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Conference Coordinators

ASNT

Chris Schnitzer **Ruth Staat**

NASA NDE Technical Discipline Team(TDT)

George Studor
ISIW 2017 Program Chair

Bill Prosser

NDE TDT
Tech Fellow

Jack Duke

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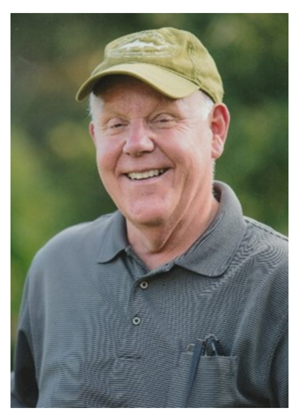

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In-Space Inspection Workshop 2017 Summary Schedule

---Jan 31----------------

7:30 – 8:30 Registration/Check- in/Display-Demo Set-up
Session 1: 8:30 – 10:00 Alamo Room - Welcome –
Session 2: 10:30 – 11:30 Alamo Room - Environments
Lunch 11:30 – 12:30 - Speaker 11:45 – 12:15 NASA/George Nelson-ISS Experiment Program
Session 3: 1:00 – 2:30
Session 3a: Alamo Room– User Needs (1)
Session 3b: Discovery Room – 3D Imaging
Session 3c: Coronado Room– Flight Systems (1)
Session 4: 3:00 – 5:00
Session 4a: Alamo Ballroom – Flight Systems (2)
Session 4b: Discovery Room - Micro-Satellite Inspection Platforms
Session 4c: Coronado Room - Penetrating Imagers

---Feb 1-------------------

8:00-8:30 –Remember Columbia - Bonnie Dunbar - former astronaut, now Texas A&M
Session 5: 8:30 – 10:00 (Coffee in Alamo)
Session 5a: Alamo Ballroom - User Needs (2)
Session 5b: Discovery Room - Image Processing and Data Automation (1)
Session 6: 10:30 – 12:00
Session 6a: Discovery Room – Inspection Sensor Test Opportunities
Session 6b: Coronado Room - User Needs (3)
Session 6c: Longhorn Room – SHM Sensors for Condition-based Inspection (1)
Lunch: 12:00 – 1:00 – Food in the Brazos Room – eat in the presentation rooms or outside at the picnic area
Session 7: 1:00 – 3:00
Session 7a: Discovery Room – Robotic Platforms for Difficult to Access Areas (1)
Session 7b: Coronado Room - Backscatter X-ray Technologies (1)
Session 7c: Longhorn Room - SHM Sensors for Condition-based Inspection (2)
Session 8: 3:30 – 5:00
Session 8a: Discovery Room – Next Gen Systems (2)
Session 8b: Coronado Room - Backscatter X-ray Technologies (2)
Session 8c: Longhorn Room - Image Processing and Data Automation (2)

---Feb 2-------------------

Session 9: 8:00 – 10:00
Session 9a: Coronado Room - Research and Development Centers
Session 9b: Longhorn Room – Measuring Hypervelocity Impact Physics
Session 9c: Lone Star Room – Collaborative Materials and NDE/Inspection (1)
Session 10: 10:30 – 12:00
Session 10a: Coronado Room - Next Generation Systems (3)
Session 10b: Longhorn Room – Robotic Platforms for Difficult to Access Areas (2)
Session 10c: Lone Star Room - Collaborative Materials & NDE/Inspection (2) – Guided Discussion:
Lunch: 12:00 – 1:00 – Lone Star Room - Lunch Speaker: American Petroleum Institute (API)/John Nyholt
Session 11: 1:00 – 3:00 - One-on-One Sessions – Lone Star, Coronado, Longhorn
Session 12: 3:30 – 4:30 Forward Planning/Close Workshop – George Studor & All Available

Note: Jan 30 2pm-4pm – Tour Pipeline Research Council Technology Development Center (No reservation req.)http://prci.org/index.php/tdc/ Hans Deeb, 6410-J Langfield Road, Houston, TX; (281) 846-7570

In-Space Inspection Workshop 2017 Presentation Agenda

Tuesday, January 31

7:30 – 8:30 Registration/Check- in/Display-Demo Set-up

Session 1: 8:30 – 10:00 Alamo Room - Welcome – NASA/NESC/NDE/Bill Prosser; ASNT/Duke; Gilruth/Dylan Smith

1. Workshop Overview and Concepts Driving the Session Topics/NASA/NESC/George Studor
2. External Inspection Capability/Challenges for ISS and Orion: NASA/ISAG/Jacobs/Robert Scharf
3. Soyuz Inspection: NASA JSC/Michael Rollins/Gary Kilgo

Break: 10:00 – 10:30

Session 2: 10:30 – 11:30 Alamo Room - Environments

1. Micro-Meteoroid and Orbital Debris (MMOD) Models: NASA/JSC/Mark Matney
2. On-Orbit Detection of Spacecraft Charging Effects – NESC/MSFC/Joe Minnow

Lunch 11:30 – 12:30

Lunch Speaker 11:45 – 12:15 "Accommodating Technology Demonstrations on ISS" NASA JSC/George Nelson

Session 3: 12:30 – 2:30

Session 3a: Alamo Room– User Needs (1)

1. Shuttle Columbia Lessons Learned: NASA JSC/Ben Pawlik
2. On-Orbit Inspection of EVA Hardware: NASA/Kevin Wells
3. ISS Leak Detection and Repair: NASA/JSC/ES2/Kornel Nagy
4. Inflatable Habitat Inspection Needs: NASA/JSC/ES2/Doug Litteken

Session 3b: Discovery Room – 3D Imaging

1. 3D from Tango: Dot Product/Tom Greaves
2. High Precision Industrial 3D Metrology Technology for Aerospace Applications: Capture3D/Steve Deremer
3. The New Generation of Optical Sensors: Photon-X/Preston Bornman
4. Merging Raman Spectral & 3D Imaging LIDAR for In-Space Inspection: SPEC/Brad Sallee

Session 3c: Coronado Room– Flight Systems (1)

1. RELL (Robotic External Leak Locator) On-orbit Demo: NASA JSC/Adam Naids
2. Development of the Space Debris Sensor (SDS): NASA JSC/Joe Hamilton
3. Orion External Camera System for EM-1/EM-2 Missions: Deep Space Systems/Steven Bailey
4. Networked System for Inspection and Situational Awareness: EV/Ken Fisher & Vic Studer

Break 2:30 – 3:00

Session 4: 3:00 – 5:00

Session 4a: Alamo Ballroom – Flight Systems (2) - ISS Inspection External Enhancements and On-Orbit Demos

