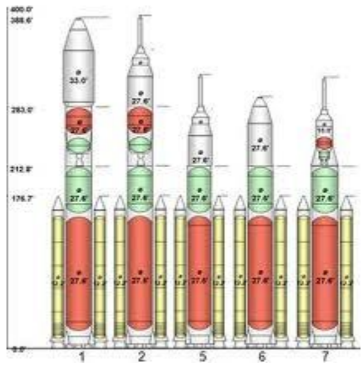

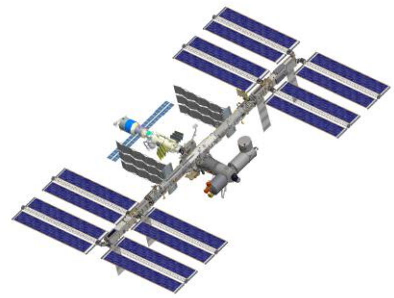

American Institute of Aeronautics and Astronautics
Houston Section
In Collaboration with INCOSE Presents

Annual Technical Symposium 2014

NASA/JSC Gilruth Center
Houston, Texas
Friday, May 9, 2014

PROGRAM

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Ellen Gillespie
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Michael Martin
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Laura Sarmiento
Douglas Yazell
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CONTENTS

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EXPLORE. DISCOVER. UNDERSTAND.

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PROGRAM SUMMARY

7:45 AM – 4:30 PM	**Registration Desk on First Floor**	**Alamo Ballroom**
8:00 AM - 9:00 AM	***Speaker*:** **Pete Hasbrook - State of the ISS**	**Alamo Ballroom**
Session A 9:00 AM – 10:15 AM	1. Climate Change 2. Safety and Mission Assurance (S&MA) 3. Space Commercialization 4. INCOSE	Discovery Rio Grande Longhorn Lone Star
Session B 10:30 AM – 11:45 AM	1. Climate Change 2. S&MA 3. GN&C 4. INCOSE	Discovery Rio Grande Longhorn Lone Star

12:00 NOON – 1:30 PM	**Lunch**	**Alamo Ballroom**

12:00 PM – 1:30 PM	***Space Commercialization Panel Speakers*:** Former astronauts Chris Ferguson, Lee “Bru” Archambault, and Arturo Machuca from the Houston Airport Director's Office	**Alamo Ballroom**
Session C 1:45 PM – 3:00 PM	1. Robotics and History 2. Astrodynamics 3. EVA and Space Exploration 4. INCOSE	Discovery Rio Grande Longhorn Lone Star

Social at Perry's Steakhouse

487 Bay Area Blvd., Houston, TX 77058

Morning Program – Session A

8:00 - 9:00	**Morning Key Note Speaker – Pete Hasbrook**			
	Discovery (1)	**Rio Grande (2)**	**Longhorn (3)**	**Lone Star (4)**
	Session A-1: **Theme – Climate Change** **Chair: Douglas Yazell**	**Session A-2:** **Theme – S&MA** **Chair: Roger Kleinhammer**	**Session A-3:** **Theme – Space Commercialization** **Chair: Steve Everett**	**Session A-4:** **Theme – Systems Eng (INCOSE)**
9:00 - 9:25	**A-1.1** Climate Change Science and Public Policy **Douglas Yazell and Daniel Cohan**	**A-2.1** Building a Database for a Quantitative Model **Joseph Kahn**	**A-3.1** Technology Transfer and Commercialization **Kumar Krishen, Ph.D**	**INCOSE-1** Why Do I Need To Understand Systems Engineering? **Courtney Wright & Tony Williams**
9:25 – 9:50		**A-2.2** Data Used in Quantified Reliability Models **Roger Kleinhammer**	**A-3.2** Accelerating Space Commercialization **Alex Monchak, MBA**	**INCOSE-1.2** Systems Engineering Requirements **Ken Robinson**
9:50 - 10:15		**A-2.3** The "Best" Reliability Data for the Job **Roger Kleinhammer**	**A-3.3** **INCOSE –** An Integrated Approach to Making Mars Exploration More Feasible and Cost Effective **Wayne McCandless**	
10:15 – 10:30	15 Minute Break			

Morning Program – Session B

	Discovery (1)	Rio Grande (2)	Longhorn (3)	Lone Star (4)
	Session B-1: **Theme – Climate Change** **Chair: Douglas Yazell**	**Session B-2:** **Theme – S&MA** **Chair: Roger Kleinhammer**	**Session B-3:** **Theme – GN&C** **Chair: Steve Everett**	**Session B-4:** **Theme – Systems Eng (INCOSE)**
10:30 – 10:55	**B-1.1** Climate Change Science and Public Policy **Douglas Yazell and Adrian Shelley**	**B-2.1** An Example of Risk-Informed Design **Richard Banke, Ph.D.**	**B-3.1** Model Based GN&C Simulation and Flight Software **Ryan Odegard**	**INCOSE-2** Virtual Black Boxes for Commercial Airliners: A Systems Engineering Approach **Wayne McCandless**
10:55 - 11:20		**B-2.2** What to Expect When Your Workplace is in Deep Space **Dianna DeMott**	**B-3.2** Savitzky-Golay-Filter Application to Moment Of Inertia Estimation **James Turner**	
11:20 – 11:45		**B-2.3** Using the Systems Engineering Life-Cycle to Develop and Agent-Based Model and Simulation **Ipek Bozkurt**	**B-3.3** Optimal Covariance Minimization Algorithm For The Continuous Kalman Filter **James Turner**	
12:00 - 1:30	***Lunch Key Note Space Commercialization Panel Speakers:*** **Former astronauts Chris Ferguson, Lee "Bru" Archambault, and Arturo Machuca from the Houston Airport Director's Office**			

