  

AIAA Houston Section

In Collaboration with INCOSE
Presents

Annual Technical Symposium 2011

NASA/JSC Gilruth Center
Houston, Texas
Friday, May 20, 2011

CONFERENCE PROCEEDINGS

General Chair

Satya Pilla/Boeing

Organizing Committee

Ellen Gillespie
Douglas Yazell
Al Jackson/JSC
Daniel Nobles/SAIC
Steven Everett/Boeing
Sheik Ahsan/NASA
Matt Johnson/Lockheed
Antony Williams/Jacobs

PROGRAM SUMMARY

7:45 AM – 4:30 PM	**Registration Desk on First Floor**	**Next to Alamo Room**

8:15 AM - 8:45 AM	**Speaker: Mark Erminger**	**Alamo Ballroom**
Session A 9:00 AM – 10:30 AM	1. **Astrodynamics** 2. **Struct & Mech Engineering** 3. **EE, Com, GN&C** 4. **Systems Engineering**	San Jacinto Coronado Longhorn Lone Star
Session B 10:45 AM – 12:15 PM	1. **Astrodynamics** 2. **Struct & Mech Engineering** 3. **EE, Com, GN&C** 4. **Systems Engineering**	San Jacinto Coronado Longhorn Lone Star

12:15 PM – 1:30 PM	**Lunch**	**Alamo Ballroom**

12:30 PM – 1:30 PM	**Speaker: Brewster Shaw**	**Alamo Ballroom**
Session C 1:45 PM – 3:15 PM	1. **Flight Sciences** 2. **Hardware Systems** 3. **Exploration Concepts** 4. **Systems Eng**	San Jacinto Coronado Longhorn Lone Star
Session D 3:30 PM – 4:30 PM	1. **Propulsion** 2. **Technologies** 3. **Operations Management** 4. **Space Journalism**	San Jacinto Coronado Longhorn Lone Star

Morning Program – Session A

Time	San Jacinto (1)	Coronado (2)	Longhorn (3)	Lone Star (4)
8:15 - 9:00	**Morning Key Note Speaker - Mark Erminger**			
	Session A-1: **Theme - Astrodynamics** **Session Chair: Al Jackson**	**Session A-2:** **Theme – Struct & Mech** **Session Chair: Mike Laible**	**Session A-3:** **Theme – EE, Com, GN&C** **Session Chair: Doug Yazell**	**Session A-4:** **Theme – Systems Eng (INCOSE)** **Session Chair: Ben Edwards**
9:00 - 9:30	**A-1.1** Near-Earth Object Orbits Offering Enhanced Accessibility For Human Space Flight: **Daniel Adamo**	**A-2.1** Impact of Structural Deadband Non-Linearities on Random Vibration Environments: **Sundeep Bhatia**	**A-3.1** Wireless Power Transmission Roadmap: **Garland Bauch**	**9:00 – 10:00** **INCOSE-1** Pad Abort: **John Saltzman**
9:30 – 10:00	**A-1.2** Solution to the Sagan Dilemma via Surface Albedo Modification Technique: **Shen Ge**	**A-2.2** Special Topics in Random Vibrations: **Arya Majid**	**A-3.2** Ultra-Wideband Tracking System Design for Relative Navigation: **Jianjun (David) Ni**	
10:00 - 10:30	**A-1.3** Multi-Tiered Implementation for Near-Earth Asteroid Mitigation: **David Hyland**	**A-2.3** An Overview of STS-132 MRM1 Cargo Element Thermal Model Development & Analyses: **Miguel Fernando Perez**	**A-3.3** Soft-Decision-Data Reshuffle to Mitigate Pulsed Radio Frequency Interference: **Jianjun (David) Ni**	**10:00 – 11:00** **INCOSE-2** Project M/Morpheus: **Jennifer Mitchell**
10:30 – 10:45	15 Minute Break			

Morning Program – Session B

	San Jacinto (1)	Coronado (2)	Longhorn (3)	Lone Star (4)
	Session B-1: **Theme - Astrodynamics** **Session Chair: Dan Adamo**	**Session B-2:** **Theme – Struct & Mech** **Session Chair: Erica Bruno**	**Session B-3:** **Theme – EE, Com, GN&C** **Session Chair: Ellen Gillespie**	**Session B-4:** **Theme – Systems Eng (INCOSE)** **Session Chair: Ben Edwards**
10:45 – 11:15	**B-1.1** A Mission Template for Exploration and Mitigation of Potentially Hazardous Near Earth Asteroids: **David Hyland**	**B-2.1** ISS Microgravity Environment/ Unusual ISS Rate Signature: **Michael Laible**	**B-3.1** Configuring the Orion Guidance, Navigation, and Control Flight Software for Automated Sequencing: **Ryan Odegard**	
11:15 - 11:45	**B-1.2** A Permanently-Acting NEA Mitigation Technique via the Yarkovsky Effect: **David Hyland**	**B-2.2** A Comparison of Dual Wall Ballistic Limit Predictions for Spherical and Elliptical Shapes: **James Lee Foster**	**B-3.2** A New Approach to GN&C Mission Design and Analysis: **David Woffinden**	**11:00 – 12:00** **INCOSE-3 Constellation SE&I: Joe Caram**
11:45 – 12:15	**B-1.3** A Review of Proximity Operations for Asteroid Missions: **Al Jackson**	**B-2.3** Overview of the NASA Docking System (NDS) and the International Docking System Standard (IDSS): **George Parma**	**B-3.3** Signing and Validating Proximity Operations Rendezvous and Approach Trajectories for the Cygnus Mission: **Renato Zanetti**	
12:30 - 1:30	**Lunch Key Note Speaker – Brewster Shaw**			

Afternoon program – Session C

	San Jacinto (1)	Coronado (2)	Longhorn (3)	Lone Star (4)
	Session C-1: **Theme - Flight** **Session Chair: Sarah Shull**	**Session C-2:** **Theme – Flight Hardware Systems** **Session Chair: Gary Brown**	**Session C-3:** **Theme – Exploration Concepts** **Session Chair: Matt Johnson**	**Session C-4:** **Theme – Systems Eng** **Session Chair: Ben Edwards**
1:45 - 2:15	**C-1.1** Orion Flight Dynamics Design Trades: **Mark Jackson**	**C-2.1** Student-Built Reconnaissance Unmanned Aircraft System: **Michael Szmuk**	**C-3.1** Return to the Apollo Sites: **Rob Kelso**	**1:45 – 2:45** **INCOSE-4** Panel Discussion - Common and Contrasting Themes in Lessons Learned: **Linda Bromley (Moderator)** **John Saltzman, Joe Caram, Jennifer Mitchel**
2:15 - 2:45	**C-1.2** FASTRAC Satellites in Orbit: **Sebastian Munoz**	**C-2.2** Method for Detection and Confirmation of Multiple Failure Modes with Numerous Survivor Data: **Mark Powell**	**C-3.2** Emerging Commercial Space - New Markets as a Function of Altitude Regimes: **Rob Kelso**	
2:45 - 3:15	**C-1.3** On Using High Lift-to-Drag Ratio Waveriders for Missions in the Martian Atmosphere: **Patrick Rodi**	**C-2.3** Method for Investigating Repair/Refurbishment Effectiveness: **Mark Powell**	**C-3.3** Toward an embedded Suggestion Collection and Modular Assembly System for Space Commercialization: Research in Progress: **Alex Monchak**	
3:15 - 3:30	15 Minute Break			

