ESMD Senior Design Listings
(Updated: June 04, 2008)

Note: Space Grant Consortia in Alaska, Hawaii, Iowa, Kansas, Kentucky, New Hampshire, Oklahoma and Puerto Rico are not incorporating ESMD senior design projects.

NASA senior design projects are contingent on project funding, mentor availability and management approval.

To jump to a certain center's listings, click on one of the links below.

NASA Center	Project ID	Title	Description
Ames Research Center (ARC)			

ARC	ARC1-03-SD	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	ARC1-02-SD	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.

ARC	ARC1-04-SD	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.
Dryden Flight Research Center (DFRC)			
DFRC	DFRC4-14-SD	Intelligent data acquisition and on-board data processing	Develop architectures and simulation approaches for real-time data acquisition and processing of in-flight aerodynamic parameters
DFRC	DFRC4-13-SD	Interoperable intelligent guidance and control architectures for autonomous operations	Develop soft-computing approaches that enable guidance and control of autonomous aerial platforms to perform docking maneuvers, refueling, and a multitude of other self-guided operations
DFRC	DFRC4-12-SD	Fiber-optic sensors for dynamic measurements	Develop novel approaches to measure mechanical stresses using tunable fiber-optic sensors
DFRC	DFRC4-11-SD	Guidance and control of unconventional vehicles	Use Multidisciplinary Analysis and Optimization (MDAO) software to assess the stability of non-conventional aerial platforms
DFRC	DFRC4-10-SD	Sensor-guided vehicles	Develop architectures for integrating structural sensors into avionics for robust autonomous control of aerial vehicles
DFRC	DFRC1-09-SD	Sensor-guided flight control avionics	Develop novel approaches to reliable and robust autonomous control
DFRC	DFRC1-08-SD	Next Generation Air Transportation systems	Develop simulation approaches to examine operational concepts for the next generation of aerial transportation systems
DFRC	DFRC4-07-SD	Dynamic soaring/Autonomous autopilot	Develop aerial platforms that exhibit autonomy and dynamic soaring capabilities
DFRC	DFRC4-06-SD	Small-scale fuel cell applications	Demonstrate small-scale fuel cell applications for aerial platforms
DFRC	DFRC4-05-SD	Intelligent power management	Develop efficient approaches for power management of critical on-line assets, systems, and subsystems

DFRC	DFRC4-04-SD	Ad-hoc networking (store and forward) with buffered data management	Develop methods that store and forward critical operational data for rapid assessment of situational awareness
DFRC	DFRC4-03-SD	Distributed data systems and integration	Develop efficient strategies for networking in highly cluttered data-driven environments and methods to integrate distributed data systems
DFRC	DFRC4-02-SD	Adaptive logic and learning systems	Develop approaches for machine-learning and techniques to adapt to changing operating constraints
DFRC	DFRC4-01-SD	Intelligent health monitoring of spacecraft	Develop approaches to self-monitor and diagnose the in-flight health of spacecraft
Glenn Research Center (GRC)			
GRC	GRC3-06-SD	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.
GRC	GRC1-05-SD	Battery Packaging for Astronaut?s Suit	The goal of this project is to develop a packaging method of Lithium-Ion batteries for an astronaut?s suit. The packaging must allow full mobility of an astronaut and easy recharging. It must also be equipped with an appropriate thermal protection and cooling system to maintain the battery operation temperature in the range of -60 C to +60 C.