Afternoon program – Session C

	Discovery (1)	Rio Grande (2)	Longhorn (3)	Lone Star (4)
	Session C-1: Theme – Robotics and History Chair: Dr. Zafar Taqvi	**Session C-2: Theme –Astrodynamics Chair: Dr. Al Jackson**	**Session C-3: Theme – EVA and Space Exploration Chair: Larry Friesen**	**Session C-4 Theme – Systems Eng (INCOSE)**
1:45 - 2:10	**C-1.1** NOAA and the ARCs **Dr. Paul Frenger, MD**	**C-2.1** Gravity Losses, the Rocket Equation and "U" **Wes Kelly**	**C-3.1** Integration of Optimized Leading Edges onto Wave Rider Configurations **Patrick Rodi, Ph.D.**	**INCOSE-3** Railroad Accident Investigation **Smokey Culver**
2:10 - 2:35	**C-1.2** Design and Implementation of a Semi-Autonomous Mobile Robot Prototype **Fatih Karabacak**	**C-2.2** Stability of Lunar Distant Retrograde Orbits **Gary Turner, Ph.D.**	**C-3.2 INCOSE –** Look Ahead and Listen Now **Terry Hill**	
2:35 - 3:00	**C-1.3** Suddenly Tomorrow Came – The Audiobook Project **Ted Kenny**	**C-2.3** The Casimir Effect: Traveling Faster than Light **John M. Dilorio**	**C-3.3** MAJIC: A Gyroscopically Actuated Astronaut Mobility Unit for Future EVA Missions **Michele Carpenter, Ph.D.**	
3:00 - ???	**Social at Perry's Steakhouse** **487 Bay Area Blvd., Houston, TX 77058**			

SYMPOSIUM LOCATION

The American Institute of Aeronautics and Astronautics (AIAA), Houston Section, welcomes you to the 2014 Annual Technical Symposium at NASA/JSC Gilruth Center on May 9, 2014.

Enter Gilruth Center using JSC Public Access Gate 5 on Space Center Boulevard if you do not have a JSC badge. The morning and afternoon technical presentations are in the Lone Star, Longhorn, and Coronado rooms on the second floor, and the Discovery Room on the first floor. The morning keynote speech and the luncheon are on the first floor in the Alamo Ballroom.

The Gilruth Center will offer free internet for ATS.

<u>Guest Credentials</u>
User: group1430
Password: 20grp143014

How to connect:

1. Turn on the wireless card and ensure you are near a Wireless Access Point
2. In your wireless client utility, specify the SSID to "nasaguest" to connect to the guest network. Alternatively, you can scan for wireless networks and select the network labeled "nasaguest" from the list of networks your wireless card finds.
3. Open a Web Browser (IE, Firefox, etc.). You will then be re-directed to the JSC Guest Captive Portal Access Login page.
4. At the Captive Portal Login page, enter the user ID and password enclosed in this email and click connect.
5. You will then be connected to the guest network.

Encryption
The JSC Guest Network does not require the configuration of any type of encryption to connect. Furthermore, all traffic on the Guest Network will not be encrypted.