Afternoon Program – Session D

	San Jacinto (1)		Coronado (2)		Longhorn (3)		Lone Star (4)
	Session D-1: **Theme - Propulsion** **Session Chair: Sheikh Ahsan**		**Session D-2:** **Theme – Technologies** **Session Chair: Zafar Taqvi**		**Session D-3:** **Theme – Operations Management** **Session Chair: Satya Pilla**		**Session D-4:** **Theme – Space Journalism** **Session Chair: Douglas Yazell**
3:30 - 4:00	**D-1.1** Wall pressure unsteadiness and side loads in over expanded rocket nozzles: **Woutijn Baars**		**D-2.1** The Future of Extravehicular Activity Technology Development: **Cinda Chullen**		**D-3.1** Culture Change in the Mission Control Center: Safe Flight Control without Paper Procedures: **Michael Hurt**		**3:15 - 4:30** **Space Journalism** - Panel Discussion:
4:00 - 4:30	**D-1.2** Adaptive Filtering for Reusable Rocket Engine Behaviors: **Rube Williams**		**D-2.2** Plasma Physics Applications for Aerospace Technology: **Alfonso Tarditi**		**D-3.2** Work Product Assessment Concept: **Melanie Weisman**		

TECHNICAL PROGRAM

TECHNICAL SESSIONS

Three sessions will run in parallel in the morning and afternoon. Morning sessions start at 9:00 AM and end by noon. Lunch program begins at 12 noon and lasts for about an hour and fifteen minutes. Afternoon sessions start at 1:30 PM and end by 4:30 PM.

The sessions are held in the four meeting rooms on the first and second floors of the Gilruth Center.

PRESENTATIONS

Each presentation is allocated 30 minutes total time, including questions and any initial setup. Session chairs will maintain this pace to ensure that attendees can see presentations according to the posted schedule. Each room will be equipped with a laptop computer and a computer projector.

A-1.1

Session A-1 **San Jacinto Room**

Astrodynamics

Session Chair: **Al Jackson**

9:00 AM

A-1.1 Near-Earth Object Orbits Offering Enhanced Accessibility for Human Space Flight

Daniel R. Adamo
Independent Astrodynamics Consultant, Houston, Texas 77059
and
Brent Wm. Barbee
Flight Dynamics Engineer, NASA Goddard Space Flight Center, Greenbelt, Maryland 20771

Near-Earth objects can be grouped into multiple orbit classifications, among them being the Aten group, whose members have orbits crossing Earth's with semi-major axes less than 1 astronomical unit. Atens comprise well under 10% of known near-Earth objects. This is in dramatic contrast to results from recent human space flight near-Earth object accessibility studies, where the most favorable known destinations are typically almost 50% Atens. A geocentric dynamics theory explains this enhanced Aten accessibility and leads to an understanding of where the most accessible near-Earth objects reside. Without a comprehensive space-based survey, however, highly accessible Atens will remain largely unknown.

This presentation reviews results from a recent accessibility study of *known* near-Earth objects, showing where the most accessible human space flight destinations map into heliocentric semimajor axis, eccentricity, and inclination (a, e, i) coordinate space. A technique to systematically evaluate this space for human space flight accessibility using *fictitious* near-Earth objects is presented, together with preliminary evaluation results. These results are shown to confirm theoretical predictions of where the most accessible near-Earth objects for human space flight are to be found in (a, e, i) coordinate space.

A-1.2

Session A-1 **San Jacinto Room**

Astrodynamics

Session Chair: **Al Jackson**

9:30 AM

A-1.2 Solution to the Sagan Dilemma via Surface Albedo Modification Technique

Virgiliu Pop, Romanian Space Agency
Shen Ge, Texas A&M University

Near Earth Asteroids (NEAs) pose a persistent threat to Earth through possible collisions. Though techniques have been developed to alter the trajectories of these objects, there remains the possibility that the same technique can be alternately used as a weapon. The Sagan dilemma, i.e. "if one can deflect an asteroid away from a collision, one can also deflect an asteroid toward a collision", is a hard dilemma to escape for many approaches. Altering the Yarkovsky effect on an asteroid through changing its surface albedo is one technique where sufficient precision exists to alter an asteroid's trajectory to not strike Earth but not enough precision exists to use the asteroid as a targeted weapon. This paper presents the technical justification of this technique in lieu of resolving the Sagan dilemma as well as its legal implications.

Session A-1 **San Jacinto Room**

Astrodynamics

Session Chair: **Al Jackson**

10:00 AM

A-1.3 Multi-Tiered Implementation for Near-Earth Asteroid Mitigation

*D. C. Hyland, Professor of Aerospace Engineering, Texas A&M University **S. Ge, ***H. Kim, L. Medina, R. Munoz, R. Margulieux, B. Young, X. Bai, N. Satak

The close approach of the near earth asteroid Apophis in 2029 presents an opportunity to test mitigation techniques. A mission launched at least six years prior to the asteroid arrival can test an innovative slow push technique using the spacecraft's surface albedo treatment system (SATS). This albedo modification is implemented through painting the surface of the asteroid with albedo changing powders (ACPs) via a triboelectric dispenser, hence directly changing the Yarkovsky effect. This paper addresses the design of such a mission platform from a multi-tiered comprehensive perspective including details of the actual mitigation platform, the necessary preliminary LEO flight tests, and ground experiments for the design of SATS.

A-2.1

Session A-2 **Coronado Room**

Structural & Mechanical Engineering

Session Chair: **Mike Laible**

9:00 AM

A-2.1 Impact of Structural Deadband Non-Linearities on Random Vibration Environments

Sagar Vidyasagar[1] and Sundeep Bhatia[2] *Lockheed Martin Corporation*

A methodology has been developed to determine the impact of deadbands in component attachments to random vibration environments. Advanced computational techniques previously developed to simulate/investigate the impact of complex component interfaces involving deadbands have been effectively employed here. These results may be of particular interest to the commercial launch vehicle programs that are to carry orbital replacement units to the International Space Station on the AFRAM/PFRAM FSE system that has finite joint tolerances. Results from the present study show the same trends as a random vibration test conducted by the Orion program to assess the impacts of joint slops. The process affords what-if studies to mitigate elevated responses in the high frequency regime.

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1 Technical Fellow, Lockheed Martin Corporation, Houston, Texas.
2 Senior Staff Engineer, Loads & Dynamics, Lockheed Martin Corporation, Houston, Texas.