1. EHDC (External High Definition Camera) Capability: NASA/JSC/Michael Rollins/Gary Kilgo
2. Solar Array Mast Imagery Discussion for ISIW: NASA/JSC/Gary Kilgo
3. Dextre-Deployable Vision Sensor(DDVS): Canadian Space Agency/Sebastien Gemme
4. VIPIR-2 and RAVEN On-orbit Tests for Spacecraft Servicing*:* GSFC/LMSS/Justin Cassidy

Session 4b: Discovery Room - Micro-Satellite Inspection Platforms

1. Free Flying Satellite Inspector: Aerospace Corp/Dave Hinkley
2. The Evolution of Nano Satellite Proximity Operations: Tyvak, Inc./Austin Williams

3. AstroBee/SPHERES Experiment Platform on ISS: NASA Ames/Darryl LeVasseur
4. Seeker: An IVA/EVA Cubesat for In-flight Inspection & Anomaly Resolution: JSC/Chris Radke, Vienny Nguyen

Session 4c: Coronado Room - Penetrating Imagers

1. Millimeter Wave Real-time 3D Imager: Missouri S&T University/Reza Zoughi/Mohammed Ghasr
2. In-Space NDE for Screening: Southwest Research Institute(SwRI)/Jay Fisher
3. **GotoMtg:** Defect Detection by way of Dual Tuned Resonant Sensor: Exel Orbital/Kevin McGushion
4. **GotoMtg:** Differential Terahertz Imaging for Detection of Subsurface Damage: Picometrix/Dave Zimdars

Wednesday, February 1

8:00-8:30 – Bonnie Dunbar - "Remembering Columbia" former astronaut, now Texas A&M

Session 5: 8:30 – 10:00 (Coffee in Alamo)

Session 5a: Alamo Ballroom - User Needs (2)

1. Propulsion System Inspection and Monitoring Needs – NASA/JSC/EP/Chris Radke
2. ISS Internal Maintenance and its Needs: NASA/JSC/Nick Robbins
3. Overview of Current Advanced Human Mission Studies– NASA/Joe Caram/Larry Toups

Session 5b: Discovery Room - Image Processing and Data Automation (1)

1. Inspection Guidance with Visible Object Detection Support: Iowa State Univ/Rafael Radkowski
2. Extended Kalman Filtering for Localization&Mapping Applications:Texas A&M/Manoranjan Majji/John Junkins
3. Image Enhancement and Automated Inspection/Assessment: Sandia Nat'l Labs/Bob Habbit

Break: 10:00 – 10:30am (breakfast, snack available – in Brazos Room)

Session 6: 10:30 – 12:00

Session 6a: Discovery Room – Inspection Sensor Test Opportunities

1. NanoRacks ISS Facility: NanoRacks, Inc./Michael Johnson
2. Orion Systems and Potential Secondary Payload Opportunities – LM/Joe LeBlanc
3. Design & Test of Operational Lighting Environments on ISS: JSC/Wyle Labs/Toni Clark

Session 6b: Coronado Room - User Needs (3)

1. Railroad Track Inspection - The Need for Speed: Georgetown Rail/Jeb Belcher
2. Finding a Product-Application Fit for Inspection and SHM Technology: Aging Aircraft/James Hill
3. **GotoMtg:** Navy Ship and Sub NDT&E Needs: Navy Undersea Warfare Center/Patric Lockhart

Session 6c: Longhorn Room – SHM Sensors for Condition-based Inspection (1)

1. Internal Radio-frequency Instrumentation System(IRIS): NASA JSC/Ray Wagner
2. Recent Space-flight Applications of Standalone Structural Monitoring Systems: NASA JSC/Nathan Wells
3. SHM as an Enabler for Future AF Space Assets: AFRL/Space Vehicle Dir/Derek Doyle-Justin Bruh(presenter)

Lunch: 12:00 – 1:00pm – Food in the Brazos Room – eat in the presentation rooms or outside at the picnic area

Session 7: 1:00 – 3:00

Session 7a: Discovery Room – Robotic Platforms for Difficult to Access Areas (1)

1. Videoscopes Technology-Approaching Physics-Limited Resolution and Operations – Olympus/Frank LeFleur

2. Fully Controllable Videoscopes: Uniwest/Carlos Pairazaman
3. Advancements in True3D Surface Scanning & Analysis – GE/Paul Thompson
4. **GotoMtg:** Controllable Snake Inspectors and Applications: OC Robotics/Adam Mallion

Session 7b: Coronado Room - Backscatter X-ray Technologies (1)

1. Compton Imaging NDE of Spacecraft TPS: Physical Optics Corp/Victor Grubsky-Volodymyr Romanov
2. **Webex**: 120kV Hand-Held Backscatter X-Ray Imager: Heuresis Corp/Peter Rothschild
3. Versatile Detector for Scanning Beam X-ray Inspection: AS&E/Martin Rommel/Aaron Couture
4. Flexible Digital X-ray Development: DTRA/Robert Woods, Army Research Lab(ARL)/Eric Forsythe

Session 7c: Longhorn Room - SHM Sensors for Condition-based Inspection (2)

1. Propellant Tank Quantity Sensing in Zero-G: NASA/Nehemiah Williams, **GotoMtg:** NASA/KSC/Rudy Werlink
2. SHM for Long Duration Spaceflight Habitats: X-Wave Innovations/Dan Xiang
3. Expandable sensor networks for Structural Health Monitoring: Accelent Technologies/Kumar-Bergman-Li3.

Break 3:00 – 3:30pm – Snacks will be in the Brazos Room (2nd Floor)

Session 8: 3:30 – 5:00

Session 8a: Discovery Room – Next Gen Systems (2)

1. Contact Point Corrosion on Carbon Steel: VIR Inspection/Brian K. Beresford
2. Field-portable Electron Microscopy In Space: Voxa/Chris Own
3. Thermography Modeling and Information Integration: Iowa State Center for NDE/Steve Holland

Session 8b: Coronado Room - Backscatter X-ray Technologies (2)

1. Measuring Modulation Transfer Function for Backscatter Radiography NDE: University of Florida/Jim Baciak
2. MiniMax & MERAY X-Ray, Thermal Neutron Radiography of Gas: Los Alamos Nat'l Lab/Scott Watson
3. Measurements of Random Rough Surfaces at Submillimeter Wavelengths: NIST/Erich Grossman

Session 8c: Longhorn Room - Image Processing and Data Automation (2)