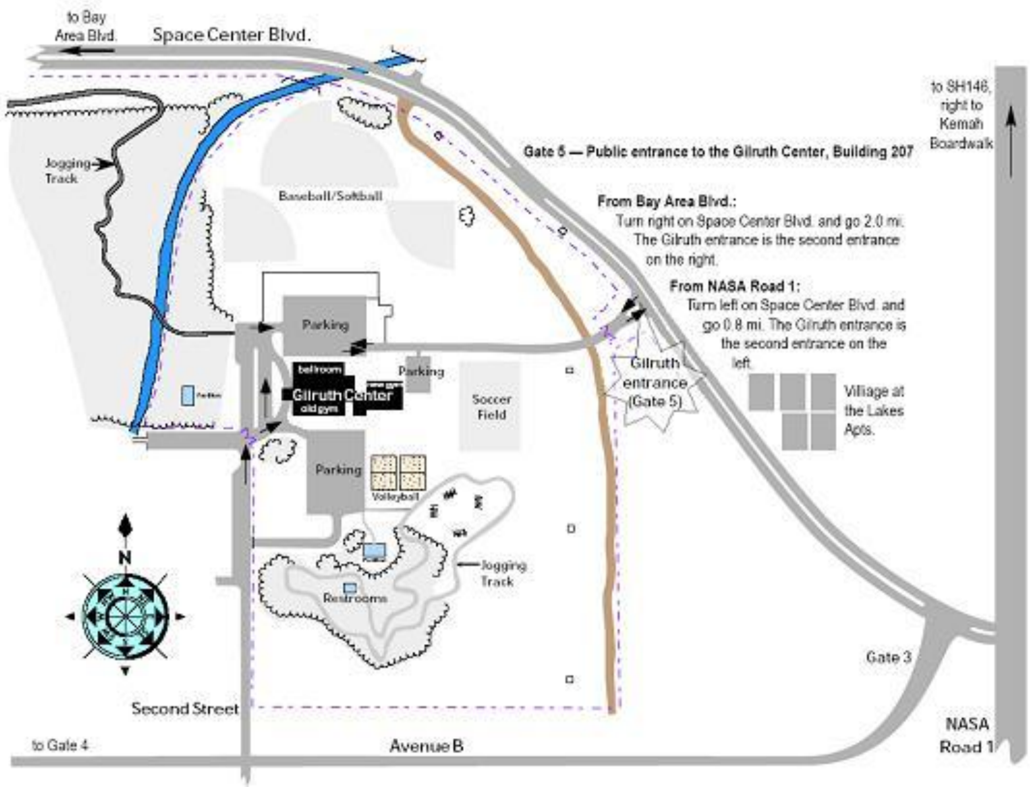

Figure 1. JSC Gate 5 Public Entrance Map

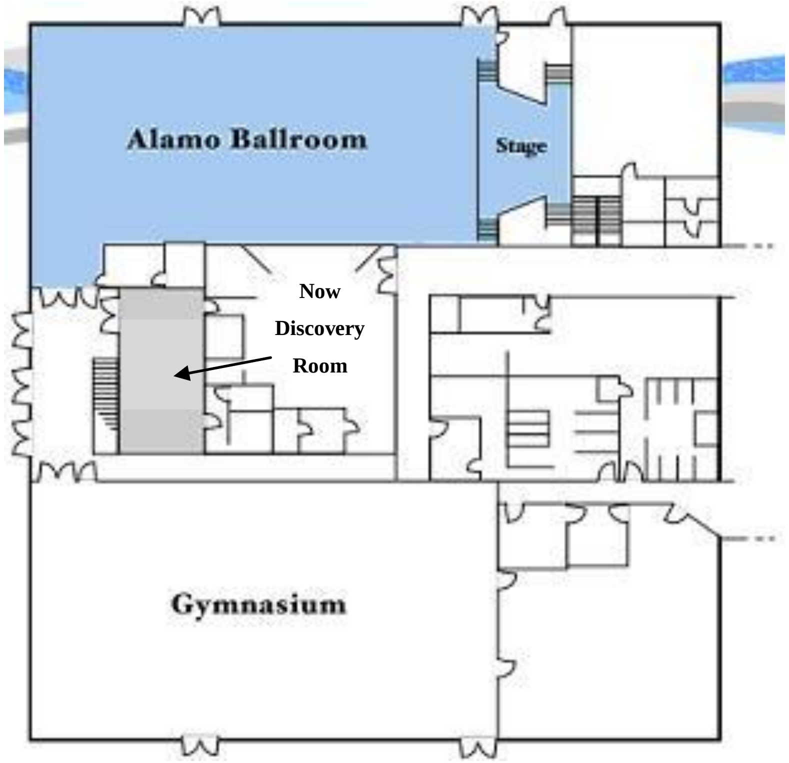

Figure 2. Gilruth Center First Floor

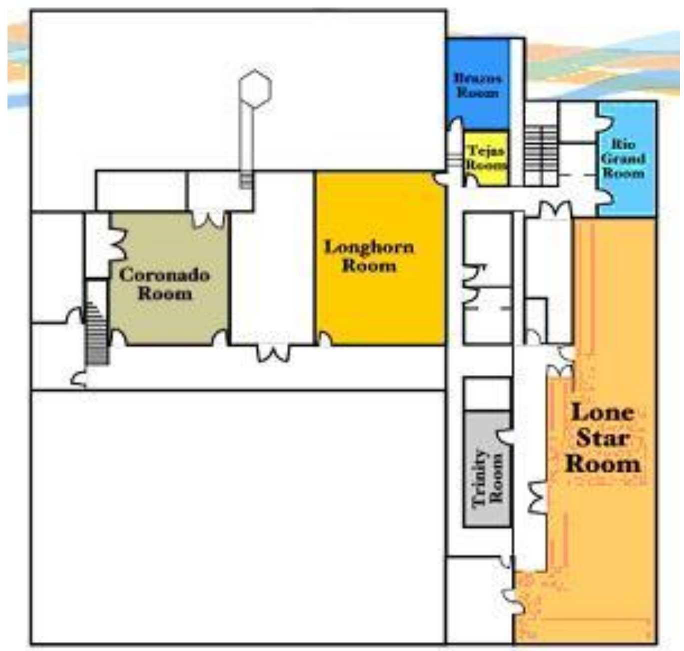

Figure 3. Gilruth Center Second Floor

SYMPOSIUM INFORMATION

REGISTRATION

Registration is free for presenters, $15 AIAA Student Members, $20 for AIAA and INCOSE 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.

Morning, 8:00-9:00 AM, Alamo Ballroom

Keynote Speakers: Pete Hasbrook
"State of the ISS"

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

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Lunch, Noon–1:30 PM, Alamo Ballroom

Space Commercialization Keynote Speaker Panel: Chris Ferguson, Lee "Bru" Archambault, and Arturo Machuca.

Blue's Town BBQ Buffet, baked beans, potato salad, Texas toast, fruit cobbler
Fresh Brewed Starbucks Coffee, Iced Tea

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 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 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 supplied by the Session Chair.

Session A-1 **Discovery Room**

Climate Change

Session Chair: Douglas Yazell

9:00 AM

A-1.1 Climate Change Science and Public Policy

Douglas Yazell and Daniel Cohan

Climate change science appears in short summaries from three groups, the American Geophysical Union (AGU), the American Institute of Physics (AIP), and the American Meteorological Society (AMS). A new website, the Climate Change National Forum (CCNF) includes Texas A&M University professor and Texas State Climatologist John-Nielsen Gammon and University of Houston professor Barry Lefer (both in our AIAA Houston Section territory), and this website invites Scientists and Member-Scientists of those three groups to participate in their website. More helpful short science summaries are available from the National Research Council (NRC), the American Association for the Advancement of Science (AAAS), and the National Academy of Science (NAS). These sources agree with the reports from the United Nations Intergovernmental Panel on Climate Change (UN IPCC). The RapidScat climate change science instrument is scheduled to be installed on the International Space Station in 2014. The NASA website is also a good science guide: Climate Change, Vital Signs of the Planet. Climate change public policy includes the C40 Cities Climate Leadership Group. Since 2005, Houston Mayors Bill White and Annise Parker ensured Houston took sensible steps in response to what the AGU document calls the urgent need for action. President Obama is taking sensible action. Douglas Yazell's Climate Change Science & Public Policy cover story will be submitted for the March/April 2014 issue of Horizons, to be online by April 30, 2014. Two confirmed invited speakers for this session as of April 24, 2014, are Dr. Daniel Cohan of Rice University and Adrian Shelley, Executive Director, Air Alliance Houston.