GRC	GRC1-04-SD	Lunar Surface Mobility	This senior design project opportunity is for considering many different forms of lunar surface transportations depending on specific mobility needs. These include for example how to effectively and reliably carry an object of up to 10 metric tons from a landing site of a Lunar Surface Access Module (LSAM) to a habitat and how to move an object in and out of a moon crater. Creative out of box thinking which is not constrained with regular wheeled type vehicles is encouraged.
GRC	GRC1-03-SD	Mechanical Components and Simulations for Modular Mobility Test Demonstration (MMTD) vehicle	At GRC, a wide range of mechanical systems for the next generation lunar rover are developed and tested through the test vehicle called Modular Mobility Test Demonstration (MMTD) vehicle. The Simulated Lunar OPEration (SLOPE) facility provides the MMTD a test environment of a simulated lunar surface terrain with up to 45 degrees of inclination. Some of important mechanical issues include terramechanics (the study of interactions between vehicle wheels and various terrains specifically the simulated lunar surface), drive train, and suspension. Senior design project opportunities are available for designing and fabricating mechanical components, developing wheel/soil interaction models, etc.
GRC	GRC1-02-SD	User Friendly Body Attachment Gears Health Dx'es	Vision Research and Human Health Diagnostics Laboratory at GRC conducts research on diagnosing human health non-invasively through countermeasures using eye and skin as a window to the body. The objective of this project is to develop user friendly body attachment gears with health monitoring sensors and probes. One particular example of such body attachment gears is a helmet equipped with oximeter probes and possibly with dynamic light scattering and corneal topographer eye examining probes. For more information about the lab visit the following web site: http://exploration.grc.nasa.gov/grcbio/VisionResearch/

GRC	GRC1-01-SD	Ray Domes for Lunar Surface Communication Devices	Under the Constellation mission, a permanent base will be settled on the lunar surface for exploration. Various communication devices such as Lunar Communication Terminals (LCT) will be installed on the moon surface. The goal of this project is to design a ray dome protecting communication devices and build a scale model of it. The ray dome protects communication devices from accumulating moon dust and flying moon dust particles generated by the thrust from the Lunar Surface Access Module (LSAM). The flying particles reach the speed as high as 2 km/sec. The ray dome should be foldable or collapsible for easy transportation and installation. It must also withstand the harsh moon environment including the extreme temperature variation in the range of 100 to 420 K.
Goddard Space Flight Center (GSFC)			
GSFC	GSFC1-09-SD	Walk & Roll Robot Mobility	Develop detailed design of the innovative "Walk & Roll" robot components and perform simulations of the robot mobility, including kinematics, leg mechanicals, and Directed Flux motors.
GSFC	GSFC1-08-SD	Shape-shifting tetrahedral robots for rugged terrain	Develop intelligent controllers to coordinate the configuration of tetrahedral robots for motion over rugged terrain.

GSFC	GSFC1-07-SD	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 intruments 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 important tool in selecting landing sites will be to 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.
GSFC	GSFC2-06-SD	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	GSFC2-05-SD	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	GSFC4-04-SD	SuitSat Follow on	Engineering students will provide recommendations designs of instruments on SuitSat follow on that are in alignment with Exploration goals and objectives, for example a radiation shielding or monitoring experiment. http://science.nasa.gov/headlines/y2006/26jan_suitsat.htm

GSFC	GSFC4-03-SD	Exploration Systems Architectural Study Mission Design	Engineering students would be provided with the current ESAS documents and evaluate the current strategy and provide recommendations.
GSFC	GSFC1-02-SD	Design of Helium-3 Mining Equipment for the Moon	Dr. Harrison Schmitt (Apollo-17) has published a book, "Return to the Moon". It is not a travel log. It is a detailed technical study of the commercial possibilities of mining He-3 on the Moon to meet the energy crisis on Earth. The technical detail of Dr. Schmitt's study is most impressive, but it does have a number of areas that could be addressed by student design projects or a competition. One of these areas is the processing of lunar regolith to extract the volatiles. A Lunar Volatiles Harvester will be needed that can dig of extremely gritty material, screen it, move it, heat it to 700 C, sequester the volatiles, and discharging it. All this must be done in the lunar environment using extremely reliable equipment that is solar powered and can be easily maintained by a combination of a few astronauts and robots controlled from Earth. No mean task. I am suggesting we organize student competitions on critical details of this design. Considerable work on this idea can now be found in Wiki Lunarpedia under the key words: Lunar Volatiles Harvester Spec, Sandworms, Industrial Mechanisms, Student Projects, and Business Plans List.