1. Automated Interpretation of In-space NDT Data of Carbon Composite Damage: TRI Austin/Carl Magnuson
2. Enhanced Attribution of Spacecraft Malfunctions: Ridgetop Group Inc./Doug Goodman
3. Total Focusing Method (TFM) for Phased Array Ultrasound: Advanced OEM Solutions/Gavin Dao

Thursday, February 2, 2017

Session 9: 8:00 – 10:00

Session 9a: Coronado Room - Research and Development Centers

1. Penetrating Imager Technologies: Pacific NW National Labs/Doug McMakin
2. Iowa State Center for Non Destructive Evaluation: Iowa State Univ/Steve Holland
3. Guided Acoustical Wavefield Imaging for Damage Detection, Characterization &more: GTech/Massimo Ruzzene
4. Integrity Assessment of Difficult to Inspect Pipelines Evaluating Select Areas Using High Resolution NDE: Pipeline Research Council International(PRCI)/Technology Development Center(TDC): Hans Deeb

   Note: Don't miss the PRCI/TDC Tour: January 30, 2:00-4:00pm (now they tell me!)

Session 9b: Longhorn Room – Measuring Hypervelocity Impact Physics

1. Multi-Spectral Measurements for Detection, Location & Evaluation of Impacts: Invocon/Aaron Trott
2. Chemical Sensing Array Platform for Continuous and Autonomous Event Monitoring: JPL/Abhigit Shevade
3. **GotoMtg:** MMOD Hypervelocity Impact Test & Piggyback Sensing: Univ of Dayton Res Inst/Kevin Poormon
4. **GotoMtg:** Hypervelocity Impact Testing at NASA's WSTF: NASA/WSTF/Karen Rodriguez

Session 9c: Lone Star Room – Collaborative Materials and NDE/Inspection (1)

1. **Webex:** Self-Healing Polymers and Composites – Univ of Illinois Urbana/Nancy Sottos
2. In-Space Manufacturing and Verification: Made in Space, Inc./Derek Thomas
3. How to Create a 3D Model from Scanned Data in 5 Easy Steps: NASA/JSC/ES2/Richard Hagen
4. In-Situ Repair of TPS: NASA/JSC/ES/Mike Fowler

Break: 10:00 – 10:30
Session 10: 10:30 – 12:00
Session 10a: Coronado Room - Next Generation Systems (3)

1. Systems for COPV Quality Assurance and MMOD Impacts: NASA WSTF/Charles Nichols
2. Damage Detection in Composite Materials&Quantitative Structural Assessment:Digital Wave Corp/Mike Gorman
3. Acousto-Ultrasonics NDE for Damage Severity in Composite Materials: Texas A&M/Ramesh Talreja

Session 10b: Longhorn Room – Robotic Platforms for Difficult to Access Areas (2)

1. EPM Grippers,DogTags & LISA Arms for In-Space Inspection & Servicing:Altius Space Machines/Jonathan Goff
2. Thin Cable-like Robots for Inspection: Clemson Univ/Ian Walker
3. Gecko Inspired Adhesives for Robotic Space Applications: JPL/Stanford/Arul Suresh

Session 10c: Lone Star Room - Collaborative Materials and NDE/Inspection (2) - Open & Guided Discussion:

NASA/NESC/Materials Tech Fellow: Rick Russell

- Materials characterization of plasma as it leaves the hole during the impact & dust left around the hole
- Materials characterization of leaks on or floating away from the spacecraft or EVA suit.
- Materials doping to allow sensors to provide damage shape/depth corresponding to the NDE tool used.
- Materials support simpler TPS repair, self-healing of Inflatable/other pressure vessels, TPS & substrate.
- Materials selection for 3D printing to enhance inspection and save impact testing.

Lunch: Lone Star Room – 12:00 – 1:00
- Lunch Speaker: American Petroleum Institute (API)/John Nyholt
"Bridging the Gap between the Aerospace and Petro-Chemical Industries"

Session 11: 1:00 – 3:00 - One-on-One Sessions – Lone Star, Coronado, Longhorn
15 minute sessions can be scheduled ahead of time at the Registration Desk (see next page for sample)
Note: **Demonstrations/Displays in Discovery Room**

Break: 3:00 – 3:30

Session 12: 3:30 – 4:30 Forward Planning/Close Workshop – George Studor & All Available ISIW Survivors

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Session 11 One-on-One Sign In Sheet
Sign Up at Registration Desk
LS=Lone Star Room, C=Coronado Room, LH=Longhorn Room

Note: Some "Hosts" and May not be available for the entire time, their availability will be determined Jan 31.

One-on-One Tables and 15 Minute Time Slots

Table	Candidate Topic	Org	User	1	2	3	4	5	6	7	8
LoneStar Room											
LS-1	ISS Exterior/Image Science & Analysis	1-2 / NASA	Scharf/Moore								
LS-2	ISS Interior Maintenance/Operations	5a-2/NASA	Robbins								
LS-3	ISS Module Leak Detect/Location	3a-3/NASA	Nagy								
LS-4	ISS Experiment Program	3-0/NASA	Nelson + TBD								
LS-5	ISS Astrobee/SPHERES Experiment Lab	4b-3/NASA	LeVasseur								
LS-6	ISS NanoRacks Facility	6a-1/NanoRacks	Johnson								
LS-7	Orion Secondary Payloads	6a-2/LM	LeBlanc								
LS-8	MMOD Models	2-1/NASA	Matney								
LS-9	EM Charging	2-2/NASA	Minnow								
LS-10	EVA Needs	3a-2/NASA	Wells								
LS-11	Spacecraft Thermal Protection Sys	1on1/NASA	Bouslog								
LS-12	Inflatable Modules	3a-4/NASA	Litteken								
LS-13	Advanced Human Spaceflight Missions	5a-3/NASA	Toups(Caram)								
LS-14	Lighting Environment Test Facility	6a-3/NASA	Clark								
Coronado Room											
C-1	Propulsion Systems	5a-1/NASA	Radke/Hurlbert								
C-2	COPV monitoring/Insp	10a-1/NASA	Nichols								
C-3	Spacecraft Vehicle Imagery Sys.	3c-4/NASA/JSC	Fisher/Studer								
C-4	NASA NESC NDE/SHM Discipline	*NASA/NESC*	Prosser/Hodges								
C-5	NASANESC Materials Tech Discipline	*NASA/NESC*	Russell								
C-6	Civilian/DOD Threats	7b-4/DTRA/ARL	Woods/Forsythe								
C-7	TSA Threats	DHS	Foster								
C-8	Material Characterization for NDE	8b-3/NIST	Grossman								
C-9	ASNT-Education Initiative	1-on-1/ASNT	Duke+Keck?								
C-10	Iowa State Center for NDE/Thermograp	9a-2/8a-3/I State	Holland								
C-11	Spaceflight Sensors and NDE R&D	4c-2/SWRI	J. Fisher								
Longhorn Room											
LH-1	Backscatter Xray	8b-1/UofFlorida	Baciak								
LH-2	Laboratory R&D	*5b-3/Sandia NL*	Habbit								
LH-3	Compact Field Radiography	8b-2/LANL	Watson								
LH-4	Penetrating Imagers	9a-1/PNNL	McMakin								
LH-5	Aging Aircraft	6b-2/A-Aircraft	Hill								
LH-6	NDE for Manufacture in Space	9c2/madeinspac	Thomas								
LH-7	Rail-track Inspection-Georgetown Rail	6b-1	Belcher								
LH-8	Oil and Gas – American Petroleum Inst.	11-0/API	Nyholt								
LH-9	Oil & Gas	BP	Truch								
LH-10	Pipeline Res Council/Tech Dev Center	9a-4/TDC	Deeb								