Session A-2 **Rio Grande Room**

S&MA

Session Chair: Roger Kleinhammer

9:00 AM

A-2.1 Building a Database for a Quantitative Model

Joseph Kahn

A database can greatly benefit a quantitative analysis. The defining characteristic of a quantitative risk, or reliability, model is the use of failure estimate data. Models can easily contain a thousand Basic Events, relying on hundreds of individual data sources. Obviously, entering so much data by hand will eventually lead to errors. Not so obviously entering data this way does not aid linking the Basic Events to the data sources.

The best way to organize large amounts of data on a computer is with a database. But a model does not require a large, enterprise-level database with dedicated developers and administrators. A database built in Excel can be quite sufficient.

A simple spreadsheet database can link every Basic Event to the individual data source selected for them. This database can also contain the manipulations appropriate for how the data is used in the model. These manipulations include stressing factors based on use and maintenance cycles, dormancy, unique failure modes, the modeling of multiple items as a single "Super component" Basic Event, and Bayesian Updating based on flight and testing experience. A simple, unique metadata field in both the model and database provides a link from any Basic Event in the model to its data source and all relevant calculations.

Session A-2 **Rio Grande Room**

S&MA

Session Chair: Roger Kleinhammer

9:25 AM

A-2.2 Data Used in Quantified Reliability Models

Roger Kleinhammer

Data is the crux to developing quantitative risk and reliability models, without the data there is no quantification. The means to find and identify reliability data or failure numbers to quantify fault tree models during conceptual and design phases is often the quagmire that precludes early decision makers consideration of potential risk drivers that will influence design.

The analyst tasked with addressing a system or product reliability depends on the availability of data. But, where ~~is~~ does that data come from and what does it really apply to? Commercial industries, government agencies, and other international sources might have available data similar to what you are looking for. In general, internal and external technical reports and data based on similar and dissimilar equipment is often the first and only place checked. A common philosophy is "I have a number – that is good enough". But, is it? Have you ever considered the difference in reported data from various federal datasets and technical reports when compared to similar sources from national and/or international datasets? Just how well does your data compare?

Understanding how the reported data was derived, and interpreting the information and details associated with the data is as important as the data itself.

Session A-2 **Rio Grande Room**

S&MA

Session Chair: Roger Kleinhammer

9:50 AM

A-2.3 The "Best" Reliability Data for the Job

Roger Kleinhammer

Data is the crux to developing quantitative risk and reliability models, without the data there is no quantification. The means to find and identify reliability data or failure numbers to quantify fault tree models during conceptual and design phases is often the quagmire that precludes early decision makers consideration of potential risk drivers that will influence design.

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Session A-3 **Longhorn Room**

Space Commercialization

Session Chair: Steve Everett

9:00 AM

A-3.1 Technology Transfer and Commercialization

Kumar Krishnen, Ph.D

One of the key strategic implementation goals at NASA Johnson Space Center (JSC) is to expand relevance of its missions to life on Earth. In view of this, JSC will vigorously pursue mutually beneficial partnerships to maximize economic and societal impact. The primary responsibility of transfer and commercialization of technology and intellectual property (IP) is in support of this goal and is carried out at JSC by the Technology Transfer and Commercialization Office (TTCO) under the newly-formed Strategic Opportunities & Partnership Development Office (SOPDO). As JSC develops a new and diverse portfolio of projects, customers and stakeholders, the Center is positioned to collaborate and pursue new opportunities that enable our exploration goals and contribute to the advancement of science and technology for societal and economic benefit. This paper will document the goals and metrics of new and modified approaches for achieving substantial success. The elements of the new program include the following: New training topics for TTCO personnel; training and early contact with innovators, engineers, scientists, and management; early involvement of TTCO in Center-funded technology and research projects; involvement of Houston Technology Center, JSC Innovation Development Center, BayTech Technology Consortium, and other organizations in implementing faster and better processes; enhanced communication between various stakeholders; efficient and timely review methods; and timely recognition programs including Success Stories, Center publicity, awards and other means. The metrics for the effectiveness of new approaches that will be discussed in this presentation will include: software usage agreements, licenses, IP portfolio movement, Spinoff stories, Tech Brief magazine articles, new technology reports, patents and patent applications, Small Business Innovation Research (SBIR) and Small Business Technology Transfer Research (STTR) projects.

.

Session A-3 **Longhorn Room**

Space Commercialization

Session Chair: Steve Everett

9:25 AM

A-3.2 Accelerating Space Commercialization

Alex Monchak

Space commercialization depends on acceptance, which begins with examining a technology acceptance model and then deriving a similar equation. There is a rich history with the Technology Acceptance Model (TAM) which applies to technology acceptance (See Monchak & Kim, Examining Trends of Technology Diffusion, ICIS 2011 Proceedings). The TAM can be extended to space commercialization (See Monchak, Jeong, Kim & Helm, Toward an Initial Business Analysis Framework for Public Oriented Human Space Commercialization, SWDSI 2011 Proceeding) and is expanded in this research to an equation involving space commercialization acceptance. Specifically, the equation is w1*E + w2*U = A where E is ease of use, U is usefulness, w1 and w2 are weights of E and U respectively and A is acceptance with A = 1 as total acceptance. Alternatively, with equal weights the equation is 0.5*E + 0.5*U = A and may be written by including the weights with the variables as simply E + U = A. Other variables may be used to derive E or U, but only E & U is needed to derive A. Space commercialization (C) changes over time, so C(A, t) = f(A) where acceptance is also a function of time A = f(E, U, t). So by considering the motion of acceptance with respect to time A = A(t) in the complex plane (E, U) for A = E + iU, the velocity is given by the first derivative with respect to time, v = (d/dt)*A(t), and the acceleration is given by the second derivative with respect to time, a = (d^2/dt^2)*A(t). While commercial acceptance is observed and measured periodically at discrete intervals, often by a survey or business results, the underlying acceptance is continuous, therefore partial derivatives exist. So, acceptance of space commercialization can be determined theoretically by adding a time term to the equation A = w1*E + w2*U. Accelerating space commercialization can then be analyzed by evaluating the second partial derivative with respect to time, a = (d^2/dt^2)*A(E, U, t).

