associated piping) which uses Liquid Nitrogen to achieve 145 degree Rankine LOX. The actual storage vessel to be used is an 11,000 gallon Liquid Oxygen tank and the required time to decrease LOX temperature is 12 hours maximum. Proof of concept can be done on a much smaller scale to demonstrate proper operation.

NASA Center	ESMD Related Area	Project Title	Senior Design Project Description
SSC	Propulsion	Thermocouple Analysis For Cryogenics Temperature Measurement in Testing of Rocket Engines	In the testing of rocket engines for space exploration, it is important to understand temperature measurement in cryogenic fluids. Temperature measurement helps characterize the rocket engine's operating conditions and performance. Accurately determining the temperature requires a good fundamental background in sensor characteristics of numerous temperature devices and the reason for using each in specific situations. All devices have one common performance indicator called a "time constant". Determining the time constant of temperature sensors that are suddenly submerged in a cryogenic fluid can be a challenge. Rapid boiling ensues once a room temperature probe is dipped into the cryogenic fluid. Therefore, NASA has a need to determine the time constant of different types of thermocouples (T/Cs) and Resistance Thermal Devices (RTDs) in cryogenics (normally LN2 will be used). There are many different types of thermocouples and RTDs available for rocket engine testing. Analysis is needed for determining the best overall thermocouple and RTD. This project seeks to analyze and record the characteristics of various types of thermocouples and RTDs in order to accomplish that task. The thermocouples and RTDs will undergo a cryogenic dip test and a specialized oil dip test. Variables of the thermocouple include type, probe diameter, length, depth of dip, grounded or ungrounded, open tip or closed tip, orientation, output mv, and body materials compatibility with certain cryogenics. In addition, T/Cs should be compared to RTDs that are specifically used in the rocket engine testing world for more accurate measurement in steady state conditions. Normally, RTDs are slower in response. Similar variable information will be needed for RTDs. In Industry, RTD manufacturers measure time constants in a specific Dow Corning Oil at a certain temperature and flow to accurately determine the time constant without boiling. The Dow Corning oil will be used as a control for the experiment and is required for T/Cs and RTDs alike. It is anticipated that the results of this project will provide a wealth of information and experience to the students as well as practical and valuable information available to NASA for rocket engine testing.
SSC	Propulsion	Cryogenic Pipe Stress	At NASA Stennis Space Center the use of cryogenics is very important to the testing of rocket engines used for space exploration. It is important to know the characteristics of piping that carry cryogenic fluid to the testing stands. For this project we need to be able to evaluate piping surface temperature and stress as a function of flow condition (full LN flow, trickle LN flow and no flow) and environment for a pipe containing Liquid Nitrogen (LN). For example, if the pipe is chilled with LN we should be able to measure the surface temperature and pipe stress for the different flow conditions. Next we should be able to expose the top of the pipe to sunlight and rain to see how that affects the pipe outer temperatures and stresses along with the varied flow conditions. The collected data should be compared with a model of the system in ANSYS or equivalent software.