GSFC	GSFC1-02-SD	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.
GSFC	GSFC1-01-SD	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.
Jet Propulsion Laboratory (JPL)			
JPL	JPL1-26-SD	Wide Area Automated Object Recognition System	Planetary exploration requires various types of sensing systems to study the environment. In harsh surface environments, there is a need to build underground habitats where sensors from the habitat can "peek" above ground to rapidly perform automated object recognition and surveillance of the surface conditions. A typical example could be identifying and tracking dust storms on Mars.
JPL	JPL1-17-SD	Formation flight systems ? navigation, guidance, and control	Develop approaches for formation flight involving a swarm of aerial robotic platforms
JPL	JPL1-16-SD	Advanced concepts for cliff-climbing robots	Develop robots that can climb cliffs

JPL	JPL1-15-SD	Concepts for robotic construction machinery	Develop concepts for robots used in habitat construction (collaborating robots)
JPL	JPL1-10-SD	Robotic platform concepts for Lunar mining operations	Develop robotic platforms for mining operations and end-to-end processing systems
JPL	JPL1-02-SD	Brain-Machine interfaces	Planetary exploration requires many forms of communications between humans, and between humans and machines. The objective is to develop more effective brain-machine interfaces so humans can communicate with machines using controlled brainwaves.
JPL	JPL1-01-SD	NASA MSFC ER21	The objective is to develop a 360 degree vision system that can be effectively utilized in dusty planetary environments. The system must be capable of providing continuous monitoring of external environmental conditions for above ground and below ground habitats.
Johnson Space Center (JSC)			
JSC	JSC3-16-SD	Electric Propulsion Systems	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.

JSC	JSC1-15-SD	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	JSC4-14-SD	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	JSC4-13-SD	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	JSC1-12-SD	Lunar lander dust mat	Since there will much walking at the base of the lander, especially around the airlock, design a lunar mat 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 mesh prior to entering the airlock.
JSC	JSC1-11-SD	Dust tolerant hand tools.	Standard tools, such as ratchets, folding handles on tools, and extendable devices, such as tripods will be used during lunar assemble, 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.
JSC	JSC1-10-SD	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	JSC1-09-SD	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	JSC1-08-SD	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	JSC1-07-SD	Lunar Lander Large Cargo Unloading System (EC Pr #3)	Design of a robotic/EVA assisted system to unload and move large cargo/modules from a lunar lander. CHALLENGE GOALS AND OBJECTIVES: The task would be to design a future lunar lander large cargo unloading system that can robotically or EVA assisted robotically unload and position cargo and modules. This large cargo handling 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 large cargo handling system. The Advanced EVA Technology Group will provide information on the previous designs of large cargo handling systems and some concepts from previous studies

JSC	JSC1-06-SD	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	JSC1-05-SD	(Five projects) Software Defined radio(SDR) Project	(5 projects) Design various components (VGA and keyboard Interface in VHDL, VHDL debugger/logic analyzer, Audio Module, RF Board, USB interface, Ethernet Layer) for the Software Defined radio (SDR) Project. Projects may involve one or more of these sub-areas.
JSC	JSC1-04-SD	Remote Image System Acquisition (RISA) - Multispectral Imaging	The purpose of the RISA Multispectral Imaging project is to develop methods to use multispectral imaging for materials identification, locating vegetation, atmospheric penetration, and improving methods to identify properties of interest to the NASA mission to meet exploration objectives.
JSC	JSC1-02-SD	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 imager designed specifically for the space environment. The imager will be used to monitor the health and status of the crew and vehicle as well as used on Lunar and Martian surfaces. The SC4 design will be based on the existing SC3 and SC2 imagers.