Session A-3 **Longhorn Room**

Space Commercialization

Session Chair: Steve Everett

9:50 AM

A-3.3 INCOSE – An Integrated Approach to Making Mars Exploration More Feasible and Cost Effective

Wayne McCandless

Affordability is the key to Mars exploration – How best to achieve and demonstrate affordability

Space enthusiasts insist that NASA, international partners, and private enterprise commit to an ambitious plan to explore and ultimately colonize Mars. The primary argument presented is the emotional appeal of "because it's there." This paper contends that a Mars program can only be viable if every link in the chain is demonstrated to be affordable and technologically feasible. It proposes what some of these links ought to be; from LEO, the Moon, interplanetary space, and finally the martian surface. A look at our Human Space Flight legacy is taken to identify those elements to be built upon and those that might best be rejected.

Session A-4 **Lone Star Room**

Systems Engineering (INCOSE)

9:00 AM

INCOSE-1 Why Do I Need To Understand Systems Engineering?

Courtney Wright & Tony Williams

Where does systems engineering fit into the project lifecycle? What kinds of problems can systems engineering answer? How can a systems approach help my project succeed (or prevent it from failure)? Tony Williams will answer these questions and describe why NASA needs people who understand systems engineers.

Are you already performing systems engineering functions and tasks, but without the benefits of understanding prior approaches and lessons learned? Do you want to learn more about systems engineering and aren't sure which learning approach is best? Courtney Wright will talk about the INCOSE Certification Program for Systems Engineers, comparing it to other options for working professionals.

Session A-4 **Lone Star Room**

Systems Engineering
(INCOSE)

INCOSE-1.2 Systems Engineering Requirements

Ken Robinson

Are you already performing systems engineering functions and tasks, but without the benefits of understanding prior approaches and lessons learned? Do you want to learn more about systems engineering and aren't sure which learning approach is best?

Ken Robinson is an adjunct professor at San Jacinto College teaching system engineering. Ken has many years experience as a systems and test engineer in aerospace and software industries.

Session B-1 **Discovery Room**

Climate Change

Session Chair: Douglas Yazell

10:30 AM

B-1.1 Climate Change Science and Public Policy

Douglas Yazell and Adrian Shelley

Climate change science appears in short summaries from three groups, the American Geophysical Union (AGU), the American Institute of Physics (AIP), and the American Meteorological Society (AMS). A new website, the Climate Change National Forum (CCNF) includes Texas A&M University professor and Texas State Climatologist John-Nielsen Gammon and University of Houston professor Barry Lefer (both in our AIAA Houston Section territory), and this website invites Scientists and Member-Scientists of those three groups to participate in their website. More helpful short science summaries are available from the National Research Council (NRC), the American Association for the Advancement of Science (AAAS), and the National Academy of Science (NAS). These sources agree with the reports from the United Nations Intergovernmental Panel on Climate Change (UN IPCC). The RapidScat climate change science instrument is scheduled to be installed on the International Space Station in 2014. The NASA website is also a good science guide: Climate Change, Vital Signs of the Planet. Climate change public policy includes the C40 Cities Climate Leadership Group. Since 2005, Houston Mayors Bill White and Annise Parker ensured Houston took sensible steps in response to what the AGU document calls the urgent need for action. President Obama is taking sensible action. Douglas Yazell's Climate Change Science & Public Policy cover story will be submitted for the March/April 2014 issue of Horizons, to be online by April 30, 2014. Two confirmed invited speakers for this session as of April 24, 2014, are Dr. Daniel Cohan of Rice University and Adrian Shelley, Executive Director, Air Alliance Houston.

Session B-2 **Rio Grande Room**

S&MA

Session Chair: Roger Kleinhammer

10:30 AM

B-2.1 An Example of Risk-Informed Design

Richard Banke, Ph.D.

NASA Engineering requested a Probabilistic Risk Assessment (PRA) to compare the difference in the risk of Loss of Crew (LOC) and Loss of Mission (LOM) between different designs of a fluid assembly. They were concerned that the configuration favored by the design team was more susceptible to leakage than a second proposed design, but realized that a quantitative analysis to compare the risks between the two designs might strengthen their argument. The analysis showed that while the second design did help improve the probability of LOC, it did not help from a probability of LOM perspective. This drove the analysis team to propose a minor design change that would drive the probability of LOM down considerably.

The analysis also demonstrated that there was another major risk driver that was not immediately obvious from a typical engineering study of the design and was therefore unexpected. None of the proposed alternatives were addressing this risk.

This type of trade study demonstrates the importance of performing a PRA in order to completely understand a system's design. It allows managers to use risk as another one of the commodities (e.g., mass, cost, schedule, fault tolerance) that can be traded early in the design of a new system.

Session B-2 **Rio Grande Room**

S&MA

Session Chair: Roger Kleinhammer

10:55 AM

B-2.2 What to Expect When Your Workplace is in Deep Space

Dianna DeMott

Working life on a vehicle going to Mars would have some things in common with going to work on Earth, but most would have that twist to remind you that you're not on Earth anymore. Regardless of where we are or what we're working on humans need to eat, sleep, stay healthy and stay active and alert to perform well on the job. Studies on Earth have shown how important each element is to an individual's wellbeing and job performance.