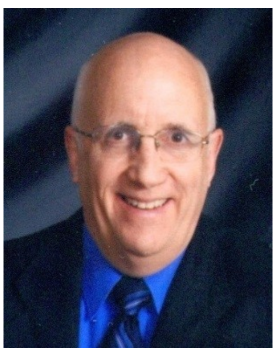
Additional One-on-One User/Stakeholders who will not be Presenting:

Joe Foster, Program Manager
Homeland Security Advanced Research Projects
Explosives CounterMeasures
202-254-5314; 202-251-5684
BAA information:
https://baa2.st.dhs.gov/portal/BAA/

Dave Truch, BP Technology Director, DIO
IT&S Information Technology and Services
BP - 501 Westlake Park Blvd., Houston, Texas, 77079
Lync : +1 281 892 7008; Cell: +1 630 854 2978:
Admin: Rosa Hilburn - +1 281 892 3376
Email: dave.truch@bp.com

Session: 1-1 **George Studor - NESC/NDE – ISIW 2017 Workshop Chair**
"Workshop Overview and Concepts Driving the Session Topics Chosen"
George.f.studor@nasa.gov; gmstudor@gmail.com
763-208-9283; 281-415-3986(cell)

Abstract: George will use the hardcopy ISIW 2017 Program pamphlet to overview the workshop purpose, key technologies, method of enabling partnerships, how to use the pamphlet, presentation loading, identify key players in making the workshop a success, address the organization and agenda, location of rooms, use of wireless access and codes, webex/telecom remote access, how to find demo tables, sign -up for one-on-one sessions, food provisions and future planning discussions. Our conference could not be timelier, in that at 7:59am Central time Feb 1st, is when we lost our beloved crew on Columbia 14 years ago…we plan to remember that.



Background: Mr. George Studor is a retired NASA senior project engineer for technology applications and currently supports the NASA Engineering and Safety Center via three technical discipline teams (TDTs):
- NDE—In-Space Inspection
- Avionics—Wireless Community of Practice
- Robotic Spacecraft— Natural Systems into Systems Engineering Process.

January 19th marked the completion a 2 ½ year study and report to the NESC on MMOD risks, Shuttle Lessons Learned and potentially mitigating technologies that can be applied in space for damage detection and characterization. Prior to that, George initiated and supported a year-long Soyuz Descent Module Re-Entry Thermal Protection Systems inspection study under Jacobs Engineering/LZ Technologies in the JSC/XI4 Image Science and Analysis branch to address the ke issue of inspection capability and implementation of Soyuz. George is retired NASA (2013) and USAF(1999) as a Major and former C-130 Pilot. He lives with his wife Mary (and his 97 year old mother-in-law too!) in Minneapolis.

1981-1982 - MS Astronautical Engineering, USAF AFIT
1972-1976 - BS Astronautical Engineering, USAF Academy

Session: 1-2
"ISS and Orion Ext. Inspection Capabilities / Challenges"
Demo: No
Poster: No
One-on-One Table: Yes

Robert Scharf | Randy Moore
NASA/JSC/XI4/Image Science & Analysis Group
Robert.Scharf-1@nasa.gov; Randall.C.Moore@nasa.gov
281-682-8092; 281-244-1079

Abstract: The rationale and strategy for inspection of the International Space Station (ISS) and Orion is based largely on lessons learned during the Shuttle/Mir, ISS Phase 1 Program. Experience gained through the survey of Mir established the basis for conducting similar surveys of ISS. Imagery is used today, as it was then, as a means for monitoring the condition of the spacecraft, support problem solving and anomaly investigations, and to provide early detection of changes affecting the long-term health of the aging station. The engineering data derived from imagery validates environment and dynamic models, contributes to spacecraft design measures and supports risk reduction. During the assembly and early utilization phase of ISS, the Space Shuttle provided an excellent platform for the acquisition of ISS surfae imagery while docked and during proximity maneuvers, providing 100% coverage. Now, the ISS relies upon its own suite of inspection assets. ISS inspection coverage is constrained by the limits of the procured technology, installation locations, and operational priorities. This presentation will provide an overview of the available ISS and Orion inspection assets (primarily regarding external imagery) and summarize the challenges in acquiring a comprehensive survey of space vehicles.

Bio: Robert Scharf Robert currently serves as the Jacobs Contractor Manager of the Image Science and Analysis Section in the Science Department on the JSC Engineering Technology and Science (JETS) Contract managing a wide range of image analysis services provided to Astromaterials Research & Exploration Science (ARES/NASA) and various space programs. Starting in 1995, he has served in various roles as an Imaging Scientist, Mir External Photo/TV Survey Lead, ISS External Survey Lead, Orbiter Inspection Coordinator, and Project Manager prior to becoming Manager in 2012.

Bio: Randy Moore is the NASA manager of the JSC Image Science and Analysis Group. The Image Science and Analysis Group consists of scientists, engineers and specialists providing unique expertise in the planning, acquisition, handling, modification, analysis and interpretation of photo and video imagery. Prior to joining the Image Science and Analysis Group in 2012, Mr. Moore's assignments included Project Manager for the upgrade and sustaining engineering of internal and external camera systems for the Space Shuttle and Project Manager for an external high definition video camera for Space Station.

