# American Institute of Aeronautics and Astronautics
# Houston Section
## Presents

# Annual Technical Symposium 2015

**NASA/JSC Gilruth Center**
**Houston, Texas**
**Friday, June 5, 2015**

# PROGRAM

**General Chair**

Justine Wiles

**Organizing Committee**

Irene Chan
Michael Frostad
Ted Kenny
Michael Martin
Laura Sarmiento
BeBe Kelly-Serrato
Douglas Yazell
Technical Committee Chairs

# CONTENTS

# THANKS TO OUR 2015 CORPORATE SPONSORS

AIAA Houston Section
Since 1962

JACOBS®

# PROGRAM SUMMARY

| | | |
|---|---|---|
| **7:45 AM – 3:30 PM** | **Registration Desk on First Floor** | **Alamo Ballroom** |
| **8:00 AM – 8:45 AM** | ***Welcome and Networking*** | **Alamo Ballroom** |
| **Session A**<br>8:45 AM – 10:00 AM | 1. Structural Mechanics<br>2. Climate Change Science & Public Policy<br>3. Space Commercialization<br>4. Poster Session | Discovery<br>Lone Star<br>Longhorn<br>Rio Grande |
| **Session B**<br>10:15 AM – 11:30 AM | 1. GN&C<br>2. Climate Change Science<br>3. Space Exploration<br>4. Poster Session | Discovery<br>Lone Star<br>Longhorn<br>Rio Grande |

| | | |
|---|---|---|
| **11:30 NOON – 1:30 PM** | **Lunch** | **Alamo Ballroom** |

| | | |
|---|---|---|
| **11:45 PM – 1:30 PM** | ***Human Exploration Research Analog (HERA) Panel Speakers*: Jason Schneiderman, Brandon Vessey, Ethan Good, Ricky Jedrey and Captain Linda Roehrborn**<br>**Facilitator: BeBe Kelly-Serrato** | **Alamo Ballroom** |
| **Session C**<br>1:45 PM – 3:00 PM | 1. Systems Engineering<br>2. Other<br>3. Astrodynamics/Automation<br>4. University of Houston AIAA Students | Discovery<br>Lone Star<br>Longhorn<br>Rio Grande |

# Morning Program – Session A

| 8:00 – 8:45 | Welcome and Networking | | | |
|---|---|---|---|---|
| | **Discovery (1)** | **Lone Star (2)** | **Longhorn (3)** | **Rio Grande (4)** |
| | **Session A-1: Theme – Structural Mechanics** | **Session A-2: Theme – Climate Change Science & Public Policy** | **Session A-3: Theme – Space Commercialization** | **Poster Session** |
| 8:45 - 9:20 | **A-1.1** ISS ULF-7Stage Correlation Analysis **Michael R Laible** | **A-2.1** Climate Change & Local Responses **Douglas Yazell and Michael Frostad** | **A-3.1** Commercial Space Freighters **Don A. Nelson** | |
| 9:25 - 10:00 | **A-1.2** The Ultimate Factor of Safety for Aircraft and Spacecraft – Its History, Applications and Misconceptions **John J. Zipay** | **A-2.2** The Mars Imperative for Species Survival and Inspiration of a Globalized Culture **Donald C. Barker** | **A-3.2** Advent Launch Services **James Akkerman** | |
| 10:00 – 10:15 | 15 Minute Break | | | |

# Morning Program – Session B

| | Discovery (1) | Lone Star (2) | Longhorn (3) | Rio Grande (4) |
|---|---|---|---|---|
| | **Session B-1: Theme – GN&C** | **Session B-2: Theme – Climate Change Science** | **Session B-3: Theme – Space Exploration** | **Poster Session** |
| **10:15 – 10:50** | **B-1.1** Enhanced Computation of the State Transition Matrix for Perturbed Orbital Motion Using Modified Chebyshev Picard Iteration **Julie L. Read** | **B-2.1** Climate Change for Engineers **Harold H. Doiron** | **B-3.1** The Cascade Distillation System **Julia Worrell** | |
| **10:55 – 11:30** | **B-1.2** Empirical State Error Covariance Matrix for Batch Estimation **Joseph (Joe) H. Frisbee, Jr.** | | **B-3.2** Overview of Orion EFT-1 Flight **David Dannemiller** | |
| **11:30 - 1:30** | ***Lunch Key Note Human Exploration Research Analog (HERA) Panel Speakers:*** **Jason Schneiderman, Brandon Vessey, Ethan Good, Ricky Jedrey and Captain Linda Roehrborn Facilitator: BeBe Kelly-Serrato** | | | |

# Afternoon program – Session C

| | Discovery (1) | Lone Star (2) | Longhorn (3) | Rio Grande (4) |
|---|---|---|---|---|
| | **Session C-1: Theme – Systems Engineering** | **Session C-2: Theme – Other** | **Session C-3: Theme – Astrodynamics/Automation** | **Session C-4: Theme – University of Houston AIAA Student Speakers** |
| **1:45 - 2:20** | **C-1.1** Open Innovation in Space Systems Engineering **James E. Johnson and Steven N. Rader** | **C-2.1** The Waverider Racing League **Dr. Patrick E. Rodi and George "Jeff" Bennett** | **C-3.1** Traversable Wormholes and Interstellar Travel **Dr. Albert A Jackson** | **C-4.1** Capturing the Auroral Soundscape **Sikender Shahid and Rachel Gamblin**<br><br>**C-4.2** Calculating Total Electron Content in Fairbanks, AK **Arian Ehteshami and Hamza Ahmad** |
| **2:25 - 3:00** | | **C-2.2** An Improved Approach to Optimize Neural Network Activation Functions for Increased Accuracy **Dr. Patrick E. Rodi** | **C-3.2** Autonomous Fault Protection for Solar Probe Plus **Justin Thomas** | **C-4.3** Balloon Measurements of Atmospheric Electric Fields during Aurorae **Chris Bias** |

# SYMPOSIUM LOCATION

The American Institute of Aeronautics and Astronautics (AIAA), Houston Section, welcomes you to the 2015 Annual Technical Symposium at NASA/JSC Gilruth Center on June 5, 2015.