JSC	JSC1-01-SD	Planetary EVA Suit Fuel Cell	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.
Kennedy Space Center (KSC)			
KSC	KSC2-10-SD	Ground Operations	Perform analysis and assessment of launch complex 39 crawler way to support future heavy lift launch vehicles
KSC	KSC2-09-SD	Simulation that Supports Synthesis	Determine simulation tools/techniques that will assist engineers to work more efficiently during test and evaluation.
KSC	KSC2-08-SD	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
KSC	KSC1-07-SD	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.
KSC	KSC1-06-SD	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	KSC1-05-SD	Lunar Regolith Excavation O2 Prod/Outpost Emplace	The feedstock required for O2 production on the moon is Lunar Regolith (soil). 100 metric tonnes (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	KSC2-04-SD	Simulation-based Product Realization	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.
KSC	KSC1-03-SD	Lunar Regolith Processing Challenges for Oxygen Production	KT-D has been a member of a multi-center NASA project team to develop and experiment to go into the permanently shadowed craters of the lunar poles to make a determination on the quantity and form of hydrogen seen from orbit. In the first year, KSC ran a University Competition on the topic of ISRU and allowed Senior-level design teams from across the country to compete to propose a design solution to a portion of this problem. ISRU has a multitude of technical challenges that would fit nicely into this Senior Design realm, from Reaction Chamber Seals, Regolith Transfer, Regolith Excavation, Regolith Reduction for Oxygen Production, etc.

KSC	KSC1-02-SD	Senior Biological Engineer	NASA Exploration Senior Design Project: Habitat Module Components, Subsystems and Systems 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. The minimum 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 (CO_2/O_2 cycling), take advantage of transpired water production, and improve the efficiency of processing water and food production in a controlled environment. The terminal design should develop the subsystems for an integrated biological system that will provide at least a 1 person-equivalent of air revitalization, a 5 person-equivalent of water, and a 0.1 to 0.5 person-equivalent of food. System elements for the plant production subsystem should include water and nutrient delivery technologies, control, monitoring, and sensors for remote, semi-automated operation. Other major elements should include LED lighting to support plant growth, thermal control systems, atmospheric monitoring and control (CO_2, O_2, H_2O, ethylene, etc.), and crop health monitoring. Biological waste processing elements/systems should be designed to treat inedible plant material and other solid wastes, provide a soluble nutrient source for recycling back to hydroponic plant production, and the recovery and polishing of water processed through the plant systems. Design considerations should include the capability for integration of biological systems with resupply and physical/chemical systems to achieve a reduction of resupply mass and improved life cycle costs coupled with increased reliability and robustness. The design problems should be reduced to an appropriate focus and scope for the student?s experience, academic backgrounds, and expected outcome within the allotted time of the design course. Design elements should be compartmented from the habitat subsystems; plant-based food production and processing, solid waste processing, and water recovery; and address one or more specific aspects of the six requirements for the system elements to serve as stand-alone design projects.

KSC	KSC2-01-SD	Packetized Telemetry Converter	Utilizing reconfigurable logic devices, develop a system that accepts packetized telemetry 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 provide the flexibility to update the translation routines without requiring hardware change-out.
Langley Research Center (LaRC)			
LaRC	LARC1-10-SD	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 & has potential for the future spacecraft and lunar lander work. A graduate student would be best suited for this particular topic as it 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 & propagation of a number of uncertainties will require a knowledge of probabilistic analysis. MDOE can be used to minimize or control some uncertainties. The focus of the graduate student's effort will be in the application of probabilistic analysis for uncertainty quantification to an impact dynamics application. In order to most effectively work on the project the graduate student should have knowledge in either nonlinear, transient-dynamic structures or probabilistic analysis. In addition, experience with finite element modeling & signal processing would be helpful.