Session: 1-3
"Soyuz Inspection"
Demo: No
Poster: No
One-on-One Table: No

Michael Rollins | Gary Kilgo
Jacobs Tech. | Barrios Tech.
john.m.rollins@nasa.gov
gary.w.kilgo@nasa.gov
281-483-1262 | 281-244-7926

Abstract: (Soyuz Inspection) Soyuz spacecraft are generally docked at the ISS for about 6 month The Image Science and Analysis Group(ISAG) works with the ISS program to develop and improv inspection capabilities for finding micrometeoroid and orbital debris (MMOD) impacts to the Soyuz descent modules. Techniques used to date have involved use of fixed-mount external cameras as well as imaging with high resolution digital still cameras through ISS windows.

Background: Michael Rollins is an image analyst with Jacobs Technology, supporting ISAG at NASA Johnson Space Center. Since receiving PhD in Electrical Engineering in 1992, Michael has worked as an image analyst, starting with Science and Technology Corporation, and has supported JSC since 1998. Principal areas of work have included smoke and obscurant feature tracking, optical-correlator–based pattern recognition, crewed mission imager planning and testing, on-orbit spacecraft inspection and separation event analysis, and interferometry experiments.

Background: Gary Kilgo is an image analyst with Barrios Technologies, supporting the Image Science and Analysis Group at NASA Johnson Space Center. Previously, he was the lead Photographic and Video trainer for 22 Space Shuttle missions while employed with United Space Alliance (USA). Since joining Image Science and Analysis Group four years ago, he has been responsible for coordinating and analyzing the photographic surveys of the International Space Station.

Session 2-1
"Micro-Meteoroid and Orbital Debris (MMOD) Models"
Demo: No
Poster: No
One-on-One Table: Yes

Mark Matney
NASA JSC/XI4/Planetary Studies
mark.matney-1@nasa.gov
281-483-2258

Abstract: Despite of the tireless work by space surveillance assets, much of the Earth debris environment is not easily measured or tracked. For every object that is in an orbit we can track, there are hundreds of small debris that are too small to be tracked but still large enough to damage spacecraft. In addition, even if we knew today's environment with perfect knowledge, the debris environment is dynamic and would change tomorrow. Therefore, orbital debris scientists rely on numerical modeling to understand the nature of the debris environment and its risk to space operations throughout Earth orbit and into the future. This talk will summarize the ways in which modeling complements measurements to help give us a better picture of what is occurring in Earth orbit, and helps us to better conduct current and future space operations.

Bio: Mark Matney is the Modeling Lead for NASA's Orbital Debris Program Office at Johnson Space Center. He received his PhD in Space Physics and Astronomy from Rice University and has spent the last 25 years doing orbital debris research, first as a contractor and for the last 15 years at NASA. Mark has worked closely with the design of virtually all NASA Orbital Debris models, including the ORDEM series of environmental models.

Session: 2-2	
"On-Orbit Detection of Spacecraft Charging Effects"	**Joseph I. Minow**
Demo: No	**NASA/MSFC**
Poster: No	**joseph.minow@nasa.gov**
One-on-One Table: Yes	**256-544-2850**

Abstract: Spacecraft charging is a significant threat to spacecraft systems operating in hot space plasma environments because electrostatic discharge currents originating from charged materials can damage or destroy critical spacecraft components and materials. While numerous on-orbit anomalies and failures have been attributed to charging over the years, anomaly investigations are often hampered by the relatively small amount of information typically available from on-orbit systems. We first review charging mechanisms and the type of damage that can result from excess charge density on (or in) spacecraft materials. We then discuss the opportunities that in-space inspection of spacecraft may provide to better characterize charging damage and provide engineering teams with useful information that may lead to future improvements in spacecraft designs that mitigate charging hazards.

Background: Joseph Minow is the NASA Technical Fellow for Space Environments at Langley Research Center. After completing a PhD in physics from University of Alaska Fairbanks, he worked at NASA's Marshall Space Flight Center (MSFC) in the field of space environments and their effects on space systems, first with Sverdrup Technology (now Jacobs Engineering) for 5+ years and then as a civil servant with MSFC's Environments Branch for 11+ years. Dr. Minow's interests include characterizing space environments for space system design and operations, analysis and modeling of space plasma and ionizing radiation environments and effects, and investigation of on-orbit anomalies. He has contributed over 150 conference presentations, publications, and technical reports on topics related to space environments and their effects on space systems.

Lunch Speaker Jan 31 (11:45- 12:15)	
"Accommodating Technology Demonstrations on ISS"	**George C. Nelson**
Demo: No	**NASA – Johnson Space Center**
Poster: No	**George.Nelson-1@nasa.gov**
One-on-One Table: yes	**281.244.8514**

Abstract: The mission of the International Space Station (ISS) Program includes advancing science and technology research as well as demonstrating capabilities to enable future exploration missions beyond low Earth orbit. The ISS Program is utilizing the space station as a test bed to demonstrate operation techniques and capabilities that enable future missions. Several inspection related investigations have been conducted already on ISS and it continues to be the most robust and affordable means by which new space technologies can be demonstrated and tested. Access to the ISS is through the program's Research Integration Office and, specifically for non-NASA funded efforts, the Center for the Advancement of Science In Space (CASIS).

Background: Dr. George Nelson manages the ISS Technology and Science Research office in the ISS Research Integration office. Through this role he and his team accept and help to facilitate all of the NASA funded engineering and science research conducted on the ISS.

Session: 3a-1

Shuttle Columbia Lessons Learned

Demo: No

Poster: No

One-on-One Table: NO

Benjamin Pawlik
NASA/VA4
Benjamin.pawlik-1@nasa.gov
281-244-7089

Abstract: Following the Columbia accident, it was recognized that a timely process was required to inspect the Shuttle Orbiter to identify potentially catastrophic damages, and perform mitigation actions to protect the lives of the crew. The inspection processes, analysis tools, and repair methods did not exist at the time of Columbia, and had to be created and integrated together to allow end-to-end completion within the limited number of days on-orbit that the Orbiter consumables provided. The development of the real-time integrated process, and its maturation over several missions, provide several lessons in preparing for the inspection and evaluation of future vehicle damages.

Speaker Bio: Benjamin Pawlik was the NASA Mission Evaluation Room Manager for the Space Shuttle Return-to-Flight missions following the Columbia accident, and led the development of the post-Columbia real-time Damage Assessment Team process. He is currently a Mission Manager within the NASA Commercial Crew Program.