To travel in space we create a vehicle that provides the basic needs required by humans, these include carrying supplies of air, water and food. However we also need the protective shell to carry the humans, all their supplies and the systems to ensure that people can breathe, stay warm, address all bodily functions and stay healthy in space. In addition to just surviving the new environments, work tasks such as equipment maintenance and repair, normal crew operations and special science experiments will be performed. Some of the factors that will affect the crew performance include: environmental adaptation to weightlessness, dealing with cramped living quarters, physical changes caused by space travel, and how the tools, equipment, training and support information are used throughout the voyage.

Different conditions can affect how the crew performs their work; we need to know more about living and working under these conditions to have successful human exploration in space.

Session B-2 **Rio Grande Room**

S&MA

Session Chair: Roger Kleinhammer

11:20 AM

B-2.3 Using the Systems Engineering Life-Cycle to Develop and Agent-Based Model and Simulation

Ipek Bozkurt

The discipline of Systems Engineering is established on a foundation that consists of concepts such as holistic/systemic view, system requirements, system hierarchy, and life-cycle orientation. All of these concepts come together to form a systems engineering framework that can be used to design, develop and deliver successful and robust systems. The focus of this study is to analyze how this framework can be used to design, develop and deliver an agent-based model (ABM) and simulation.

ABM is one of the most important modeling and simulation (M&S) paradigms that focuses on micro-level analyses. It has been used extensively in many areas within both social sciences and technical fields. Complementing studies that use ABM as a tool, there is literature on how to successfully construct an ABM (See Gilbert and Terna , 2000; Bonabeau , 2002; Macal and North , 2005). These studies focus on characteristics of an "agent", the purposes of modeling, and simulation steps. The present study will use the systems engineering life-cycle approach (i.e. conceptual, preliminary and detailed design, production, operation and support, and disposal) as a methodology to construct an ABM and simulation.

Session B-3 **Longhorn Room**

GN&C

Session Chair: Steve Everett

10:30 AM

B-3.1 Model Based GN&C Simulation and Flight Software Development for Orion Missions Beyond LEO

Ryan Odegard

For Orion missions beyond low Earth orbit (LEO), the Guidance, Navigation, and Control (GN&C) system is being developed using a model-based approach for simulation and flight software. Lessons learned from the development of GN&C algorithms and flight software for the Orion Exploration Flight Test One (EFT-1) vehicle have been applied to the development of further capabilities for Orion GN&C beyond EFT-1. Continuing the use of a Model-Based Development (MBD) approach with the Matlab®/Simulink® tool suite, the process for GN&C development and analysis has been largely improved. Furthermore, a model-based simulation environment in Simulink greatly eases the process for early, rapid development of flight algorithms. The benefits seen by employing lessons learned from EFT-1 are described, as well as the approach for implementing additional MBD techniques. Also detailed are the key enablers for improvements to the MBD process, including enhanced configuration management techniques for model-based software systems, automated code and artifact generation, and automated testing and integration.

Session B-3 **Longhorn Room**

GN&C

Session Chair: Steve Everett

10:55 AM

B-3.2 Savitzky-Golay-Filter Application to Moment Of Inertia Estimation

James Turner, Donghoon Kim , Sanghyun Lee

The authors present a methodology to estimate the inertia for a spacecraft given noisy angular velocity measurements. Without filtering the noisy data, the accuracy of the estimated inertia deteriorates rapidly. During the past decades, researchers have developed several methods to reduce the measurement noise by using digital filtering techniques. The goal is to generate the angular accelerations, which are a function of the moment of inertia tensor components.
An estimate for the moment of inertia components is obtained by presenting a linked filtering method that combines inputs from an extended Kalman filter (EKF) with a Savitzky-Golay filter (SGF). The three-step algorithm consists of the following steps: (1) the EKF is applied for reducing noise effects for angular velocities, (2) the SGF is introduced to generate angular accelerations given the filtered angular velocities, and (3) the linear least-squares method is utilized for estimating the inertia of the spacecraft using the filtered angular velocities and the extrapolated angular accelerations. Note that sensitivity studies are performed to obtain an optimal order of the SGF. Numerical simulations are conducted to address the performance of the proposed method.

Session B-3 **Longhorn Room**

GN&C

Session Chair: Steve Everett

11:20 AM

B-3.3 Optimal Covariance Minimization Algorithm For The Continuous Kalman Filter

James Turner, Kim(1) and Kevin Hernández(2)

The classical Kalman Filter algorithms obtains an optimal Kalman gain matrix by computing a stationary value for the covariance time derivative. This approach has proven to be extremely valuable for many engineering and scientific applications. The innovation of this work is that it develops a direct optimization approach for computing optimal Kalman gains. The resulting gain calculations rigorously minimize the a posteriori error covariance by computing a stationary value directly for the error covariance, as a function of correction gains for the filter. The resulting gain solutions directly minimize the measurement errors for the Filter. Algorithmic computational differentiation is used for generating the sensitivity partial derivatives required in the error covariance minimizing necessary conditions. Both first- and second-order correction strategies are presented for minimizing the elements of the error covariance matrix. The optimal Kalman gains are obtained numerically: no closed-form analytic solutions are available. The proposed analysis approach is expected to be broadly useful for estimation and control problems, where model uncertainty is important for engineering level of fidelity applications.