Enter Gilruth Center using JSC Public Access on Space Center Boulevard if you do not have a JSC badge. The morning and afternoon technical presentations are in the Lone Star and Longhorn rooms on the second floor, and the Discovery Room on the first floor. The technical posters will be located in the Rio Grande room for the duration of the day. The morning keynote speech and the luncheon are on the first floor in the Alamo Ballroom.

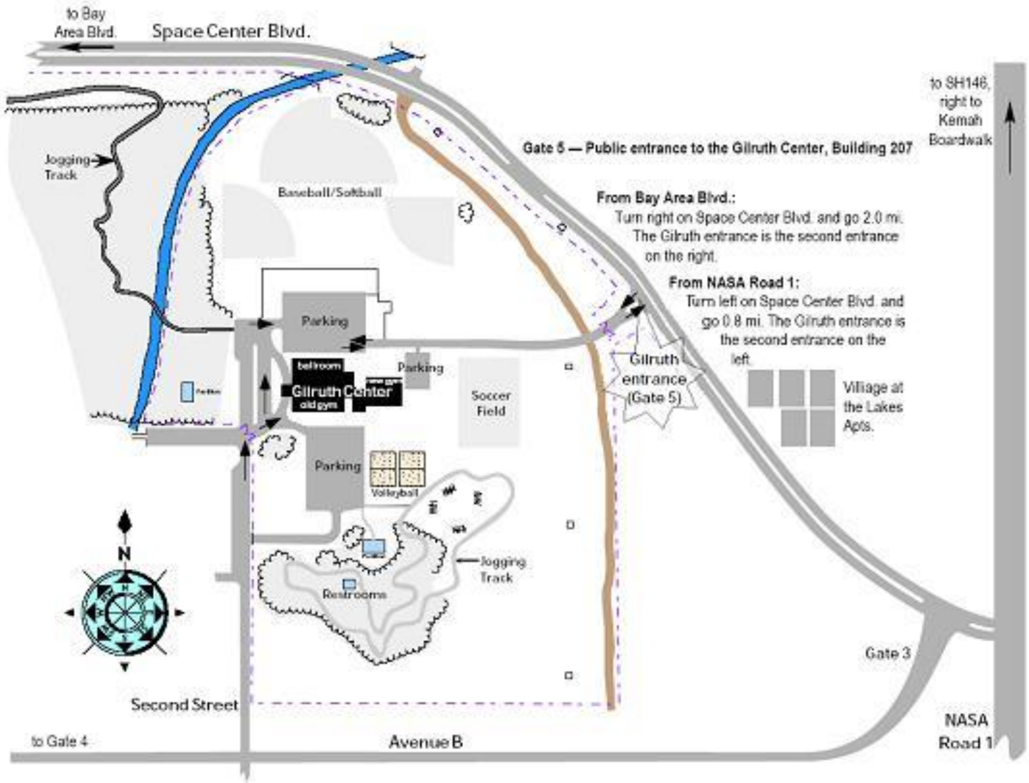


**Figure 1. JSC Gate 5 Public Entrance Map**

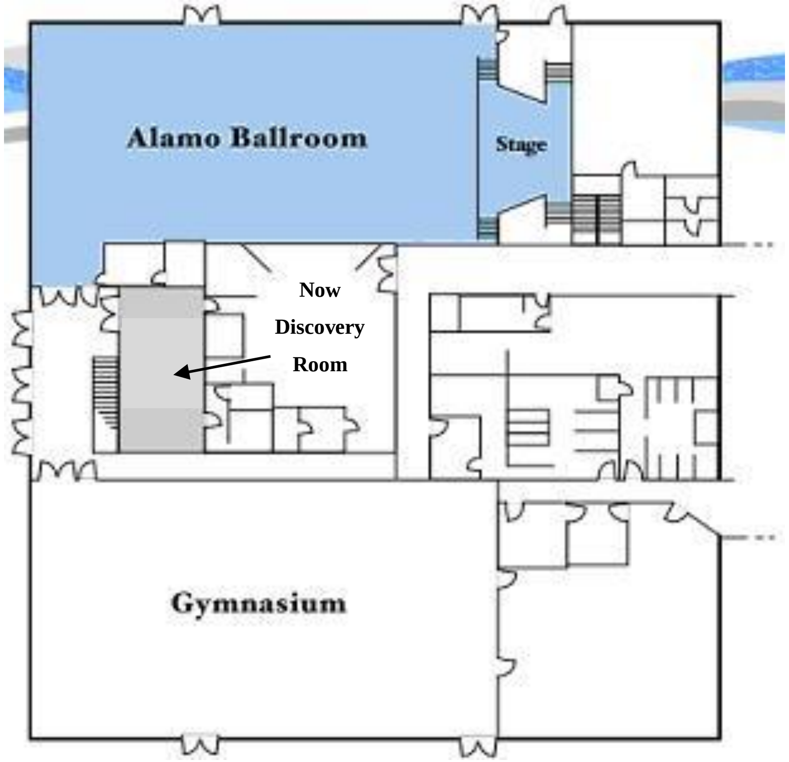


**Figure 2. Gilruth Center First Floor**

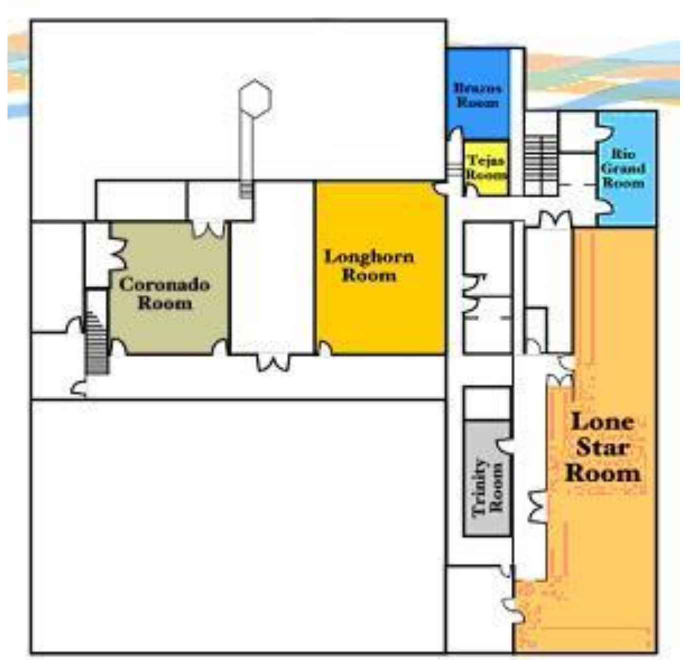


**Figure 3. Gilruth Center Second Floor**

# SYMPOSIUM INFORMATION

## REGISTRATION

Registration is $20 AIAA Student Members, $15 for AIAA Members, and $25 for non-members. All registrations include a light breakfast and lunch for all attendees and is open all day beginning at 7:45 AM. Advance reservations are recommended but not required. Advance registration is easy to do on the web at www.aiaahouston.org. The registration desk is located in the hallway leading to the Alamo Ballroom. Registration is paid online. There is no additional fee for the buffet lunch – the cost is included in the registration fee.

## Special Events

**Morning, 8:00-8:45 AM, Alamo Ballroom**

Welcome and Networking

*Complimentary coffee, bottled water, assorted juices, and breakfast food provided*

---

**Lunch, 11:30–1:30 PM, Alamo Ballroom**

Human Exploration Research Analog (HERA) Panel Speakers

*Lunch buffet*
*Complimentary coffee, bottled water, Iced Tea*

# TECHNICAL PROGRAM

## TECHNICAL SESSIONS

Three sessions will run in parallel in the morning and afternoon. Morning sessions start at 8:45 AM and end by 11:30 AM. Lunch program begins at 11:30 AM and lasts for about two hours. Afternoon sessions start at 1:45 PM and end by 3:00 PM.

The sessions are held in one meeting room on the first floor and three meeting rooms on the second floor of the Gilruth Center.

## PRESENTATIONS

Each presentation is allocated 35 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 supplied by the Session Chair.

# Structural Mechanics

**8:45 AM**

## A-1.1 ISS ULF-7 Stage Correlation Analysis

**Michael R. Laible**

This report summarizes the on-orbit structural dynamic data and the related modal analysis, model validation and correlation performed for the ISS configuration ISS Stage ULF7 (DTF D2-December 2012, and D4-June 2014). The objective of this analysis is to validate and correlate analytical models used to verify the ISS critical interface dynamic loads.