Session 3a-2	**Kevin Wells, EVA Chief Engineer**
"On-Orbit Inspection of EVA Hardware"	**NASA/Johnson Space Center**
Demo: No Poster: No	**kevin.wells-1@nasa.gov**
One-on-One Table: Yes	**281.244.0299**

Abstract: Following the end of the Space Shuttle Program, space suits and other EVA hardware are required to remain on-obit for durations much longer than they were designed to support. Coupled with the limitations on launch (up-mass) and return (down-mass) opportunities, these longer stays on ISS require increased efforts in on-orbit troubleshooting and repair in order to keep the hardware ready to support spacewalks for ISS maintenance and contingencies. Additionally, the age of the Extravehicular Mobility Unit (EMU)—approaching 40 years—has increased the need in recent years to perform non-destructive evaluation of EMU hardware. New inspection techniques are providing opportunities to investigate failures in the aging system and to provide better, more modern verification data in areas that were previously unavailable to the EMU hardware engineers.

Background: **Kevin Wells** is the EVA Chief Engineer at Johnson Space Center. He previously served as the EMU Hardware Manager in the EVA Office, where he was responsible for programmatic integration of EMU system hardware for ISS and Shuttle programs and navigated the transition to the post-Shuttle environment for resupply and sustaining of EVA hardware for ISS. His first job with NASA was in the EVA Tools & Crew Aids branch in the Engineering Directorate—where during the post-Columbia accident Return-to-Flight effort, he managed several Orbiter Thermal Protection System EVA repair hardware projects.

Session 3a-3	
"ISS Leak Detection and Repair"	**Kornel Nagy**
Demo: No	**NASA JSC/ES2**
Poster: No	**Kornel.Nagy-1@nasa.gov**
One-on-One Table: Yes	**281-483-9518**

Abstract: ISS has multiple pressurized modules that were developed by NASA and the ISS International Partners. There is a probability of damage to the pressurized modules by the low Earth orbit MMOD environment. The MMOD impacts may be severe enough to penetrate the pressure shell of the modules, resulting in an atmospheric leak. Detecting the location and repairing the MMOD damage is required to assure crew safety. The presentation is an overview and status of the ISS on-orbit Leak Detection and Repair effort.

Background: Dr. Kornel Nagy serves as structural engineer at NASA Johnson Space Center supporting ISS and future programs. He served as System Manager for Structural and Mechanical Systems for the International Space Station from 1996 to 2016. He was responsible for technical integration of the Structural, Mechanical, Meteoroid and Orbital Debris Protection and Loads and Dynamics Discipline areas for ISS. He served as Structures System Development Manager for Space Station Freedom Work Package 2. He has led design teams for Aero Braking Orbital Transfer Vehicle preliminary design, for Assured Crew Return Vehicle Study, for the Space Station Freedom Pre-Integrated Truss preliminary design and for the Space Station Redesign Option C. He has have been awarded ten US patents and three international patents. He is a registered professional engineer.

Session: 3a-4	**Doug Litteken**
“Inflatable Habitat Inspection Needs”	**Lightweight Structures**
Demo: No	**NASA Johnson Space Center**
Poster: No	**douglas.litteken@nasa.gov**
One-on-One Table: Yes	**281-483-0574**

Abstract: Inflatable habitats have been developed by NASA and commercial companies for use in space applications as human habitats. They provide significant volume savings compared to traditional metallic habitats and can enable large habitable volumes long duration exploration missions. An inflatable is a fabric based pressure vessel that is composed of a stack of fabric laye that provide air retention, structural support, micro-meteoroid and orbital debris protection, thermal protection, and atomic oxygen protection. From ground level developmental testing all the way up through flight and in-space operational life, these structures need to be properly monitored and inspected. Because of their unique construction, however, they require new inspection techniques to detect and measure damage to each layer. The presentation will cover the inspection needs of not only each material layer, but the ground testing, flight testing, and operational configurations that require inspections.

Background: Doug Litteken is a design and test engineer in the Structural Engineering Division, Structures Branch (ES2) at NASA Johnson Space Center. His work is focused on Lightweight Habitable Structures including inflatables and composites. He has worked with inflatables since 2009 and is actively investigating instrumentation and structural health monitoring for flexible structures. Aside from inflatables, he is a mechanical designer for the Parachute Canopy Instrumentation Platform (PCIP) team (2015-present) to capture wireless, real-time, structural data from a parachute canopy. He has recently received his master’s degree in mechanical engineering, with a focus on composite structures.

Session: 3b-1	
"3D from the Tango"	**Tom Greaves**
Demo: Yes	**DotProduct**
Poster: No	**tom@dotproduct3d.com**
One-on-One Table: No	**978-766-7050**

Abstract: Capturing and documenting the world in 3D on a phone has arrived with the Lenovo Tango Phab2 Pro. The Lenovo Phab2 Pro is the 3rd generation Tango device and the first Tango with a time-of-flight depth sensor. The first generation Tango "Peanut" was demonstrated by DotPoduct at ISIW 2014. Greaves will present data captured with the device and present some early analysis comparing the results with the Z+F 5010X laser scanner and the DotProduct DPI-8 scanner. Greaves will discuss use cases for the device and discuss the strengths and limitations of the technology. Workflows for extracting features from the color point cloud produced by the Tangos for use in CAD, BIM and analysis tools will also be discussed and demonstrated. Remarkably, some of the workflows can be executed end-to-end on the phone itself which features the Qualcomm Snapdragon 652 processor with 4 gigabytes of RAM.

Bio: Tom Greaves is chief marketing officer at DotProduct LLC where he is responsible for sales, marketing and customer support. DotProduct is a startup based in Boston with satellite offices in Houston and Wiesbaden, Germany. The company develops 3D data capture and processing software which allows mobile devices to capture and document the world in 3D. Before joining DotProduct, Greaves was executive director of CyArk, a not-for-profit whose mission is to document cultural heritage sites in 3D. Greaves founded the SPAR conferences in 2003 to serve the 3D laser scanning community. Greaves is a graduate of the Sloan School at MIT and has a M.Sc. in Physics from the University of British Columbia and a B.Sc. in Physics from Queen's University at Kingston.

Session 3b-2
"High Precision Industrial 3D Metrology Technology for Aerospace Applications"
Demo: Yes
Poster: Yes **www.capture3d.com**

Steve DeRemer
Capture 3D, Inc.
steve.deremer@capture3d.com
(281) 788-4402

Abstract: This talk will cover various aerospace applications, and how companies are replacing their traditional contact measurement equipment or adding additional measurement capacity with non-contact structured light metrology to have a better understanding of their manufacturing and production processes. Being able to shorten measurement setup and data collection time allows companies to focus on true process optimization. By having high quality color map inspection data on their part, mold, tool, and/or die allows companies to quickly apply the optimal corrective action and accurately predict trends to help speed up time to market, eliminate iterations and save an enormous amount of costs that were once being spent on rework and waste. Optical 3D structured light systems acquire the entire component geometry in a dense point cloud instead of only measuring individual points. The measured data obtained can be used in areas as inspection, reverse engineering, in pattern, tool and mold making, in engineering and machining (CAD/CAM), during first article inspection, in production related quality assurance (CAQ) and in process control (PCS).