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(1)(2)Texas A&M University, 745 H.R. Bright Bldg., College Station, TX 77840, 979-458-1429, turner@tamu.edu / khernandezpardo@gmail.com

Session B-4 **Lone Star Room**

Systems Engingeering (INCOSE)

10:30 AM

INCOSE-2 Virtual Black Boxes for Commercial Airliners: A Systems Engineering Approach

Wayne McCandless

In the wake of the loss of Malaysia Air flight 370, there has been much discussion of the need for a capability to continuously track the location of aircraft globally and in real time, and in the event of a severe flight anomaly, a crash, critical human error or a criminal act, provide a record of aircraft conditions useful in the reconstruction and diagnosis of the incident. In this paper, we examine the functional requirements for such a system and evaluate its technological feasibility. In so doing, an overview of the various steps of the systems engineering & integration process is presented.

Session C-1 **Discovery Room**

Robotics and History

Session Chair: Dr. Zafar Taqvi

1:45 PM

C-1.1 NOAA and the ARCs

Dr. Paul Frenger, MD

Missions to Mars, the outer planets and to other star systems need complex, robust support systems to allow astronauts to set up permanent colonies. Durable human habitats and equipment to modify the planet's surface, atmosphere and seas are among these. A space-based version of the National Oceanic and Atmospheric Administration (NOAA) could be employed to coordinate planetary terraforming. NOAA has a 44-year history of Earth environmental research, weather analysis and disaster warnings [http://en.wikipedia.org/wiki/NOAA.]. With assistance from NASA, NOAA could help make our new celestial homes more Earth-like [L. Morin et al, "Rocks to Robots: Concepts for Initial Robotic Lunar Resource Development, Workshop on Automation and Robotics / Innovation, 2011, NASA, pg.12].

Spacecraft which venture out on deep space missions must be built to maintain Earth-derived life, possibly for decades at a time and maybe with an unconscious crew in stasis. The author refers to these ships as ARCs ("Autonomous Robotic Conveyors"). Besides human astronauts, ARCs would contain carefully-chosen plants and animal life, much like the Ark of Biblical fame. Some ARCs containing instruments, construction equipment and supplies would be sent out in advance of the manned ships. Last year the author proposed adding robotic crew to deep space missions to improve their chances of success [P. Frenger, "GRANNIE 4: Helping Astronauts in Deep Space", AIAA Symposium, 2013, NASA, pg.29]. He calls this artificial intelligence protector GRANNIE ("Guardian Robotic Agent with Neural Networks, Intellect and Emotions"). GRANNIE would serve as the ARC's ship computer system like that on the Normandy SR-2 spaceship of the 2007-2012 Mass Effect game trilogy. With a human-like personality, intellectual and emotional traits and a vast knowledge base, GRANNIE's android body would interact with people like the Mass Effect EDI robot avatar [http://masseffect.wikia.com/wiki/EDI]. GRANNIE would chat in an informal way, play interactive games, serve meals, but also could medicate patients or assist with surgical emergencies, semi-autonomously and without Earth guidance. After landing, the ARC technology would be scavenged and male-and-female derived GRANNIE robots bred to help their former human shipmates / now co-colonists [P. Frenger, "Human Sexual Function Emulator", Biomed Sci Instrum, 47, 2011, pg.275-281].

Session C-1 **Discovery Room**

Robotics and History

Session Chair: Dr. Zafar Taqvi

2:10 PM

C-1.2 Design and Implementation of a Semi-Autonomous Mobile Robot Prototype

Fatih Karabacak

Robots were first utilized in the industry for various purposes as programmable machines to perform a set of pre-specified tasks without interacting with humans in the course of operation. However, in recent years, significant efforts have been reported in the literature for human-robot interactions. In systems where humans and robotics interact during the execution of a task, robots do not perform preprogrammed tasks, but execute different sets of actions depending on the commands sent by humans. In this work, basic human body movements such as moving arms to various directions are represented by a humanoid-shaped robot.

Session C-1 **Discovery Room**

Robotics and History

Session Chair: Dr. Zafar Taqvi

2:35 PM

C-1.3 Suddenly Tomorrow Came – The Audiobook Project

Ted Kenny

Last year we started into a large undertaking to create an audiobook of the formal JSC history – Suddenly Tomorrow Came. The Core idea was a recording of the JSC history by those who are making the current history happen. This presentation is to bring people up to speed, discuss engagement opportunities, gather ideas, and discuss how and when this project will be complete.

Session C-2 **Rio Grande Room**

Astrodynamics

Session Chair: Dr. Al Jackson

1:45 PM

C-2.1 Gravity Losses, the Rocket Equation and "U"

Wes Kelly

Newtonian equations of motion (e.g., kinetic and potential energy) address instantaneous changes of velocity well enough, but what should be done with changes of potential energy or position? When we consider the example of the Bohr atom adapted to quantum mechanics, changes in electron position proceed in a manner without analog in the macroscopic world and "delta-R" takes us a down a path that isn't a path at all. So what about classical mechanics?
A feature many analysis tools use for ascent trajectories is a tabulation of "velocity losses" against a total ideal velocity capability packed into a prospective launch vehicle design: gravity, drag, steering and engine nozzle losses. Some of us accustomed to simulating ascents to low earth orbit note a recurring total ideal velocity of ~30,000 fps. If this adheres, should we use the Space Shuttle as a numerical example in an inertial frame (due East launch from the Cape to 57 nautical miles altitude and 25,680 fps cutoff velocity with 0.65 degree flight path angle), we need to account for 5,657 fps, an excess of over 20%. This would need to be accounted for in a preliminary design.
Then, fifteen years ago, several of us doing performance studies of the Venture Star SSTO from several different launch sites noted an anomalous improvement for an Idaho candidate, apparently due to an elevation of 4500 feet at liftoff. Later, when dealing with horizontally takeoff vehicles, we examined velocity losses further to find specifically that velocity gravity losses due to gravity were following a formula

$DV_{GRAV} = (2 \ g \ Dh)^{0.5}$

Could this mean that DV_{GRAV} was essentially derived from "work"? And that work is an addition of extra potential energy to a conservative Newtonian system?