During the ISS configurations under consideration, on-orbit dynamic measurements were collected using the three main ISS instrumentation systems; Internal Wireless Instrumentation System (IWIS), External Wireless Instrumentation System (EWIS), Space Acceleration Measurement System (SAMS) and the Structural Dynamic Measurement System (SDMS). The measurements were recorded during several nominal on-orbit Dedicated Thruster Firing test.

Experimental modal analyses were performed on the measured data to extract modal parameters including frequency, damping, and mode shape information. Correlation and comparisons between test and analytical frequencies and mode shapes were performed to assess the accuracy of the analytical models for the configurations under consideration. Based on the frequency comparisons, the accuracy of the mathematical models is assessed and model refinement recommendations are given.

**Presenter Biography:**
Mr. Laible is a Senior Engineer with Boeing working in the Loads and Microgravity Analysis group for the International Space Station. His education includes a Bachelors of Science in Aerospace engineering with a concentration in orbital mechanics from St. Louis University, Parks College. His career includes hardware design, Tethered Satellite analysis, Shuttle Operations – Rendezvous and Prox-ops, ISS assembly operations, and ISS Loads and Microgravity analysis. Current work is in ISS Post Flight analysis in the Loads and Dynamics group.

# Structural Mechanics

**9:25 AM**

## A-1.2 The Ultimate Factor of Safety for Aircraft and Spacecraft – Its History, Applications and Misconceptions

**John J. Zipay**

The ultimate factor of safety (FOSULT) concept used in aircraft and spacecraft has evolved over many decades. Currently an FOSULT 1.5 is the FAR-mandated value for aircraft while an FOSULT of 1.4 has been used in various spacecraft. This paper was motivated by the desire to concisely explain the origins, proper interpretation and application of the ultimate factor of safety concept, since the authors have seen throughout their careers many misconceptions and incorrect applications of this concept. The history of the ultimate factor of safety concept is briefly summarized, the proper application of the factor of safety in aircraft design, structural analysis and operations is covered in detail, examples of limit load exceedance in aircraft and spacecraft are discussed, the evolution of the 1.4 FOSULT for spacecraft is described and some misconceptions regarding the ultimate factor of safety concept are addressed. It is hoped that this paper can be a summary resource for engineers to understand the origin, purpose and proper application of the ultimate factor of safety