A-2.2

Session A-2 Coronado Room

Structural & Mechanical Engineering

Session Chair: **Mike Laible**

9:30 AM

A-2.2 Special Topics in Random Vibrations

Arya Majed[1] and Ed Henkel[2],*Applied Structural Dynamics, Inc.*
Ali Kolaini[3], *NASA/JPL*
and
Sagar Vidyasagar[4] and Sundeep Bhatia[5], *Lockheed Martin Corporation*

This presentation discusses some special topics of current interest in the area of random vibrations. There will be a short section on each topic. The topics include:

(1) Generalized Mass Attenuation (GMA): This section presents an improved method of prediction for random vibration mass attenuation. This development was a collaborative effort between ASD and the NESC under the stewardship of Dennis Kern (NASA/JPL) and Curt Larsen (NESC). The method, its benefits, and comparisons of raw predictions to the NASA/JPL acoustic test of a panel/box coupled system conducted by Ali Kolaini (NASA/JPL) are presented.

(2) Impact of structural deadband nonlinearities on random vibration environments: This section presents results from advanced computational methods developed at ASD to ascertain the impact of structural deadband nonlinearities on random vibration environments. These results may be of particular interest to the commercial launch vehicle programs that are to carry orbital replacement units to the ISS on the AFRAM/PFRAM FSE system. Results show the same trends as a random vibration test conduced by the Orion program to assess the impacts of joint slops.

(3) An assessment of SEA assumptions in random vibration calculations: In this section, we assess the impact of the SEA requirement for "spatial averaging" on random vibration calculations by comparing the spatial averaged mean-square response to that predicted by random vibration calculations utilizing partial differential equation models of beams and panels. Additional SEA assumptions and their impact may also be discussed.

(4) Random vibration calculations involving the Corcos TBL model acting on panels: In this section, we utilize a partial differential equation model of a panel to discuss the sensitivity of the center panel response to Corcos decay coefficient and convection velocity parameter variations. The results may be of value to the various panel test programs that are utilizing the Corcos model.

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1 Chief, Structural Dynamics/Advanced Methods, Applied Structural Dynamics, Inc., Houston, Texas.

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3 Principal Engineer, NASA/JPL, Pasadena, California.
4 Technical Fellow, Lockheed Martin Corporation, Houston, Texas.
5 Senior Staff Engineer, Loads & Dynamics, Lockheed Martin Corporation, Houston, Texas.

A-2.3

Session A-2 **Coronado Room**

Structural & Mechanical Engineering

Session Chair: **Mike Laible**

10:00 AM

A-2.3 An Overview of STS-132 MRM1 Cargo Element Thermal Model Development & Analyses

Miguel Fernando Perez and Elias Azzi
Lockheed Martin, Cargo Mission Contract, Houston, TX 77598
and
Evgeny Menkin and Timothy B. Davies
NASA Johnson Space Center, Houston, Texas 77058

STS-132 was launched in May 2010 and delivered the Russian Mini Research Module 1 (MRM1) cargo element to the International Space Station as part of the ULF-4 assembly flight. The cargo element consisted of the module outfitted with externally mounted Multi-purpose Laboratory Module (MLM) Airlock, MLM radiator, Portable Work Platform (PWP), and a European Robotic Arm (ERA) spare elbow. Prior to every Shuttle flight, hardware developers are required to determine compatibility of their hardware to thermal environments experienced during the Shuttle mission and once the element is integrated with the ISS. Thermal models are provided to the Shuttle program to determine the impact of the payload on the Orbiter hardware, as well as the ISS program to determine impacts on other ISS payloads in the Orbiter. Historically the Russian International Partner (IP) develops models in formats not compatible with software used by Space Shuttle or ISS programs. This prompted NASA and Lockheed Martin to develop a unique set of thermal models for the MRM1 cargo element. Subsequent ULF-4 mission analyses performed with the models assessed the launch to activation response, identified operational criteria documented in flight rules, and ensured compliance with the mission timeline and no hazards to the crew, orbiter, or ISS.

This presentation provides an overview of the work performed, depicts unique approaches in model development, discusses lessons learned, and issue resolution approaches. Though development and analysis efforts spanned over four years and presented various integration challenges it provided an example of successful collaboration with our International Partners.

Biographies

Miguel Fernando Perez is a Thermal Analyst with 22 years of experience in the Shuttle and ISS programs. He was project lead overseeing the development of the MRM1 cargo element thermal models. He is currently working for

Lockheed Martin in Houston, Texas supporting thermal analyses for the Cargo Mission Contract as well as the Orion program.
Elias Azzi is an Environmental/Thermal Systems Lead Engineer with 20 years of experience in the Shuttle and ISS programs. He was flight lead for STS-132/ULF-4 overseeing the Launch to Activation thermal analyses. He is currently working for Lockheed Martin in Houston, Texas supporting thermal analyses for the Orion program.

Evgeny Menkin is an ISS Program Integration Representative with 22 years of experience in human spaceflight programs for MIR and ISS. He was the principal lead on the project and coordinator between NASA, Lockheed Martin, and RSC-E. He is currently working for Ares Corporation in Houston, Texas supporting the NASA ISS Vehicle Integrated Performance and Resources (VIPER) team.

Timothy B. Davies is a Thermal Analyst with 15 years of experience in the Shuttle and ISS programs. He was the ULF-4 flight lead for NASA ISS PTCS as well as the principal representative for NASA ISS PTCS providing technical oversight and ensuring requirements compliance. He is currently working for NASA JSC in Houston, Texas as system manager for Orion PTCS, and integration and verification of visiting vehicles for ISS PTCS

A-3.1

Session A-3 **Longhorn Room**

EE, Com, GN&C

Session Chair: **Doug Yazell**

9:00 AM

A-3.1 Wireless Power Transmission Roadmap

Garland Bauch

The vision of achieving Wire Power Transmission (WPT) on a global scale was proposed over 100 years ago by Tesla. A WPT tower was constructed on Long Island, NY in the early 1900's and later torn down when funding issues arose with the financial backer J. P. Morgan. In the 1970's, NASA proposed building and launching Solar Power Satellites in earth orbit to transmit power to the earth for energy. This proposal didn't proceed to develop and implementation because the oil crisis at that time ended and the economic payback was not adequate. This presentation will show a roadmap WPT activities and events from 1960 til the present by various country, company, and government entities. Roadmap demonstrations/tests shown will include power transmission to model lunar rovers, airplanes, rockets, airships, space elevators, helicopters, and surface applications. Today, there is renewed interest in WPT for application to in-space travel as well is energy for earth surface energy. Technical and environmental challenges associated with developing and implementing WPT will also be discussed.

A-3.2

Session A-3 **Longhorn Room**

EE, Com, GN&C

Session Chair: **Doug Yazell**

9:30 AM

A-3.2 Ultra-Wideband Tracking System Design for Relative Navigation

Jianjun (David) Ni, Dickey Arndt, Phong Ngo, Kent Dekome, John Dusl

This presentation briefly discusses a design effort for a prototype ultra-wideband (UWB) time-difference-of-arrival (TDOA) tracking system that is currently under development at NASA Johnson Space Center (JSC). The system is being designed for use in localization and navigation of a rover in a GPS deprived environment for surface missions. In one application enabled by the UWB tracking, a robotic vehicle carrying equipments can autonomously follow a crewed rover from work site to work site such that resources can be carried from one landing mission to the next thereby saving up-mass. The UWB Systems Group at JSC has developed a UWB TDOA High Resolution Proximity Tracking System which can achieve sub-inch tracking accuracy of a target within the radius of the tracking baseline [1]. By extending the tracking capability beyond the radius of the tracking baseline, a tracking system is being designed to enable relative navigation between two vehicles for surface missions. A prototype UWB TDOA tracking system has been designed, implemented, tested, and proven feasible for relative navigation of robotic vehicles. Future work includes testing the system with the application code to increase the tracking update rate and evaluating the linear tracking baseline to improve the flexibility of antenna mounting on the following vehicle.

