JSC Senior Design Project and or Intern Request Form

ES-1

Project Title:	Crew Force Loading on Primary and Secondary Structure
Project Description:	Crew loads often are a significant load case for primary structure, secondary structure, and payloads. While there is Shuttle-era on-orbit data, the raw data is unavailable for further data reduction. This project would measure human force inputs (in JSC facilities with appropriate funding/approvals) due to a variety of activities and develop enhanced load conditions based on force magnitude, moment, and/or energy compared to the static load applied currently in manned spacecraft design.
Choose most appropriate area of research:	☐ Planetary Surface Systems ☐ Ground Operations ☐ Propulsion X **Spacecraft** ☐ Human Health Program
Program Applicability	X **ISS** X **CEV/SLS** X **Commercial Crew** ☐ Asteroid ☐ Adv. Technology (AES/STMD)
Choose one project:	**Roles and Responsibilities of Senior Design POC/Mentor**
☒Senior Design	I have coordinated with my management and I am able to support at least three (3) teleconferences (kick-off, mid-term, and final) with a Senior Design Project Team at a university that chooses my project. I understand that I shall not provide any sensitive or classified information to the Senior Design Project students of faculty. I will provide feedback to the project team if requested.
☐Internship	I have coordinated with my management and I am able to support an intern. If an intern is selected for my project, I will provide an environment where an intern can grow and we may have a mutually beneficial and successful internship. My project will be able to provide a desk space, work area, and computer for an intern. I will review any final report or presentation that the intern generates during his/her internship and submit it to Export Control (DAA) for approval. This project opportunity will be posted in OSSI, through the office of Education (use exact same title). OSSI website: : https://intern.nasa.gov
Check desired Timeframe for Internship:	☐ Year long X **Summer** X **Fall** X **Spring (any 3-4 month duration should be OK)**
Check desired Major/Minor(s) for Internship:	X**Aerospace Engineering** X **Aeronautical Engineering** ☐ Astronautical Engineering X **Biomedical Engineering** ☐ Chemical Engineering ☐ Civil Environmental ☐ Health Engineering ☐ Electrical, Electronic Engineering ☐ Computer Engineering X **Engineering Physics** ☐ Industrial Manufacturing Engineering ☐ Materials, Metallurgical Engineering X **Mechanical Engineering, Mechanics** ☐ Nuclear Engineering ☐ Astronomy, Astrophysics ☐ Chemistry ☐ Optics ☐ Physics ☐ Atmospheric Sciences ☐ Geography ☐ Geosciences ☐ Oceanography ☐ Natural Resource Management ☐ Mathematics, Applied Mathematics ☐ Computer Science ☐ Astrobiology ☐ Biology ☐ Biochemistry/Biophysics ☐ Microbiology Bacteriology ☐ Chemical Engineering ☐Other, please specify:

Mentor Name:	James P. Smith, Ph.D.	Mentor's E-mail:	James.P.Smith@nasa.gov
Title & Organization:	Engineer, NASA/JSC/ES2	Phone #:	281-483-1242
Alternate POC/Mentor Name:		Alternate's E-mail:	
Education Office Signature and Date:		Intern Mentor's Signature & Date:	12 June 2013
As supervisor/manager, I approve of the above named individual as Senior Design Project POC of Intern Mentor.		Supervisor/Manager's Signature & Date	Gary Gallentine 6/10/13
(For Intern Request Only) As Administrative Officer, I am aware that the above named Intern Mentor has submitted a request for an Intern.		Administrative Officer's Signature & Date: 6/11/13	Dera A Yocko

Title: Crew Force Loading on Primary and Secondary Structure

Sponsor: NASA Johnson Space Center, Engineering Directorate, Structural Engineering Division

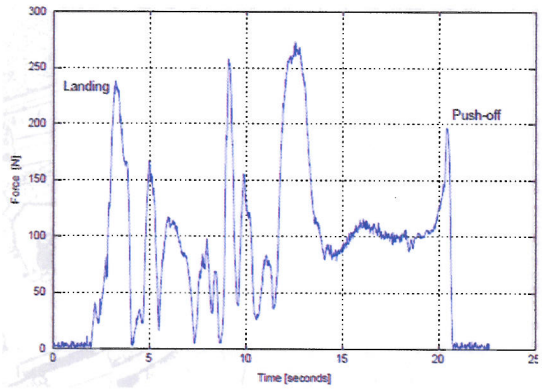
Personnel: 1 Engineer, 1 Student, test subject(s)

Expected person-hours: 300 Deadline: Spring 2014

Statement of Work:

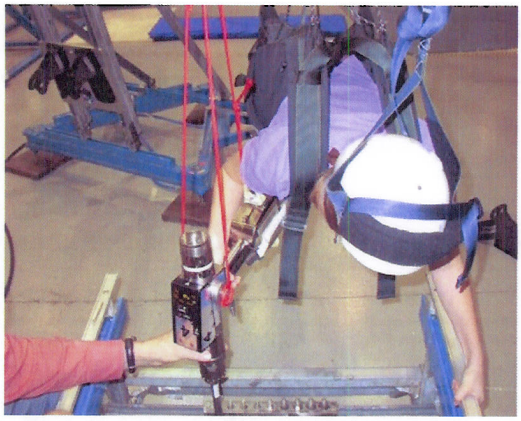
One of the design conditions for primary structure, secondary structure, and payload hardware is crew loading. Crew loading may come from suited or unsuited crew members and may be applied by the limbs or as an arresting motion of the entire body. The retired Shuttle Program has well-documented force-time load events defined in NSTS-21000-IDD-ISS for extra-vehicular activity (EVA) events. The load events in this document include inadvertent kick forces, lay back maneuvers, translation motions, and more. However, the level of detail associated with the EVA events does not exist for intra-vehicular activity (IVA). SSP 50005 defines static load events for activities such as crew push-offs and inadvertent kicks. These static loads have been used in the design of spacecraft and payloads and often become the most critical load case for the structure, leading to potentially bloated structural design and increased, unbeneficial mass. The magnitude of the load events are based on decades old flight experiments that examined the peak force only, and not the force profile as a function of time. Over time, the time history data for these experiments has been lost, so additional reduction of data can not be performed to enhance the uses of this data.

The objective of this project will be to measure loads applied by humans in a variety of actions. Loads will be characterized for conditions such as push-off, landing (that is, coming to a stop after a soaring motion), inadvertent kick loads, and handling motions. The reactions will be measured primarily with accelerometers placed on the test subjects bodies. In some cases, load cells may also be used to measure forces directly. Test subjects up to 95th percentile American males will be used. Test subjects will load structure using facilities such as the Structures Test Laboratory (test subjects can hang in a sling similar to testing performed for the EVA Pistol Grip Tool), air bearing floor, or the ARGOS lab to simulate zero-g. The stiffness and mechanical impedance of the test structures will be varied to determine how interface stiffness affects the loading conditions. Time histories will be recorded such that better estimates of load profile can be determined. Data reduction will determine the appropriate design methodologies for future programs, and the methodologies may include time based force forcing functions, a momentum requirement, or an energy requirement.



Sample On-Orbit Force Time History

ARGOS Facility



Test Subject in Sling for Pistol Grip Tool Characterization

Air Bearing Floor