**Presenter Biography:**
Mr. John J. Zipay has been the Deputy Branch Chief of the Structures Branch for the past six years. In his 30-year career at NASA, he has served as the Structures Integration Manager for the International Space Station (ISS) from 1993 until 2002 overseeing the hardware development and delivery to orbit of most of the major elements of the ISS. He also served on the Tile TPS Damage Assessment Team from Return-To-Flight after the Columbia Accident through STS-108. He has worked on the Crew Module Parachute Assembly System (CPAS) for Orion by leading the development of their full-scale Parachute Drop Test Vehicle and has supported the concept development for the Asteroid Redirect Crewed Mission. He supervises 26 brilliant structural engineers that perform sustaining engineering on ISS, development of Orion and the Commercial Crew Vehicles, oversight of the development and integration of the Bigelow Expandable Activities Module and development of advanced composite structures for future spacecraft.

**Session A-2** **Lone Star Room**

# Climate Change Science & Public Policy

**8:45 AM**

## A-2.1 Climate Change Science & Public Policy

**Douglas Yazell and Michael Frostad**

The position statement title for the American Geophysical Union is "Human-Induced Climate Change Requires Urgent Action," and the Geological Society of America states, "These challenges will also require balanced and thoughtful national and international discussions leading to careful long-term planning and sustained policy actions." The NASA climate website contains a Consensus web page explaining that 97% or more of actively publishing climate scientists agree: Climate-warming trends over the past century are very likely due to human activities. In addition, it presents a statement on climate change from 18 American scientific associations and climate change position statements from 7 American scientific societies.

In the presence of these documents from science academies and specialist professional bodies representing scientific fields, we look at potential effects of climate change on the aerospace industry and propose the development of a climate change position statement for the AIAA Houston Section.

**Presenter Biographies:**
Douglas Yazell, Honeywell aerospace engineering, 1981-2011. My Honeywell career took me from Clearwater, Florida to the Los Angeles area, then in 1992 to the NASA/JSC community. My work is mostly NASA projects: space shuttle, space stations, and the Orion crew vehicle, usually working on guidance, navigation & control. My volunteering with AIAA consists of many roles, including editorial board membership for Aerospace America, the monthly AIAA magazine sent to 35,000 members and 100 corporate members. The February 2014 issue contained a climate change cover story, not connected with me, but created in part thanks to my suggestion. Since 2013 I wrote a one-page column in every bimonthly issue of Horizons, the newsletter of AIAA Houston Section (830 members): Climate Change & Local Responses (Science & Public Policy). I brought climate change science & public policy sessions to this Annual Technical Symposium in 2013 and 2014, as shown on web pages for those two events. Those web pages contain charts and an audio file.
BSEE: University of South Florida. Master of Science in Engineering: University of California, Irvine.

Michael Frostad is currently an Engineer with HX5, part of the JETS contract, providing direct engineering support to NASA JSC. He initially joined the community in the Fall of 2006 with ERC on the ESCG contract after graduating with a Masters of Aeronautics and Astronautics from the College of Engineering at the University of Washington. In his time supporting JSC he has supported the Ascent Entry Shuttle Engineering Simulator (A/E SES) through close out of the program, the development of the Advanced NASA Technology Architecture for Exploration Studies (ANTARES) simulation to support Flight Software development of the Orion Spacecraft, and provided analysis in support of NASA's Orion Exploration Flight Test-1 (EFT-1). Currently he supports NASA JSC Engineers working to get ANTARES ready for Orion's Exploration Mission-1 (EM-1).

Mr. Frostad has been a part of the American Institute of Aeronautics and Astronautics since 2003 and has been active with the Houston Section since 2010 serving on the executive council first as Young Professional Chair, then Vice-Chair of Operations, Chair, and currently as Past-Chair.

# Climate Change Science & Public Policy

**9:25 AM**

## A-2.1 The Mars Imperative for Species Survival and Inspiration of a Globalized Culture

**Donald C. Barker**

Humanity has crossed a unique technological threshold enabling self-guided survival, a first in the history of life on Earth. From a human perspective the Earth may be considered as a single interconnected ecosystem, and given our tenuous understanding and control over the environment as well as our own behaviors, ever-looming specters of social collapse, environmental decline, or even extinction dictate enacting immediate off-world diversification and self-preservation efforts. Herein, Mars is touted as the most tenable and sustainable location in which to initiate such permanent diversification. Scientific curiosity alone cannot initiate nor drive such off-world settlement and concerted impetus and public support for such an endeavor is shown to be constrained by human attention span. Lastly, the initial act of settlement uniquely serves as humanities greatest globally inspiring self-initiated endeavor, a tangible benefit capable of inspiring generations, connecting cultures and motivating college enrollments and career path choices in science, technology, engineering and math (STEM) in a manner similar to the dawn of human space exploration.

**Presenter Biography:**
Mr. Barker holds Masters Degrees in physics, psychology, mathematics, space architecture, and is currently pursuing a PhD in geology with an emphasis in lunar petrology. He has worked at Johnson Space Center for 22 years as a bio-medical engineer, flight controller, systems engineer and a science and technology researcher for the International Space Station program. He is a Certified Flight Instructor, has traveled extensively, is multilingual and an avid explorer and mountaineer. Donald's research interests concerning Mars include mission design, landing site selection, social impacts, water and resource acquisition, utilization and exploration.