We will discuss these ideas in theoretical context as well as application to launch vehicles that use both air breathing and rocket propulsion, sometimes exploiting and sometimes stepping outside of the rocket equation.

Session C-2 **Rio Grande Room**

Astrodynamics

Session Chair: Dr. Al Jackson

2:10 PM

C-2.2 Stability of Lunar Distant Retrograde Orbits

Gary Turner, Ph.D.

Distant Retrograde Orbits (DRO) represent a family of stable solutions to the n-body gravitational problem in which the target object / vehicle orbits a minor body in a retrograde direction relative to the motion of the minor body relative to a relatively close major body. In the ideal 3-body problem with spherical bodies, stable DRO solutions are available for all radii of interest. In the non-ideal case, with (n>3)-bodies, non-spherical gravity, and other environmental perturbations, the universal stability of the DRO breaks down leaving only a subset of conditions leading to stable trajectories. Because the DRO is inherently more stable than its equivalent prograde orbit, DROs are an appealing target for a number of upcoming conceptual missions. Initial results of simulations to investigate the long-term stability of retrograde orbits around Moon are presented.

Session C-2 **Rio Grande Room**

Astrodynamics

Session Chair: Dr. Al Jackson

2:35 PM

C-2.3 The Casimir Effect: Traveling Faster than Light

John M. Dilorio

Mr. John M. DiIorio will discuss the Casimir effect and how spacecraft can travel faster than light. Coupled with the Scharnhorst equation, the space surrounding the spacecraft together moves faster than light. Assisting in the presentation is several interviews with Professor Albert Einstein. Finally, a short film on NASA’s hyper-theoretical spacecraft ‘Enterprise’ will demonstrate the combined effects.

Session C-3 **Longhorn Room**

EVA and Space Exploration

Session Chair: Larry Friesen

1:45 PM

C-3.1 Integration of Optimized Leading Edges onto Wave Rider Configurations

Patrick Rodi, Ph.D.

Most waverider design approaches generate vehicles that have sharp leading edges. In reality, manufacturing and thermal limits generally require that some sort of a finite radius be used at the leading edge. Earlier research has produced an optimized leading edge generation process suitable for high speed vehicles such as waveriders. In this earlier effort, Bezier Curves were employed to represent the candidate leading edge cross sectional geometries which were then optimized using a number of cost functions including: minimum peak heating, minimum total heating, minimum drag, and minimum pressure gradient.

In the current work, optimized Bezier Curve leading edges have been generated for vehicles designed for three typical waverider applications including: a Mach 6 missile, a Mach 10 cruise vehicle, and a Mach 25 boost-glide vehicle. These leading edge geometries have been incorporated onto the waveriders and the resulting integrated vehicle aerodynamic performance has been quantified and compared to similar vehicles with conventional leading edge geometries such as hemi-cylindrical.

Session C-3 **Longhorn Room**

EVA and Space Exploration

Session Chair: Larry Friesen

2:10 PM

C-3.2 INCOSE – Look Ahead and Listen Now

Terry Hill

Complicated systems, whether human or machine in nature, all follow the basic rules of Guidance, Navigation and Control theory. Using this perspective, and reinforced with performance data, one can predict future performance or possible failure of the system in the future. This talk will give an exercised case study where these principles were used to analysis and determine what changes needed to be made and considerations weighed with extending the ISS space suit (EMU) out to the potential end of the ISS in 2028, the accepted recommendations, and waterfall of events thereafter."

Session C-3 **Longhorn Room**

EVA and Space Exploration

Session Chair: Larry Friesen

2:35 PM

C-3.3 MAJIC: A Gyroscopically Actuated Astronaut Mobility Unit for Future EVA Missions

Michele Carpenter, Ph.D.

In recent years, NASA has developed plans to explore low-gravity bodies, such as near-Earth asteroids and the Martian moons, with the eventual goal of sending humans to Mars. Since the low surface gravity does not allow astronauts to walk, or provide sufficient resistance to counter reaction forces and torques during movements, extravehicular activities (EVAs) will likely require an updated version of the Manned Maneuvering Unit (MMU). The attitude-control system (ACS) for the jetpack currently under development at NASA Johnson Space Center is based on the Simplified Aid for EVA Rescue (SAFER), which uses gas thrusters for both attitude control and translation. For tasks that require fine motor control, such as sample collection and equipment placement, the current Jetpack ACS fires thrusters to compensate the resulting changes in center-of-mass location and moments of inertia, which can adversely affect task performance. The proposed next-generation mobility unit incorporates control concepts optimized to support astronaut tasks and adds control-moment gyroscopes (CMGs) to the current Jetpack system. The control architecture of this Mobility Augmenting Jetpack with Integrated CMGs (MAJIC) considers a concept of operations that includes scenarios such as surface sample collection, equipment deployment, satellite servicing, crew member rescue, and contingency EVA missions at objects lacking built-in handholds or foot restraints. Results from an all-software system simulation and a human-in-the-loop virtual-reality simulation demonstrate that undesired compensating torques on the astronaut can be significantly reduced with the upgraded ACS while conserving onboard fuel and extending the length of EVA missions.

Session C-4 **Lone Star Room**

Systems Engingeering (INCOSE)

1:45 PM

INCOSE-3 Railroad Accident Investigation

Smokey Culver

Railroad accident investigation dealing with personal injuries to workers, derailments and crossing accidents, through the litigation process, using forensic evidence, black box data etc.

Charles L. Culver is a railroad operations consultant with expertise in train handling, rules interpretation and railroad operations in general. He offers services of litigation support to both plaintiff and defense firms in accidents/incidents involving freight and passenger trains, and has testified extensively in these areas.