Capture 3D and GOM are in a time of next generation metrology technologies, commercial off the shelf (COTS) automation, and customized automated solutions. ATOS non-contact structured blue light 3D scanners can not only accurately scan and inspect various sized parts and components, but optically track for part positioning, incorporate touch probe contact measurements, "back project" onto the part features for machining or welding, and incorporate static and dynamic deformation analysis. Our ScanBox and customized automation solutions completely automate the 3D scanning, inspection, and reporting routine. The VMR (Virtual Measuring Room) module allows for automatic sensor positioning for quick and easy offline and online programming for increased throughput, productivity, and repeatability. Automated solutions can also be integrated with a touchscreen Kiosk interface, bar code, and RFID readers.

Background: Mr. Steve DeRemer is a Technical Application Specialist at Capture 3D, a leader in innovative non-contact metrology solutions for 3D scanning, inspection, and reverse engineering applications. During his eighteen year career in the metrology field, he has utilized many different types of scanning and measurement technologies. In 2010, Mr. DeRemer joined the Capture 3D team, where he is tasked with helping companies optimize manufacturing processes with metrology, identify unique applications, and collaborate with companies on process improvement techniques.

Session 3b-3	**Preston Bornman**
"The New Generation of Optical Sensors"	**Photon-X SPI 3D**
Demo: No	**preston@photon-x.com**
Poster: No	**713-416-2281**
One-on-One Table: No	**www.photon-xllc.com**

Abstract: With NASA currently assessing the life extension capacity of the International Space Station (ISS), inspection techniques are used as a critical element in determining how long the ISS can be safely operated. Since there are limited resources available on the ISS, techniques that utilize low power, perform multiple functions, and require no radiation sources are preferred. Photon-X has developed and demonstrated a high- resolution inspection technique that utilizes Photon-x's proprietary Spatial Phase Imaging (SPI) to provide 3-D imaging using a single lens camera and natural lighting. SPI can be used across a broad dynamic range and can be used to detect emitted and reflected energy to create a 3-D image of the object under examination. SPI systems are typically comprised of a camera and a laptop. SPI imaging has been used to assess corrosion and physical damage on surfaces, biometric analysis, and object tracking, among others. The broad range of applications to the ISS, as well as future NEO and deep space operations, similarly includes corrosion damage, micro-meteoroid/orbital debris (MM/OD) damage assessment, autonomous rendezvous and docking/berthing, logistics management, biometric measurement, and autonomous robotics. The presentation introduces the fundamentals of SPI, discusses previous applications and demonstrations, and gives an overview of potential ISS and other space bound applications.

Speaker Bio: Mr. Preston Bornman is a Director for Photon-X, LLC. The Company designs and builds optical sensors and software applications that provide real-time numerical 3D capture and intelligent analytics of the physical world using the proprietary measurement of emitted electromagnetic energy. From driverless vehicles and oil rig maintenance to surgical procedures, the **Photon-X Spatial Phase Imaging (SPI)** technology has revolutionized the manner in which computers and humans see and interpret the world around them. The SPI optic sensor and companion analytic software has the potential to replace current optical sensors in nearly every current and future product that needs to see the world. **Photon-X is the New Generation of Optical Sensing and Analytics.**

Preston is the President of Wyatt Petroleum, Founder of One World Sports, a U.S. cable sports network and a Director of Photon-X. Preston also serves on the board of IDEAS Energy Services, which is the commercialization company for Photon-X in the Aerospace, Energy, and Transportation business segments. Preston has a BA from Southern Methodist University and an M. S. and B.S. in Computer Science.

Session 3b-4
"Merging Raman Spectral & 3D Imaging LIDAR for In-Space Inspection"
Demo: Yes Poster: No
One-on-One Table: No

Brad Salle
System Processes and Engineering (SPEC)
sallee@spec.com
512-479-7732
www.spec.com

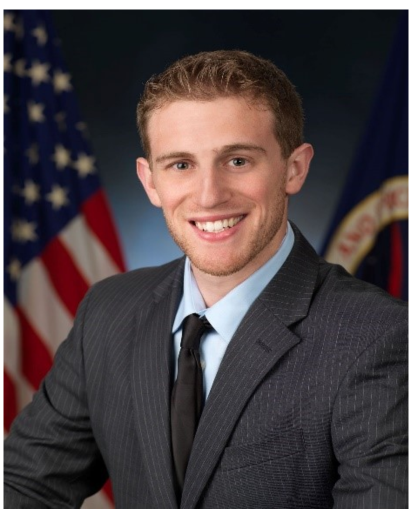
Abstract: The NASA Inspection LIDAR program details will be presented. The LIDAR is designed to inspect satellite external skins for damage caused by micro meteorites by using a Raman spectral LIDAR and an ultra-high range accuracy 3D imaging LIDAR. The Raman LIDAR can detect the chemical composition of each pixel in the scene, allowing detection of adsorbed leak materials and material ejected during a meteor impact from inner layers. The 3D imaging LIDAR can detect range down to 25 micron accuracy and has small cross range pixels, allowing detection of local deformation around a small impact hole, and detection of the depth of the hole. Both LIDAR images are combined, with a RGB imager allowing an evolving 3D image with overlay as the surface is passed over. This allows imaging inside holes as small as 0.5mm from various angles, allowing size determination of a larger subsurface hole. The LIDAR is being sized in a 2U configuration for deployment flexibility on arms or free flight platforms.

Background: Mr. Bradley Sallee is the principal investigator at System Processes and Engineering (SPEC) Inc. in Austin, Texas. Brad has led all LADAR and LADAR ROIC programs at SPEC, as well as aided in nonlinear optic programs with the Sensor Tran group and DRFM (Digital RF Memory) programs. As principle engineer at BAE Systems, Mr. Sallee was technical lead on LADAR and SAL guided missiles. Mr. Sallee has 43 years of experience in sensor and sensor countermeasure design and performance analysis. He developed radar lab measurement test techniques and software for stealth materials, an imaging Radar for field tests of stealth materials, and conducted Optical, IR and hyperspectral discrimination analysis. He holds a B.S.A.S.E from the University of Texas.