References

[1]. Jianjun (David) Ni, et al; "UWB TDOA Proximity High Resolution Tracking System", IEEE Symposium for Space Applications of Wireless & RFID (SWIRF), Houston, TX, May 2007.

A-3.3

Session A-3 **Longhorn Room**

EE, Com, GN&C

Session Chair: **Doug Yazell**

10:00 AM

A-3.3 Soft-Decision-Data Reshuffle to Mitigate Pulsed Radio Frequency Interference Impact on Low-Density-Parity-Check Code Performance

Jianjun (David) Ni

This presentation briefly discusses a research effort on mitigation techniques of pulsed radio frequency interference (RFI) on a Low-Density-Parity-Check (LDPC) code. This problem is of considerable interest in the context of providing reliable communications to the space vehicle which might suffer severe degradation due to pulsed RFI sources such as large radars. The LDPC code is one of modern forward-error-correction (FEC) codes which have the decoding performance to approach the Shannon Limit. The LDPC code studied here is the AR4JA (2048, 1024) code recommended by the Consultative Committee for Space Data Systems (CCSDS) and it has been chosen for some spacecraft design. Even though this code is designed as a powerful FEC code in the additive white Gaussian noise channel, simulation data and test results show that the performance of this LDPC decoder is severely degraded when exposed to the pulsed RFI specified in the spacecraft's transponder specifications. An analysis work (through modeling and simulation) has been conducted to evaluate the impact of the pulsed RFI and a few implemental techniques have been investigated to mitigate the pulsed RFI impact by reshuffling the soft-decision-data available at the input of the LDPC decoder. The simulation results show that the LDPC decoding performance of codeword error rate (CWER) under pulsed RFI can be improved up to four orders of magnitude through a simple soft-decision-data reshuffle scheme. This study reveals that an error floor of LDPC decoding performance appears around CWER=1E-4 when the proposed technique is applied to mitigate the pulsed RFI impact. The mechanism causing this error floor remains unknown, further investigation is necessary.

A-4

Session A-4 **Lone Star Room**

Systems Engineering

Session Chair: **Tony Williams**

A-4

9:00 AM **INCOSE-1 Pad Abort:** John Saltzman

10:00 AM **INCOSE-2: Project M/Morpheus:** Jennifer Mitchell

B-1.1

Session B-1 **San Jacinto Room**

Astrodynamics

Session Chair: **Dan Adamo**

10:45 AM

B-1.1 A MISSION TEMPLATE FOR EXPLORATION AND MITIGATION OF POTENTIALLY HAZARDOUS NEAR EARTH ASTEROIDS

D.C. Hyland, H. Altwaijry, R. Margulieux, J. Doyle, J. Sandberg, B. Young, X. Bai, B. Kuehner, J. Lopez, A. D. Ravidas, N. Satak, S. Bourgeois, T. Elgohary, Z. Levin, V. Vasiraju, L. McElduff, R. Rangarajan, and S. Ge

The Apophis Exploratory and Mitigation Platform (AEMP) concept was developed as a prototype mission to explore and deflect the Near Earth Asteroid (NEA) 99942 Apophis. Deflection from a potential 2036 impact will be achieved using a gravity tractor technique, while a permanent deflection, eliminating future threats, will be imparted using a novel albedo manipulation technique. This mission would serve as an archetypal template for future missions to small NEAs and could be adapted to mitigate other potential Earth-crossing objects.

During the pre-mitigation exploration phase the spacecraft will maneuver about the asteroid, serve as a platform to study the physical properties of the target object, and refine estimates of the trajectory.

After sufficient models have been formulated, the short term mitigation phase begins by positioning the spacecraft at a standoff near the asteroid. Two Hall thrusters are used to maintain the spacecraft position, imparting a small amount of force on the asteroid through mutual gravitation.

The asteroid Apophis crosses the Earth's orbit every seven years, posing a persistent threat. The short term mitigation technique may prevent Apophis from colliding with Earth in 2036, but future resonant returns should be considered. To continually alter the orbit of Apophis and eliminate the threat of impact, a long term technique is applied. This operates by modifying the albedo of the asteroid, thereby altering the Yarkovsky force. During the post-mitigation investigation, the spacecraft will verify the effects of the two mitigation techniques. Detailed description of the albedo change technique is given in a companion paper.

B-1.2

Session B-1 **San Jacinto Room**

Astrodynamics

Session Chair: **Dan Adamo**

11:15 AM

B-1.2 A PERMANENTLY-ACTING NEA MITIGATION TECHNIQUE VIA THE YARKOVSKY EFFECT

D.C. Hyland, R. Margulieux, J. Doyle, J. Sandberg, B. Young, X. Bai,
B. Kuehner, J. Lopez, A. D. Ravidas, N. Satak, S. Bourgeois, T. Elgohary, Z. Levin,
V. Vasiraju, L. McElduff, R. Rangarajan, and S. Ge

In a companion paper, we describe a mission to launched 2021 that could test a number of mitigation techniques on Asteroid Apophis and ascertain their effectiveness from the orbit perturbations observed in 2036.

The albedo change technique described here is the penultimate phase of the exploration/mitigation mission concept, and relies on thorough scientific exploration in the previous mission phases. To continually alter the orbit of Apophis (or similar NEAs), we propose to alter the NEA albedo to either diminish or enhance the Yarkovsky effect. Detailed calculations show that within reasonable bounds for the absorptivity and mass, and depending upon the spin state, a 5% change in the albedo of Apophis, starting in 2021, and using less than 60 kg of surfacing material, will deflect Apophis by at least 3 Earth radii by 2036.

At present, the albedo change mechanism that appears the simplest involves a device that dispenses, in a controlled fashion, ionized powder onto Apophis' surface – which is itself ionized by ultraviolet radiation. Electrostatic attraction provides the dominant force that will distribute and bind the powder to the surface.

The proposed mitigation technique offers permanently-acting and substantial NEA orbit modification using the simplest technological means. Only equipment on board a single spacecraft is used. There are no complex maneuvers or landing/docking attempts. The spacecraft station-keeps while dispensing the albedo change treatment, as the asteroid rotates under it. The albedo change dispenser itself is entirely passive, with few moving parts, and is based upon a well-known industrial coating technology.

B-1.3

Session B-1 **San Jacinto Room**

Astrodynamics

Session Chair: **Dan Adamo**

11:45 AM

B-1.3 A Review of Proximity Operations for Asteroid Missions

A.A. Jackson, PhD
Lunar and Planetary Institute Chair Astrodynamics AIAA Houston

A literature review is given of studies and papers researching proximity operations about asteroids. Close proximity missions are driven by the small body environment that they will encounter. Once the small body environment has been constrained, there are a number of approaches that can lead to a successful mission. Target bodies must sufficiently characterized prior to mission and spacecraft design, allowing for a clearly delineated set of mission operations approaches. The spacecraft and mission is designed to handle a range of possible situations, out of which most asteroids of the class being visited would fall. The large range of value of an asteroid's physical parameters can have the consequence of unstable and chaotic dynamics of vehicle motion in these force environments. A review of the dynamical environments that can occur at small bodies, their implications for spacecraft control and design, and technological solutions and challenges to the problem of operating in close proximity to these small bodies is presented.