LaRC	LARC4-09-SD	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 sample top surface. The associated signals are used to create images of nanoscale near-surface and subsurface features.
LaRC	LARC1-08-SD	Deep-UV wavelength based chem-bio detection for mineralogical & life signature characterization.	Experimentally analyze lunar & Martian soil simulants at deep UV wavelengths (in the range 193-210 nm) based on laser-induced fluorescence & Raman spectroscopy.
LaRC	LARC1-07-SD	Coherent laser radar for 3D imaging of hard targets using near-IR wavelengths.	Study coherent laser radar techniques (in the wavelength range 1-2 microns) for terrain mapping, instrument landing, & autonomous docking applications for Lunar & Mars surfaces.
LaRC	LARC1-06-SD	Frequency Modulated (FM) CW lidar development for CO2 sensing at near-IR wavelengths.	Design & development of FMCW lidar architecture suitable for CO2 profiling of Martian environment from orbiting platforms.
LaRC	LARC1-05-SD	Mid-IR laser based DIAL development for ice detection.	Modeling & Simulation of ice detection on Mars & other planetary surfaces using differential absorption schemes.
LaRC	LARC1-04-SD	Mid-IR laser based Differential Absorption Lidar (DIAL) development for water vapor detection.	Modeling & simulation of water vapor sensing on Mars & other planetary surfaces; analysis of coherent, direct & hybrid detection based system architectures.
LaRC	LARC4-03-SD	Nanomaterials characterization for aerospace applications	Characterization and imaging of carbon nanotube networks in materials using Atomic Force Microscopy

LaRC	LARC1-02-SD	Rover-Electronic design & algorithm development using LabVIEW	There are many possibilities for algorithms relating to autonomous mobility, navigation based on stereo, omni-directional, & thermal imagers, in addition to several tasks relating to image registration, behavioral robotic intelligence, user interfaces for robot guidance & supervision.
LaRC	LARC1-01-SD	Design & integration of a robotic platform for science instrument testing	Analysis of multi-input/multi-output control systems, designing power systems, robotic autonomy algorithms, stereo visualization software architectures, instrument data integration schemes, performing electromagnetic interference tests, & programming data processing algorithms in National Instrument's LabVIEW software. Current effort covers major aspects relating to mechanical hardware design & construction, sensors system integration, algorithmic data product integration, motion control system design, & implementation of an algorithm development framework. Future effort will be heavily algorithmic and software oriented.
Marshall Space Flight Center (MSFC)			
MSFC	MSFC1-20-SD	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.

MSFC	MSFC3-19-SD	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.
MSFC	MSFC3-18-SD	ROCETS (Rocket Engine Transient Simulation) Improvements	ROCETS (Rocket Engine Transient Simulation) is MSFC?s in-house tool of choice for modeling a complete rocket engine system. ROCETS use at MSFC has primarily been in steady-state and transient analysis of proposed rocket engine designs. The code is FORTRAN based and very flexible, however, it lacks user friendliness and has a rather steep learning curve. Past efforts undertaken to enhance ROCETS capabilities have focused on usability and modeling ease. One effort worthy of note has been the GCOMB (Generalized COMBustion) effort that has significantly simplified modeling transient mixtures of fluids such as that occur during purging and priming of rocket engine manifolds. The effort currently being proposed is to complete development of the integrated design tool based on ROCETS. The effort will be composed of three major efforts. First, the optimization scheme previously developed for ROCETS will be refined and made more robust. Second, design modules will be developed for rocket engine pumps, turbines, and combustion devices. Third, existing rocket engine component modules will be refined. (Each of these efforts could be a separate senior design project.)

MSFC	MSFC3-17-SD	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	MSFC3-16-SD	Diagnostics for plasma propulsion systems	Plasma thrusters are spacecraft propulsion devices that 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. There is a need to have diagnostics that can measure the time-varying plasma properties in such thrusters to validate the present theoretical understanding of such devices and to serve as experimental benchmarks that can support the development of numerical models. Senior project opportunities are available in designing and constructing robust, stand-alone diagnostic packages with plug-n-play capability for use with many thruster types and in designing and fabricating experiments for evaluation of new diagnostic techniques.