**Session A-3** **Longhorn Room**

# Space Commercialization

**8:45 AM**

## A-3.1 Commercial Space Freighters

**Don A. Nelson**

The Commercial Space Freighters will be designed to support near earth space transportation requirements, provide the capability for deep space exploration, support mankind's need to obtain deep space resources, and establish populated safe havens in deep space. Affordable and sustainable space transportation for the 21st century must be based on commercially operated reusable launchers and space based vehicles. This requires a space transportation system that has the capability to return commercial quantities of near-earth and deep space resources to the Earth's surface…a commercial space shuttle (CSS) freighter. The CSS freighter using the decommissioned space shuttle's configuration reduces the mission cost to $205 million; however there are many existing technologies that can reduce the freighter's operational cost to a profitable level for commercial enterprises.

The CSS freighter uses the orbiter airframe profile and will be autonomously operated. Passengers will be flown only on missions requiring their presence. For these missions, they will be provided escape pods which provides protection for launch, on-orbit, and entry anomalies. Launch pad assembly of the freighter will reduce operations cost and turnaround time. Rapid turn-around is a unique CSS freighter feature which reduces operation's cost, provides the capability for timely intercepts of threating asteroids/comets, and supports USAF rapid deploy missions.
The payload delivery capability, landing weight limits, and launch cost of the CSS freighter will establish the design boundaries of the future space based vehicles. Therefore the CSS freighter's operational capability will be the cornerstone for planning and development of the 21st century's space transportation system.

**Presenter Biography:**
Don A. Nelson is an aerospace consultant and writer. Mr. Nelson retired from NASA in January 1999 after 36 years with the agency. He participated in the Gemini, Apollo, Skylab, and Space Shuttle Projects as a mission planner and operations technologist. Mr. Nelson was a supporting team member for the first rendezvous in space, first manned mission to the moon, first manned lunar landing, and the first flight of the Space Shuttle. During his last 11 years at the NASA Johnson space Center, he served as a mission operations evaluator for proposed advanced space transportation projects. Mr. Nelson is a graduate of Southern Methodist University School of Engineering. He is a certified private pilot and holds a Phase VI Pilot Proficiency Wings award from the Federal Aviation Administration. Mr. Nelson is the author of: "NASA New Millennium Problems and Solutions"

# Space Commercialization

**9:25 AM**

## A-3.2 Advent Launch Services

**James Akkerman**

Advent Launch Services was featured in an article on page 13 of the July 2005 issue of Horizons, the newsletter of AIAA Houston Section. That issue is included in the newsletter archive on the AIAA Houston Section website, available for anyone to download and read for free.

Space programs have been funded mostly by government, and the focus has been on the development of technology. The challenge today is to apply that technology with minimum cost. With good engineering, we can very likely provide the world's energy using solar power satellites.

The Advent Launch System has been developed using the System Accounting Model (SAM). The cost of each system can be defined by a simple equation. Cost equals a tabulation of the items purchased plus the value of support from the other systems. The result is a series of equations. Calculating the cost for each product requires the simultaneous solution of those equations. We do this accounting with a desktop computer and a local printer.

The goal of low-cost orbital delivery was initially pursued to encourage the development of solar power satellites. The solar power satellite technology had been demonstrated, but the project was canceled primarily because of the high cost of orbital delivery. Commercial space applications are driving the launch costs down. Solar power satellites can now be very competitive.

NASA needs to get to work on a solar power satellite program, using the SAM from Advent Launch Services.

**Presenter Biography:**
James Akkerman earned his bachelor's and master's degrees in mechanical engineering from the University of Texas, and he is a Texas registered professional engineer. He worked for Ling-Temco-Vought (later named the LTV Corporation) as a reaction control system propulsion specialist on the Solid Controlled Orbital Utility Test System (the Scout family of rockets). His Ling-Temco-Vought work also included working on the Freon 14 system for the NASA Manned Maneuvering Unit.

He then worked for NASA Johnson Space Center as Subsystem Manager for the Little Joe II Booster, Assistant Subsystem Manger for the Apollo Reaction Control System, Subsystem Manager for the Skylab Reaction Control System, System Engineer for the Space Shuttle Flight Control Power System, Program Manager for the Mini Sniffer drone aircraft engine development, and a member of the Future Program Office as a proponent of Solar Power Satellites.

His patents include a blood pump for cardiac surgeon Michael E. DeBakey, a motorcycle testing machine, an automatic compression adjusting machine, and a high altitude aircraft engine.

He once set a Go-Kart speed record of 161 miles per hour. [Wikipedia states that Go-Karts vary widely in speed and some (known as Superkarts) can reach speeds exceeding 160 mph.]

His personal businesses include Akkerman Engineering and Manufacturing from 1960 to 2005 and Advent Launch Services since 2001.

# GN&C

**10:15 AM**

## B-1.1 Enhanced Computation of the State Transition Matrix for Perturbed Orbital Motion Using Modified Chebyshev Picard Iteration

**Julie L. Read**

Modified Chebyshev Picard Iteration (MCPI) is used to solve linear and nonlinear, high precision, long-term orbit propagation problems through iteratively finding an orthogonal function approximation for large time segments of the entire state trajectory. This method utilizes Picard iteration, which generates a sequence of path approximations, and discrete Chebyshev Polynomials, which are orthogonal and also enable both efficient and accurate function approximation. The nodes consistent with discrete Chebyshev orthogonality are generated using cosine sampling; this strategy also reduces the Runge effect and as a consequence of orthogonality, there is no matrix inversion required to find the basis function coefficients.