B-2.1

Session B-2 **Coronado Room**

Structural & Mechanical Engineering

Session Chair: **Erica Bruno**

10:45 AM

B-2.1 ISS Microgravity Environment/ Unusual ISS Rate Signature

Michael R. Laible
Boeing, International Space Station, Loads and Dynamics
13100 Space Center Blvd
Houston, TX 77059

The Microgravity performance assessment of the International Space Station (ISS) is comprised of a quasi-steady, structural dynamic and a vibro-acoustic analysis of the ISS assembly-complete vehicle configuration. The Boeing Houston (BHOU) Loads and Dynamics Team is responsible to verify compliance with the ISS System Specification (SSP 41000) and USOS Segment (SSP 41162) microgravity requirements. To verify the ISS environment, a series of accelerometers are on-board to monitor the current environment.

This paper summarizes the results of the analysis that was performed for the Verification Analysis Cycle (VAC)-Assembly Complete (AC) and compares it to on-orbit acceleration values currently being reported. The analysis will include the predicted maximum and average environment on-board ISS during multiple activity scenarios.

On November 23, 2011 International Space Station Guidance, Navigation, and Control reported unusual pitch rate disturbance. These disturbances were an order of magnitude greater than nominal rates. The Loads and Dynamics team was asked to review and analyze current accelerometer data to investigate this disturbance.

This paper will cover the investigation process under taken by the Loads and Dynamics group. It will detail the accelerometers used and analysis performed. The analysis included performing Frequency Fourier Transform of the data to identify the mode of interest. This frequency data is then reviewed with modal analysis of the ISS system model. Once this analysis is complete and the disturbance quantified, a forcing function was produced to replicate the disturbance. This allows the Loads and Dynamics team toreport the load limit values for the 100’s of interfaces on the ISS.

B-2.2

Session B-2 **Coronado Room**

Structural & Mechanical Engineering

Session Chair: **Erica Bruno**

11:15 AM

B-2.2 A Comparison of Dual Wall Ballistic Limit Predictions for Spherical and Ellipsoidal Shapes

J . L. Foster, Jr., Ph.D., LZ Technology, Houston Texas

Explosions of and collisions among man-made satellites have produced a large secondary debris population ranging in size from sub millimeter to meters in radar cross section. The small particle component of this secondary population now poses the largest single threat to operating space vehicles. The NASA orbital debris flux model ORDEM2000 is used to estimate small debris risk. Protection against small debris is typically done with standoff or bumper shields. To date, risk calculations have assumed spherical debris and that a spherical shape will provide a valid estimate of risk. Recent articles suggest that this sphericity assumption is overly conservative. Based on an analysis of SOCIT4 test data, orbital debris up to perhaps 2 mm in size is indeed essentially spherical. With increasing size the orbital debris population becomes less spherical and, initially, it is more penetrating than spheres. When a size of about 5 mm is exceeded, debris is less penetrating than spheres. Failure to design shields with this behavior in mind can result in total risk several times that predicted for spherical projectiles. This preliminary work was carried out with the computer code FATEPEN 3.3.10 which has been calibrated for higher velocities against the shock physics code CTH. Use of CTH does not eliminate the need for hypervelocity impact tests with non-spherical projectiles to provide an experimental basis for FATEPEN at higher velocities.

B-2.3

Session B-2 **Coronado Room**

Structural & Mechanical Engineering

Session Chair: **Erica Bruno**

11:45 AM

B-2.3 Overview of the NASA Docking System (NDS) and the International Docking System Standard (IDSS)

George Parma

The NASA/JSC Engineering Directorate has been developing the technology for a Low Impact Docking System (LIDS) for many years. LIDS had been chosen to be the Constellation Program baseline. In February 2009, the International Space Station (ISS) Multilateral control Board (MCB) began an initiative to develop an International Docking System Standard (IDSS) to facilitate greater international cooperation in space and enable emergency crew rescue missions. Discussions as to whether the LIDS could be made compatible with the IDSS were under way.

With the cancellation of the Constellation Program, NASA made a policy decision to convert both of the docking ports on the United States On-orbit Segment (USOS) to IDSS ports and NASA moved the LIDS project under the ISS Program. LIDS was redesigned to become the NASA implementation of the emerging IDSS, and its name was changed to the NASA Docking System (NDS). The NDS design will be certified as a "black box" which can be integrated onto vehicles planning to dock to the ISS IDSS ports.

This presentation will discuss the evolution of the IDSS from both the LIDS and the Androgynous Peripheral Assembly System (APAS) and outline the interface requirements which are given in the IDSS Interface Definition Document (IDD). It also will give an overview of the current NDS design, and touch on ISS plans for converting its docking ports to be IDSS compliant.

The IDSS can be found at http://www.internationaldockingstandard.com, and information on the NDS at http://dockingstandard.jsc.nasa.gov.

B-3.1

Session B-3 Longhorn Room

EE, Com, GN&C

Session Chair: **Ellen Gillespie**

10:45 AM

B-3.1 CONFIGURING THE ORION GUIDANCE, NAVIGATION, AND CONTROL FLIGHT SOFTWARE FOR AUTOMATED SEQUENCING

RYAN ODEGARD

The Orion Crew Exploration Vehicle is being designed with greater automation capabilities than any other crewed spacecraft in NASA's history. The Guidance, Navigation, and Control (GN&C) flight software architecture is designed to provide a flexible and evolvable framework that accommodates increasing levels of automation over time. Within the GN&C flight software, a data-driven approach is used to configure the software. This approach allows data reconfiguration and updates to automated sequences without requiring recompilation of the software. Because of the great dependency of the automation and the flight software on the configuration data, the data management is a vital component of the processes for software certification, mission design, and flight operations.

To enable the automated sequencing and data configuration of the GN&C subsystem on Orion, a desktop database configuration tool has been developed. The database tool allows the specification of the GN&C activity sequences, the automated transitions in the software, and the corresponding parameter reconfigurations. These aspects of the GN&C automation on Orion are all coordinated via data management, and the database tool provides the ability to test the automation capabilities during the development of the GN&C software. In addition to providing the infrastructure to manage the GN&C automation, the database tool has been designed with capabilities to import and export artifacts for simulation analysis and documentation purposes. Furthermore, the database configuration tool, currently used to manage simulation data, is envisioned to evolve into a mission planning tool for generating and testing GN&C software sequences and configurations. A key enabler of the GN&C automation design, the database tool allows both the creation and maintenance of the data artifacts, as well as serving the critical role of helping to manage, visualize, and understand the data-driven parameters both during software development and throughout the life of the Orion project.