MSFC	MSFC3-15-SD	General purpose heat source simulating a radio-active heat source	A compact size radio-active heat source is considered for many heating applications for space exploration including temperature control of various mechanical and electrical components under a cryogenic environment on the moon surface. The objective of this project is to develop a general purpose heat source which simulate the conditions of the radio-active heat source so that experiments can be done in safe and cost-effective manners.
MSFC	MSFC1-14-SD	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	MSFC1-13-SD	Lunar ISRU and solar energy	Design self-support system for the Lunar outpost using lunar material and solar energy.
MSFC	MSFC3-12-SD	Liquid engine system performance modeling	Liquid engine system performance modeling & main propulsion system analysis. Includes current liquid rocket engines and future new & derivative engine analysis & predictions
MSFC	MSFC1-11-SD	Autonomous vehicle system failure detection and response	Development of computer algorithms to autonomously detect vehicle system failures and take intelligent countermeasures against such failures
MSFC	MSFC1-10-SD	Autonomous object detection and avoidance	Real-time autonomous object detection and avoidance for lunar rover and autonomous lander

MSFC	MSFC1-09-SD	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	MSFC1-08-SD	Reconfigurable Computers	Provide reconfigurable computing capability, resulting in reduction of flight spares and risk reduction for limited circuit lifetimes.
MSFC	MSFC1-07-SD	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	MSFC3-06-SD	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	MSFC1-05-SD	Lunar Precursor Robotics Program	Mobility systems are needed to identify and characterize the resources available on the lunar surface. Specifically, large craters at the lunar poles. Rover designs capable of navigating in near complete darkness, obtaining the required number of samples, and surviving 50K temperatures is an extreme challenge. The design team would be tasked to investigate various low light vision systems for telerobotic operation and combinations of power and thermal control systems to operate in the dark and in sunlit conditions.

MSFC	MSFC1-04-SD	Optical Techniques for Guidance and Navigation during Landing	Optical correlation techniques are currently being investigated for unmanned vehicle to international space station robot docking. Early results indicate that the technique is robust and matches well with the current 3-D rendering software now available. The technique could be applied equally well to landing by unmanned vehicles at a site that has either been mapped well or that has been mapped sparsely and can be rendered in 3-D. The optical correlation technique has been well characterized in the past and is now finding its way into many applications.
MSFC	MSFC1-03-SD	Lunar Surface Habitat Thermal Cntrl System Design	With diurnal temperature variations between -270oF and +240oF, designing for habitation on the lunar surface presents many challenging problems. This project will consider the design of a habitat (or vehicle) thermal control system to provide a shirt sleeve environment for crew and equipment inside of long duration lunar outpost.
MSFC	MSFC1-02-SD	In-Situ Resource Utilization (ISRU)	In-Situ Resource Utilization (ISRU) is often described as ?living of the land?, but the ?land? happens to be the Moon or Mars. ISRU provides a fertile training ground for the next generation of scientists and engineers. Any practical ISRU devices will draw on a wide range of engineering disciplines including chemical, mechanical, electrical, systems engineering and applied physics. Successful senior design teams often require just this type of mixture. Marshall Space Flight center has been active in the area of ISRU oxygen production form both Lunar and Martian resources. Oxygen is clearly important for both life support and propellant production. Lunar regolith contains oxides that can be separated by molten oxide electrolysis (MOE). This technique can produce oxygen, silicon and a variety of metals. The Martian atmosphere consists mainly of carbon dioxide. Thus, a great deal of oxygen is available on Mars if one can break the chemical bonds. This can be accomplished thermally or by using radio frequency (R.F.) plasmas. These methods of oxygen production (Lunar and Martian) have been demonstrated in the laboratory, and need to be engineered into practical devices. Engineering design criteria must include the oxygen production rate, power consumption, energy sources, reliability and the cost of transporting terrestrial consumables. Designs may be autonomous or require human interaction.

MSFC	MSFC1-21-SD	Integrated digital design-to-manufacturing environ	Opportunities for participation will include: -Digital manufacturing -Generation and translation of CAD models between distinct environments -Development of virtual environment for development and production facilities, trade studies and facility limitation/impacts -Simulations and manufacturing process development, and coordinated motions programming and controls -Modeling/reverse engineering on exiting tools and hardware -Validation of assembly sequences and related human factors operations -Manufacturing process optimization -Validation of assembly and flight hardware transportation -Digital assembly and validation
MSFC	MSFC4-01-SD	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.