Here we consider the MCPI method to compute the State Transition Matrix (STM) for the case of per-turbed motion, which has applications in many areas including celestial mechanics and control systems. Propagation of the STM is useful in determining the sensitivity of the IVP solution to the initial conditions. A solution is achieved for a spherical harmonic series representation of earth gravity (EGM2008), although the methodology is suitable for application to any gravity model. A few enhancements to the computation of the STM give it an even broader range of immediate applications, such as segmenting over an orbit, transforming the equations into a canonical form, or enabling more efficient Monte-Carlo simulations by effectively representing local gravity calculations near the nodes in sequential Picard iteration as a Taylor Series expansion. In addition, all MCPI algorithms considered herein are parallel-structured so that they are immediately well-suited for massively parallel implementation with additional speedup.

**Presenter Biography:**
Julie Read is a PhD student in Aerospace Engineering at Texas A&M University. Her current research focuses on a novel propagation technique called Modified Chebyshev Picard Iteration (MCPI) with applications in orbital mechanics.

Julie earned her B.S. in Electrical & Computer Engineering from the University of Wyoming in 2007 and a M.S. in Aerospace Engineering from the Texas A&M in 2010. She worked at a private aerospace company, Odyssey Space Research, for 2.5 years before returning to Texas A&M for her PhD.

# GN&C

**10:55 AM**

## B-1.2 Empirical State Error Covariance Matrix for Batch Estimation

**Joseph (Joe) H. Frisbee, Jr.**

State estimation techniques effectively provide mean state estimates. However, the theoretical state error covariance matrices provided as part of these techniques often suffer from a lack of confidence in their ability to describe the uncertainty in the estimated states. By a reinterpretation of the equations involved in the weighted batch least squares algorithm, it is possible to directly arrive at an empirical state error covariance matrix. The proposed empirical state error covariance matrix will contain the effect of all error sources, known or not. This empirical error covariance matrix may be calculated as a side computation for each unique batch solution. Results based on the proposed technique will be presented for a simple, two observer and measurement error only problem.

**Presenter Biography:**
Joe is the subject matter expert for the tracked orbital debris probability based collision risk and avoid-ance process for the ISS. He also worked on the same process for the Space Shuttle Program. Prior to that Joe worked on special analyses problems for the shuttle program including subject areas such as maneuvering payload re-contact, statistical analysis and dynamics. Prior to coming to the JSC community Joe worked for Tracor Aerospace (orbital debris collision risk analysis) in Austin and Lockheed Missiles and Space Company (Trident Missile trajectory analysis) in Sunnyvale. Joe has degrees from N. C. State University and the University of Texas in Austin.

# Climate Change Science & Public Policy

**10:15 AM**

## B-2.1 Climate Change for Engineers

**Harold H. Doiron**

An independent, objective engineering assessment of the Anthropogenic Global Warming controversy has been completed by an all-volunteer research team, comprised primarily of retired NASA scientists and engineers who are veterans of the Apollo Program. This paper will report on the results and conclusions of this three-year study assessing the extent to which continued, unrestricted burning of fossil fuels can warm the planet. Our conclusion, based on 165 years of physical data since CO2 levels began to rise in our atmosphere analyzed with simple models derived from Conservation of Energy, is that the planet will run out of economically recoverable fossil fuels before any harmful global warming can occur. This paper will help translate the jargon, methods and sources of uncertainty hobbling climate science, into terminology and well-developed radiation heat transfer analysis methods typically used by aerospace engineers. We concluded climate scientists claim large uncertainty in future global warming caused by burning fossil fuels, only because they give credence to the results of very complex, but un-validated, climate simulation models computing hypothesized climate changes that might occur hundreds to thousands of years into the future.

**Presenter Biography:**
Dr. Hal Doiron is the retired VP, Engineering Analysis and Test Division, InDyne, Inc. He holds a PhD in Mechanical Engineering (1970) from the University of Houston and BS. Physics (1963) from the University of Louisiana-Lafayette. He began his professional career with the Manned Spacecraft Center in June 1963. He developed Lunar Module landing dynamics computer simulations for the Apollo Program and used this new technology to support LM landing gear design, develop safe landing techniques and to select acceptable landing sites. He performed docking dynamics simulations for the Skylab Program and led the Space Shuttle Pogo Prevention Panel during Shuttle design and development. He has also held senior management positions at Reed Tool Company and McDonnell Douglas Space Systems.

# Space Exploration

**10:15 AM**

## B-3.1 The Cascade Distillation System

**Julia Worrell**

Current ISS operations dictate that water be shipped into space each year to compensate for resources lost during the treatment of wastewater or to the atmosphere. Shipping this volume of water to Mars is extremely cost prohibitive. The Cascade Distillation System (CDS) is a piece of water reclamation tech-nology being developed under the Advanced Exploration Systems Project to help extend the reach of human exploration into deep space. The goal of the project is to create a piece of equipment that, while being robust, retains a high water recovery rate and avoids the precipitation of solids. At the heart of the system is a vacuum rotary distillation unit. It operates at a reduced pressure, which allows for evaporation at lower temperatures. Control over the fluid is maintained due to the high G forces generated by rotation of the distiller head. This rotation also allows for phase separation between the vapor being generated by the distillation process and the brine left over. The feed stream typically consists of gray water, urine, and humidity condensate, and the CDS takes this stream, evaporates roughly 85% of the water, and generates a brine fluid. Product water will then be made potable by a different process. The CDS team is currently moving the system into a more flight like configuration that utilizes micro-gravity compatible bellows tanks, a flight like telemetry/control system, and more compact vacuum system.

**Presenter Biography:**
I am a chemical engineering undergraduate at the Florida Institute of Technology. I am entering my senior year. Currently, I work as an intern in EC3 on the technology development team. My mentors are Sarah Shull, Miriam Sargusingh, and Dr. Michael Callahan. I completed a rotation during the fall semester of 2014 in EC2, the design and analysis group for the Crew and Thermals Systems Division at JSC. I will be staying with EC3 till August after which I will return to Florida Tech to complete my undergraduate degree.