B-3.2

Session B-3 **Longhorn Room**

EE, Com, GN&C

Session Chair: **Ellen Gillespie**

11:15 AM

B-3.2 A New Approach to GN&C Mission Design and Analysis

When assessing the overall performance of a guidance, navigation, and control (GN&C) system, key parameters such as trajectory dispersions, navigation errors, fuel consumption, and timing of critical mission events are evaluated and analyzed. Traditionally, these performance metrics are obtained by doing hundreds or even thousands of Monte Carlo runs. Due to the complexity and the nonlinear transformations required, Monte Carlo techniques are often viewed as the only practical option. Maybeck introduced an alternative approach to Monte Carlo analysis known as linear covariance analysis (LinCov) or covariance analysis [1].

With linear covariance analysis, the same statistical information for a closed-loop GN&C system can be produced with a single simulation run. For this reason, the LinCov tool is ideal for top-level analysis because it produces Monte Carlo like results in a fraction of the time. Although linear models are ultimately required to calculate the statistical properties of the system, linear covariance analysis has a wide range of applications to non-linear systems including orbital rendezvous [2], cis-lunar [3], interplanetary missions [4], powered descent [5], and powered ascent [6].

Despite the different strengths and weakness of both analysis techniques, together these methods provide a powerful GN&C mission design and analysis tool. This presentation will show how this combined tool can be used for orbital rendezvous, lunar ascent, and lunar descent missions along with quantifying the accuracy of linear covariance analysis to its corresponding Monte Carlo results.

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B-3.3

Session B-3 **Longhorn Room**

EE, Com, GN&C

Session Chair: **Ellen Gillespie**

11:45 AM

B-3.3 Designing and Validating Proximity Operations Rendezvous and Approach Trajectories for the Cygnus Mission

Renato Zanetti
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In 2011, the Orbital Sciences Corporation Cygnus vehicle, developed to provide cargo services to the International Space Station (ISS), will conduct its first autonomous rendezvous with the ISS. The Cygnus vehicle is developed by Orbital Sciences Corporation with subcontracted support for key elements from Draper Laboratory, and Odyssey Space Research. Safety has been an integral part of the design of trajectories, sensors, reaction control system, and GN&C algorithms. This paper describes the approach used to design and validate safe trajectories for the Cygnus vehicle.

B-4

Session B-4 **Lone Star Room**

Systems Engineering

Session Chair: **Tony Williams**

B-4

11:00 AM INCOSE-3 Constellation SE&I: Joe Caram

C-1.1

Session C-1 **San Jacinto Room**

Flight Sciences

Session Chair: **Sarah Shull**

1:45 PM

C-1.1 Orion Flight Dynamics Design Trades

Mark Jackson

A significant portion of the Orion pre-PDR design effort has focused on balancing mass with performance. High level performance metrics include abort success rates, lunar surface coverage, landing accuracy and touchdown loads. These metrics may be converted to parameters that affect mass, such as ballast for stabilizing the abort vehicle, propellant to achieve increased lunar coverage or extended missions, or ballast to increase the lift-to-drag ratio to improve entry and landing performance. The Orion Flight Dynamics team was tasked to perform analyses to evaluate many of these trades. These analyses not only provide insight into the physics of each particular trade but, in aggregate, they illustrate the processes used by Orion to balance performance and mass margins, and thereby make design decisions. Lessons learned can be gleaned from a review of these studies which will be useful to other spacecraft system designers. These lessons fall into several categories, including: appropriate application of Monte Carlo analysis in design trades, managing margin in a highly mass-constrained environment, and the use of requirements to balance margin between subsystems and components. This paper provides a review of some of the trades and analyses conducted by the Flight Dynamics team, as well as systems engineering lessons learned.

C-1.2

Session C-1 **San Jacinto Room**

Flight Sciences

Session Chair: **Sarah Shull**

2:15 PM

C-1.2 FASTRAC Satellites in Orbit

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The FASTRAC (Formation Autonomy Spacecraft with Thrust, Relnav, Attitude and Crosslink) satellites, "Sara Lily" and "Emma", built by students from The University of Texas at Austin were launched on board a Minotaur IV rocket on November 19, 2010 from Kodiak, Al. Their main purpose is to demonstrate enabling technologies for small satellites. A brief history of the FASTRAC program as well as the mission's concept of operations will be showcased. The experience of launching and operating the satellites by a group of over 150 graduate and undergraduate students over 8 years and some preliminary flight results from the mission will be presented. The initiatives to engage the amateur radio community and how they have helped the team track and operate the satellites during its primary mission will also be discussed.

C-1.3

Session C-1 **San Jacinto Room**

Flight Sciences

Session Chair: **Sarah Shull**

2:45 PM

C-1.3 On Using High Lift-to-Drag Ratio Waveriders for Missions in the Martian Atmosphere

Dr. Patrick E. Rodi1
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An exploratory study has been performed on applying modern, high lift-to-drag ratio waveriders to a number of missions in and through the atmosphere of Mars. Earlier studies have usually employed older, generally conical-based, waverider design approaches. The recent Osculating Flowfield Waverider Method can generate vehicles with significantly greater aerodynamic performance than those from earlier methods. This improved waverider performance has meaningful impacts on mission within the atmosphere of Mars. The study begins with a review of the fundamentals of Martian atmospheric missions including: 1) the effects of the CO2-dominated atmosphere on aerodynamics, 2) the general thinnest of the atmosphere and its effects on lift generation, 3) the low surface gravity, which reduces the lift required to maintain a given altitude, and 4) the presence that the solar system's largest mountain, Olympus Mons, has on mission planning. A variety of missions have been examined and the range increased quantified. The greater lift-to-drag ratio available from modern waveriders is a significant enhancer for all the missions examined.

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C-2.1

Session C-2 **Coronado Room**

Flight Hardware Systems

Session Chair: **Gary Brown**

1:45 PM

C-2.1 Student-Built Reconnaissance Unmanned Aircraft System

Michael Szmuk
Jonathan Tamir
Vishnu Jyothindran

The UT UAV Group's Phoenix II Unmanned Aircraft System was designed and built by an interdisciplinary group of undergraduate and graduate students at the University of Texas at Austin. Motivated by the annual international AUVSI Student UAS competition, the system was designed to complete a low altitude Intelligence, Surveillance, and Reconnaissance (ISR) mission. To capitalize on this academic opportunity, the UT UAV Group elected to design and build an in-house airframe, automatic flight control system (AFCS), target acquisition system, and ground control station (GCS).

The AFCS uses an embedded single board computer to run a multi-threaded autopilot software, written in C, on a hard real time operating system. An Extended Kalman Filter is used to incorporate GPS, IMU, and air data measurements in forming the navigation solution. The AFCS is capable of mid-air re-tasking to accommodate a multitude of real world operational scenarios. To accomplish the ISR mission objectives, Phoenix II includes an award-winning, custom designed target acquisition system, which provides the capability to autonomously detect polygonal targets in real time. The system uses an optical camera mounted on a stabilized dualaxis gimbal to survey a search area. The video is analyzed using a statistical target detection method, and target features, such as location, shape, and color, are recorded.

Lastly, the GCS provides situational awareness and mission planning capabilities. Implemented in LabVIEW, the GCS requires only two operators. To reduce operator workload, it controls an automated tracking antenna to maintain contact with the aircraft, and facilitates target acquisition and database management.

C-2.2

Session C-2 **Coronado Room**

Flight Hardware Systems

Session Chair: **Gary Brown**

2:15 PM

C-2.2 Method for Detection and Confirmation of Multiple Failure Modes with Numerous Survivor Data

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Aerospace systems often exhibit multiple failure modes. When using commercially available reliability tools, multiple failure modes may be suggested by a *bent* regression line. Subsequent analyses segregate the data into sets to be processed separately. This segregation process raises a number of questions, especially for survivor data. The US Coast Guard HU-25 aircraft encountered such a problem. A mixture model was used with a conditional inferential approach that detected and confirmed multiple failure modes for the HU-25, without any failure and survivor data segregation. This method may be used to reliably detect multiple failure modes for any aerospace system.

C-2.3

Session C-2 **Coronado Room**

Flight Hardware Systems

Session Chair: **Gary Brown**

2:45 PM

C-2.3 Method for Investigating Repair/Refurbishment Effectiveness

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Aerospace systems that fail in service are often repaired and returned to service. Repair/refurbishment may affect future reliability, degrade or improve it. Preventative and corrective maintenance planning cost and operational effectiveness may be improved with knowledge of future reliability post repair. The US Navy F/A-18 engine was regularly repaired and returned service. This report presents a method using a novel covariate Weibull model and a conditional inferential approach to determine the F/A-18 engine reliability state post repair. This method may be used for any system that is repaired and returned to service to enhance maintenance planning cost and operational effectiveness.

C-3.1

Session C-3 **Longhorn Room**

Exploration Concepts

Session Chair: **Matt Johnson**

1:45 PM

C-3.1 Return to the Apollo Sites: Preserving Heritage and Scientific Value of the Apollo Sites for Spacecraft Visits Beginning in 2013

NASA/JSC/Rob Kelso

Several countries and private organizations have expressed plans or goals of robotic lunar surface exploration of the Moon during this decade. Various nations/space agencies to include China, Japan, Russia, India, ESA and others have expressed such intent and interest.
In the private sector realm, the X Prize Foundation and Google have jointly offered $20 million (termed the *Google Lunar X Prize*) to the first team that can land a privately financed spacecraft on the Moon before December 31, 2013; to include an additional $5 million incentive to image directly human-made artifacts, such as Apollo Program hardware, on the lunar surface.

Sites of U.S. hardware on the lunar surface may be viewed as unique ongoing experiments in biology, planetary science, space weathering, and other fields with direct relevance to NASA's long-term plans for exploration, lunar development and scientific study. It is possible that valuable, irreproducible data exist at certain prior landing sites. For this reason, steps are being taken to ensure that these data are not inadvertently compromised or destroyed during the course of future activities on the Moon. Thus, NASA is developing a white paper to document recommendations toward protecting these sites relative to lander visits expected to begin in 2013.

These recommendations cover three main areas:

1. Descent/landing
2. Mobility
3. Contamination

C-3.2

Session C-3 **Longhorn Room**

Exploration Concepts

Session Chair: **Matt Johnson**

2:15 PM

C-3.2 Emerging Commercial Space New Markets as a Function of Altitude Regimes

NASA/JSC/Rob Kelso
JMSA/Mike Smith

NewSpace, E*ntrepreneurial space*, C*ommercial space* and other labels have been used to describe approaches to space development that differ significantly from that taken by NASA and the mainstream aerospace industry. This paper presents the basis for the emerging NewSpace industry by the markets they are choosing to serve.

Commercial space development is nothing new. From the beginning of the Space Age we have seen the creation and steady growth of a vibrant private space industry based on the development of commercial communications satellites. The first government comsats were launched in the 1960s and by the 1970s commercial comsats and the businesses that they enabled, such as low cost long distance telephone calls and the distribution of television programming to cable TV companies had created a commercial space industry valued in the tens of billions of dollars.

However, *Human spaceflight* related businesses, have been slow to develop. The high cost of both the access to space and for space based operations, has severely retarded the development of such a commercial human space flight industry. Recently, NewSpace companies have emerged that make the cost problem their main focus and attack it and are doing things very differently from the way NASA and the conventional aerospace companies have pursued space systems development.

This presentation highlights an insightful look at the increasing interest from the commercial space sector in establishing commercially-sourced services and commodities across a range of altitudes: from sub-orbital research, to low earth orbit, GEO, lunar and yes…even near-earth objects (NEOs). These business propositions and emerging sectors are becoming of increasing interest to NASA in meeting their mission objectives.

C-3.3

Session C-3 **Longhorn Room**

Exploration Concepts

Session Chair: **Matt Johnson**

2:45 PM

C-3.3 Towards an embedded Suggestion Collection and Modular Assembly System for Space Commercialization: Research in Progress

Alex Monchak
Ipek Bozkurt

In the context of strategic management of technological innovation, this research addresses the trend of companies attempting to commercialize the technology demonstrated during recent mission and prior lunar landings. The context shall be called Individual Space Commerce. The present aerospace industry process, for interacting with individuals in the public, is education and outreach to individuals in the public. An embedded suggestion collection and modular assembly system approach is a novel way to collect individual demand for the purpose of achieving society engagement. This project hopes to innovatively contribute to the transition to Individual Space Commerce. The embedded nature of the system enables putting (embedding) the suggestion system inside a space commercialization application. The embedded suggestion system contributes to the transition to individual space commerce by providing (1) an embedded suggestion collection and assembly system concept, (2) the contents of the suggestion system which are the suggestions and (3) the theoretical basis for intrinsic suggestion collection. Also, contributions include the mission, philosophy and tagline. The mission is to capture suggestions intrinsically and improve public engagement in space commercialization. The philosophy is “You suggest, we deliver opportunities to engage.” The tagline is “Your Suggestions, Your Choice.” One of the fundamental aspects of the suggestion collection strategy is the intrinsic motivation theoretical foundation. Intrinsic and extrinsic modes within the suggestion collection systems may be desirable to accommodate the various suggestion expectations of individuals. Overall, the suggestion collection system concept is locally leveraged and globally linked and the contributions are supported by motivation theories.

C-4

Session C-4 **Lone Star Room**

Systems Engineering

Session Chair: **Tony Williams**

C-4

1:45 PM **INCOSE-3 Panel Discussion –** Common and Contrasting Themes in the Lessons Learned

D-1.1

Session D-1 **San Jacinto Room**

Propulsion

Session Chair: **Sheikh Ahsan**

3:30 PM

D-1.1 Wall pressure unsteadiness and side loads in over-expanded rocket nozzles

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Surveys of both the static and dynamic wall pressure signatures on the interior surface of a sub-scale, cold-flow and thrust optimized parabolic nozzle are conducted during fixed nozzle pressure ratios corresponding to FSS and RSS states. The motive is to develop a better understanding for the sources of off-axis loads during the transient start-up of over-expanded rocket nozzles. During FSS state, pressure spectra reveal frequency content resembling SWTBLI. Presumably, when the internal flow is in RSS state, separation bubbles are trapped by shocks and expansion waves; interactions between the separated flow regions and the waves produce asymmetric pressure distributions. An analysis of the azimuthal modes reveals how the breathing mode encompasses most of the resolved energy and that the side load inducing mode is coherent with the response moment measured by strain gauges mounted upstream of the nozzle on a flexible tube. Finally, the unsteady pressure is locally more energetic during RSS, albeit direct measurements of the response moments indicate higher side load activity when in FSS state. It is postulated that these discrepancies are attributed to cancellation effects between annular separation bubbles.