**Session B-3** **Longhorn Room**

# Space Exploration

**10:55 AM**

## B-3.2 Overview of Orion EFT-1 Flight

**David Dannemiller**

This presentation provides an overview of the Orion EFT-1 flight, including video of the major events.

**Presenter Biography:**
David has been working in the JSC community for 32 years supporting MPAD (Mission Planning and Analysis Division), MOD (Mission Operations Directorate), and Engineering in the areas of trajectory and GN&C. He is currently NASA Lead of the Orion GN&C Orbit MODE Team (OMT).

# Systems Engineering

**1:45 PM**

## C-1.1 Open Innovation in Space Systems Engineering

**James E. Johnson and Steven N. Rader**

Open innovation, stated by Chesbrough (2005), is a "paradigm that assumes that firms can and should use external ideas as well as internal ideas…as they look to advance their technology"[1]. At its core, open innovation is a process of querying a large population, typically outside of one's main organization for ideas, concepts, and even detailed designs for a minimal cost. Tools and services such as Yet2, In-noCentive, TopCoder, GrabCAD and others are leveraging global talent in tackling challenging problems. NASA has used such platforms to address challenges ranging from maximizing power generation of the International Space Station's solar arrays to soliciting concepts for utilizing jettisoned mass from Mars landers to conduct scientific investigations and technology demonstrations. But how could open innova-tion compliment traditional systems engineering processes? Upon reviewing the systems engineering process, we identify where open innovation tools may help address cost, schedule and technical con-cerns during the development of complex systems. From seeking novel ideas to designing hardware and products, open innovation can leverage diversity of thought to realize creative and innovative solutions to the space industry's most pressing challenges.

**Presenter Biography:**
James E. Johnson: James Johnson is an advocate for advancing the exploration of Earth and space through innovative system development. He has worked at NASA for over 14 years in various roles including supporting Space Shuttle operations as an Emergency, Environmental and Consumables Manager (EECOM) in the Mission Control Center, planning and leading a series of virtual asteroid exploration simulations as a Test Director for the Research and Technology Studies (RATS) tests in 2012, and most recently by leading NASA's Mars Balance Mass Challenge which sought global input on identifying innovative solutions to repurpose discarded mass during Mars robotic missions. He is dedicated to finding new ways to rapidly develop complex systems that benefit the understanding of our home planet and the amazing universe we choose to explore. He holds a B.E. in Mechanical Engineering from the Colorado School of Mines and a M.E. in Space Systems Engineering from Stevens Institute and currently supports NASA's Office of Planetary Protection in identifying ways to safely and effectively enable the human exploration of Mars.

Steven Rader: Steve Rader currently serves as the Deputy Manager of NASA's Center of Excellence for Collaborative Innovation (CoECI), which is working to infuse challenge and crowdsourcing innovation approaches at NASA and across the federal government. CoECI focuses on the study and use of curated, crowd-sourcing communities that utilize prize and challenge based methods to deliver innovative solutions for NASA and the US government.

Mr. Rader has Mechanical Engineering degree from Rice University and has worked at NASA's Johnson Space Center in Houston, TX for 25 years. He started his career as an environmental control and life support systems flight controller for Space Station Operations. Mr. Rader moved into flight software engineering where he developed delay tolerant communications software for the Space Shuttle and International Space Station as wells as ground and flight command & control systems for the X-38 emergency crew return vehicle. Mr. Rader led the development of NASA's Constellation Program's interoperable Command, Control, Communications & Information (C3I) architecture. After the Constellation program, Mr. Rader supported the Mars design reference mission definition and a number of analog missions studying space mission operations and design. Mr. Rader began studying crowdsourcing communities in 2011 and joined the Center of Excellence for Collaborative Innovation as the deputy manager in 2013.

**Session C-2** **Lone Star Room**

**1:45 PM**

## C-2.1 The Waverider Racing League

**Dr. Patrick E. Rodi and George "Jeff" Bennett**

The Waverider Racing League is introduced as a possible aerospace sport for the future. By combining aspects of both autoracing and airplane racing, along with augmented viewing similar to sailboat racing, the WRRL's goal is to advance aerospace technology through friendly competition. In contemporary forms of motorsports such as Formula 1 and at Le Mans, technologies "trickle down" to street cars such as all-wheel drive, anti-lock brakes, traction/stability control, active suspension, and many others. The WRRL has the potential to contribute in this area for aerospace vehicles of the future by advancing mate-rial development, propulsion, aerodynamics, and other technologies. This presentation will begin by introducing the league's goals and concept. The current design reference mission will be discussed which includes: 1) release from a bus in a retrograde low Earth orbit at "lights out", 2) fire retro engines to begin the re-entry, 3) travel around "pylons", 4) reach a pre-defined landing site, and 5) the "first to wheel stop" is the winner. A Waverider Racing League season may include many diverse courses and landing sites, each emphasizing different aspects of the waverider designs and/or providing the opportunity for many population centers to observe the waveriders as they soar past. Proposed vehicle design constraints will be examined including features for safety and cost savings. Potential audience numbers will be discussed using hypersonic vehicle visibility metrics to define when a given vehicle will be visible and for how far from the ground track.

**Presenter Biographies**:
Dr. Patrick Rodi is a Lockheed Martin Fellow specializing in aerodynamics, aerothermodynamics, optimi-zation, and grid generation. Patrick received his Ph.D. from The Center for Hypersonic Training and Re-search at The University of Texas at Austin. Dr. Rodi joined Lockheed Martin Skunk Works in 1996, where he worked on a number of hypersonic programs including the X-33 and FALCON. Patrick became the LM-Houston Aerosciences Lead for the Orion Multi-Purpose Crew Vehicle in 2007. Patrick has authored over three dozen technical papers, and is an AIAA Associate Fellow.

Jeff Bennett is a controls system analyst, and has been working on the ISS Program at JSC since 1989. He received his BS in Aerospace Engineering from Parks College in Cahokia, IL, and graduate studies at The University of Texas in Austin. Jeff joined Anadarko Industries in March 2014, working on a Boeing contract.

**Session C-2** **Lone Star Room**

**2:25 PM**

## C-2.2 An Improved Approach to Optimize Neural Network Activation Functions for Increased Accuracy

**Dr. Patrick E. Rodi**

Neural Networks have been successfully applied to many problems throughout science and engineering. Such networks learn a training set by adjusting the weights assigned between connected pairs of neu-rons. Additionally, optimization of the Neural Network's input variables has reduced the differences be-tween the predictions and the training data. In order to further improve the accuracy of the Neural Net-work predictions, the author has been developed a new approach that includes optimization of the activation function(s) used in the network's neurons. In this approach, third-order Bezier Curves are used to define the activation function. The optimizer adjusts the control points for these curves to adapt the activation function(s) to the specific problem under study. Concurrently, optimization of the weighting values is performed. In earlier work a Genetic Algorithm optimizer was used to determine the Bezier Curve control points. In current work this optimizer has been replaced with a Particle Swarm Optimization approach to significantly improve both absolute accuracy and throughput performance. Comparisons will be made between results from traditional Neural Networks and the new Neural Network approach to quantify the performance improvements for a number of test functions.

**Presenter Biography:**

Dr. Patrick Rodi is a Lockheed Martin Fellow specializing in aerodynamics, aerothermodynamics, optimization, and grid generation. Patrick received his Ph.D. from The Center for Hypersonic Training and Research at The University of Texas at Austin. Dr. Rodi joined Lockheed Martin Skunk Works in 1996, where he worked on a number of hypersonic programs including the X-33 and FALCON. Patrick became the LM-Houston Aerosciences Lead for the Orion Multi-Purpose Crew Vehicle in 2007. Patrick has authored over three dozen technical papers, and is an AIAA Associate Fellow.

# Astrodynamics

**1:45 PM**

## C-3.1 Traversable Wormholes and Interstellar Travel

**Dr. Albert A. Jackson**

Fast flight to the stars might be possible. At least a concept exists that does not violate what is known about the physics of the universe. This is the traversable wormhole invented by Thorne and Morris in 1988. This talk will cover the history of the wormhole from its conception in 1916 to the work of Einstein and Rosen in 1935. The road to the traversable wormhole goes through the history of the theory of the structure and evolution of stars. Two paths, one mathematical and one astrophysical, converge in 1963, leading to the birth of the black hole. When empirical evidence said that black holes exist, it opened the door for further exploration of wormholes. The mathematical recipe for a traversable wormhole is presented and what physical conditions must be conformed to in order to create such an object. The ongoing research is reviewed.

**Presenter Biography:**
Received my Bachelor and Master of Arts degrees in Mathematics, 1964, and Physics 1966 from University of North Texas in Denton Texas. I entered the US civil service at NASA Johnson Space Center in January of 1966 as an engineer, providing the first crew training on the Gemini Crew Trainer. Worked on a simulator for the Lunar Landing Training Vehicle and then became full time Apollo crew trainer on the Lunar Module Simulator (subsystem: the Abort Guidance System). I received my Ph.D. in physics in January of 1975 from the University of Texas at Austin. From 1975 to 2010 I worked at JSC in flight planning software, orbital dynamics, orbital debris, and engineering simulation. I am an associate fellow of the AIAA.

**Session C-3** **Longhorn Room**

# Automation and Robotics

**2:25 PM**

## C-3.2 Autonomous Fault Protection for Solar Probe Plus

**Justin Thomas**

In the summer of 2018, JHU/APL is scheduled to complete and launch the NASA Solar Probe Plus spacecraft to perform unique, previously-unachievable, in-situ solar science. A multitude of significant constraints dictate the need for advanced on-board autonomous fault protection capabilities for this robotic deep space probe: expected telecommunication outages reaching up to 6 weeks in duration, precision spacecraft attitude control to avoid catastrophic thermal conditions, an unforgiving radiation environment expected to result in random microprocessor resets and event upset effects on on-board electronics, and the need to maximize scientific data collection. To this end, on-board fault detection and recovery must be robust, correct, and timely.

To address these challenges, JHU/APL is utilizing its heritage Autonomy (software-based autonomous fault protection) approach: a centralized collection of monitor/response constructs executing within an on-board “interpretive” engine. The baseline Autonomy design at the recent Critical Design Review (CDR) indicates this Autonomy system is approximately twice as large as previous JHU/APL-developed systems. Major contributing factors to this increase include spacecraft complexity, the delicate balance between power generation and excessive thermal conditions, and the need to fail operationally without jeopardizing opportunities for precious scientific measurements.

This presentation will provide an overview of this historic mission, introduce JHU/APL’s heritage approach to autonomous software-based fault protection, significant challenges and design drivers, the resulting high-level Autonomy design, and finally outline the roadmap to launch.

**Presenter Biography:**
Mr. Thomas is a senior spacecraft software engineer in the Space Exploration Sector at the Johns Hopkins University Applied Physics Laboratory. He has served as the supervisor and technology development lead for autonomous spacecraft software at JHU/APL. His specialties include real-time systems, intelligent systems, and robotics. Mr. Thomas previously served as a JSC contractor for nearly a decade. Mr. Thomas is an Associate Fellow with the AIAA.