D-1.2

Session D-1 **San Jacinto Room**

Propulsion

Session Chair: **Sheikh Ahsan**

4:00 PM

D-1.2 Adaptive Filtering for Reusable Rocket Engine Behaviors

By Rube Williams

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Fault-tolerance and damage mitigation capabilities in reusable rocket engines are paramount for their success in a commercial industry. Ideally such behavior requires that component parts and processes are substantially overdesigned or have inherent passively safe modes. Concerning regulated behaviors, sophisticated estimation processes are required to assist controllers that have to deal with unknown and unmeasured behaviors. A practical algorithm is proposed for the fast real-time estimation of state behaviors in highly nonlinear dynamic systems. The state equations are constructively approximated using recurrent neural networks. The proposed algorithm makes minimal assumptions regarding the underlying nonlinear system dynamics and their noise statistics. The filter is demonstrated by estimating the high-pressure turbine discharge temperatures of the space shuttle main engine, during turbo pump failures modes. The filter is developed using simulated space shuttle main engine data, and its performance is tested on both simulated and actual recorded space shuttle main engine transients.

D-2.1

Session D-2 **Coronado Room**

Technologies

Session Chair: **Zafar Taqvi**

3:30 PM

D-2.1 The Future of Extravehicular Activity Technology Development

Cinda Chullen[1] and David T. Westheimer[2]

NASA Johnson Space Center, Houston, TX, 77058

Extravehicular activities (EVAs) have been critical to the success of Gemini, Apollo, Skylab, Space Shuttle, and the International Space Station (ISS) programs. Now with the ISS extension to 2020 or beyond[1] in conjunction with a current forecasted need of at least eight EVAs per year, the EVA technology life and limited availability of the Extravehicular Mobility Units (EMUs)[2] will become a critical issue eventually. The current EMU has performed critical operations to assemble the ISS and repair satellites. As the life of ISS and the vision for future mission opportunities are realized, a new EVA system capability will be necessary for the future mission applications including Near Earth Objects, Phobos, or future surface missions. These mission opportunities will demand efficient and reliable EVA technologies, particularly regenerable technologies. The latest NASA EVA system development goals have been to reduce system mass, reduce consumables and maintenance, increase EVA hardware robustness and life, increase crew member efficiency and autonomy, and enable rapid vehicle egress and ingress.[3] The goal for the future will be to further develop technologies that will be used to demonstrate a robust EVA system that has application for a variety of future missions including microgravity and surface EVA which is currently being planned though a new program focused on Advanced Exploration Systems and via the new Office of Chief Technologist (OCT). With these new programs and approaches, it will be important to partner with the commercial industry, academia, and other government entities to facilitate the EVA development of these future spacesuit technologies and demonstrations.

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D-2.2

Session D-2 **Coronado Room**

Technologies

Session Chair: **Zafar Taqvi**

4:00 PM

D-2.2 Plasma Physics Applications for Aerospace Technology

Alfonso G. Tarditi,
Physics Department, University of Houston-Clear Lake, Houston, TX

As NASA is re-aligning its objectives towards a longer term and longer range exploration in space (extended life of the ISS, missions far from low-Earth orbit), new technologies are required to address the main challenges of future space flight, to allow faster, more efficient payload transfers and safe, longer presence in space.

Plasma science, while traditionally driven largely by fusion energy research, is increasingly becoming a key element in providing answers to these critical challenges with new technology application for aerospace. Examples are electromagnetic-augmented heavy-lift propulsion, plasma-assisted combustion, in-flight lightning effects protection, micrometeorites and orbital debris and space radiation countermeasures, space weather forecasting, electric space propulsion, plasma actuators and magnetohydrodynamic steering for hypersonic atmospheric flight.

This talk will present a review of these technologies with the emphasis on near-term, low-cost developments that could foster a stronger collaboration between UHCL and the NASA Johnson Space Center.

D-3.1

Session D-3 **Longhorn Room**

Exploration Concepts

Session Chair: **Satya Pilla**

3:30 PM

D-3.1 Culture Change in the Mission Control Center: Safe Flight Control without Paper Procedures

Michael T. Hurt and Lisa P. Payne

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This presentation describes the innovative approach the Flight Procedures organization implemented to generate a culture change in the International Space Station flight control community. This has been an ongoing NASA project to save money and increase efficiency by utilizing electronic presentation of operating procedures in the ISS Mission Control Center. Budget reductions are ever-present, and NASA managers calculated approximately one million dollars per year could be saved by eliminating the production and maintenance of numerous large books of procedures (over 4500 procedures spanning 25 different books with multiple copies of each book). A three pronged approach was utilized to reassure flight controllers that the ISS vehicle could be safely and efficiently operated without the use of hardcopy procedures. First, each flight control organization was surveyed for concerns with the elimination of paper. Those concerns were individually addressed, and their resolution was accepted by the initiator. Second, benchmarking activities were conducted by visiting other control centers that currently use electronic procedures exclusively for their operations. Third, a specific book was chosen as a prototype to demonstrate the advantages of electronic distribution, efficient turnaround of approved changes, and to uncover unforeseen challenges with hardcopy elimination. This methodical approach resulted in flight control organizations realizing the advantages of electronic publications and their desire to convert their books earlier than the established plan. The overall hardcopy reduction project is ahead of schedule, the NASA customer is pleased, and our stakeholders are realizing the benefits of changing the way they do business.

D-3.2

Session D-3 **Longhorn Room**

Exploration Concepts

Session Chair: **Satya Pilla**

4:00 PM

D-3.2 Work Product Assessment Concept

Melanie Weisman, ManTech International

The "Work Product Assessment" concept is a means by which future Projects/Programs can establish a process for engineers to submit their various work products for internal assessment by a team of subject matter experts/SMEs. Approval is based on whether or not the individual work product meets defined standards. For those work products falling short of the standards, feedback (in the form of an Action Plan) from the SME team will enable the engineers to improve the work product until it is acceptable. Once the work product meets the standards for approval, the work product becomes a formal "deliverable" as part of a contractor's agreement with the customer.

This concept can work for any size centralized or de-centralized Program/Project that has access to a collaborative on-line application where standards are posted and ideal examples are shown providing guidance to the engineer. Draft work products can be posted and assessed until approval is granted.

Example rating scales - a descriptive scale and a checklist - used to assess the "readiness" of the work product are described. Also discussed are suggested metrics for evaluating the success of the concept should it be developed into a pilot test.

The underlying benefits of this concept are: setting explicit standards, making the standards visible to all affected engineers and, providing expert opinion on the quality of the work product before it becomes a formal deliverable.

D-4

Session D-4 **Lone Star Room**

Space Journalism

Session Chair: **Doug Yazell**

D-4

3:15 PM **Panel Discussion –** Space Journalism