Session: 3c-1
"Robotic External Leak Locator (RELL) and On-Orbit Baseline and Validation Test"
Demo: No Poster: No
One-on-One Table: No

Adam Naids
NASA JSC/EC7
adam.j.naids@nasa.gov
281-483-2547

Abstract: The Robotic External Leak Locator (RELL) is a robotically operated tool designed to locate ammonia leaks in the ISS External Thermal Control System (ETCS). It was built as a technology demonstration to determine if a mass spectrometer and total pressure gauge are suitable instruments for locating leaks. The project recently performed an on-orbit evaluation to measure the background environment around the ISS and understand how the background will affect future leak location. This evaluation was the most in depth of its kind and will provides unique insight into the pressure environment in the immediate vicinity of the ISS.

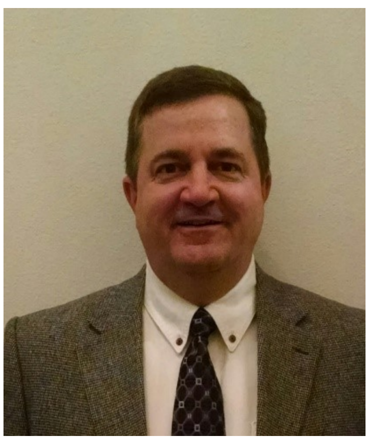


Background: Adam Naids graduated with a Bachelor's Degree in Engineering Physics from Embry-Riddle Aeronautical University. He now works at NASA's Johnson Space Center as Project Manager for Extravehicular Tools (EVA) and Equipment.

Session 3c-2
"Development of the Space Debris Sensor (SDS)"
Demo: No
Poster: No
One-on-One Table: No

Joe Hamilton
NASA/JSC/XI
joseph.a.hamilton@nasa.gov
281-483-6118

Abstract: The Space Debris Sensor (SDS) is a NASA experiment scheduled to fly aboard the International Space Station (ISS) starting in 2018. The SDS is the first flight demonstration of the Debris Resistive/Acoustic Grid Orbital NASA-Navy Sensor (DRAGONS) developed and matured by the NASA Orbital Debris Program Office. The DRAGONS concept combines several technologies to characterize the size, speed, direction, and density of small impacting objects. With a minimum two-year operational lifetime, SDS is anticipated to collect statistically significant information on orbital debris ranging from 50 µm to 500 µm in size.



Background: Joe Hamilton is the Principal Investigator for the Space Debris Sensor on ISS and the lead for radar measurements in the NASA Orbital Debris Program Office. Joe's experience includes USAF Officer/Pilot, NASA Systems Engineer, USN Test Pilot School Graduate, Concept Exploration Manager, Spacecraft Crew Survival Integrated Investigation Team, Space Shuttle Program Office, NASA Debris Radar Project Manager.

- BS in Astronautical Engineering, USAF Academy, CO.
- MA in Public Management, Midwestern State University, TX
- MS in Physical Science, University of Houston – Clear Lake, TX

Session 3c-3
"Orion External Camera System for EM-1/EM-2 Missions"
Demo: No
Poster: No
One-on-One Table: Yes

Steve Bailey
Deep Space Systems
steve.bailey@deepspacesystems.com
720-840-6895

Abstract: The engineering camera system for Orion EM-1 and EM-2 is being developed and delivered by Deep Space Systems in Littleton Colorado. The system consists of 11 cameras and two camera controllers per mission. There are two types of cameras, 7 wireless 5.8 GHz 12 Mpixel cameras with onboard compressions and recording and 4 wired USB3.0 frame grabber cameras with 5 Mpixel resolution. The Camera Controllers each have 0.5GB of RAID-1 memory and the ability to wirelessly transmit data between them via 60GHz WiGig radios with phased array tracking antennas, allowing data transmission during Crew Module and Service Module separation. There are wireless cameras on each of the 4 solar arrays. As the 2 axis solar arrays gimbal forward and aft and side to side the array mounted cameras are able to inspect the vehicle from the docking adapter to the main engine bell.

Speaker Bio: Steve Bailey is the founder of Deep Space Systems. Since its beginning in 2001 DSS has been involved with a variety of planetary exploration missions, studies and proposals. In 2009 DSS was recognized NASA's Small Business of the Year. Steve has worked exclusively on human and robotic space exploration systems since 1983, in industry, as an employee of JSC and JPL, and as an entrepreneur. He has supported human exploration projects such as the Space Shuttle and Orion, as well as robotic exploration missions including Mars Pathfinder, Mars Climate Orbiter, Mars Phoenix, and OSIRIS-REx. Steve served as the Spacecraft System Design Lead for the Mars Polar Lander and the Mars Reconnaissance Orbiter.

Session: 3c-4
"Networked System for Inspection and Situational Awareness"
Demo: No
Poster: No
One-on-One Table: Yes

Ken Fisher | Victor Studer
NASA – Johnson Space Center
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victor.j.studer@nasa.gov
281-483-1496

Abstract: The Johnson Space Center has been involved with the development of cameras and imaging systems for manned spacecraft since the 1960's. We are continuing this tradition by adapting the latest technology into the imaging systems being developed for today's spacecraft. The imaging system on Orion and others have been the focus of recent work. With video and computers merging into common systems, it is important to follow that trend by using standardized computer hardware and standard computer interfaces along with wired and wireless networking to build the system. This presentation outlines a low cost approach to build a general purpose imaging system that can be applied to spacecraft, spacesuits, and other vehicles.

Background: Ken Fisher is a senior design engineer at the NASA Johnson Space Center and has been involved in the development of imagery and video systems for NASA spacecraft for over 27 years. He was instrumental in the transition from the analog video system on the Space Shuttle to a digital high definition video system. He has also been involved with the development of various imagery upgrades for the International Space Station. Ken holds BSEE and MSEE degrees from the University of Connecticut and an MSEE from Rice University.

Session: 4a-1
"EHDC (External High Definition Camera) Capability"
Demo: No
Poster: No
One-on-One Table: No

Michael Rollins | Gary Kilgo
Jacobs Tech. | Barrios Tech.
john.m.rollins@nasa.gov
gary.w.kilgo@nasa.gov
281-483-1262 | 281-244-7926

Abstract: (EHDC Capability) External High Definition Cameras are in the process of being mounted onto to existing fixed cameras at certain ISS external locations. The camera systems involve high-resolution commercial off-the-shelf cameras as well as a zoom lens, protective housing, and (initially) WiFi connectivity to the ISS, and they share pan and tilt units with earlier-placed standard-definition video cameras. The resolution of the cameras will make them very valuable in ISS external inspection and situational awareness operations.

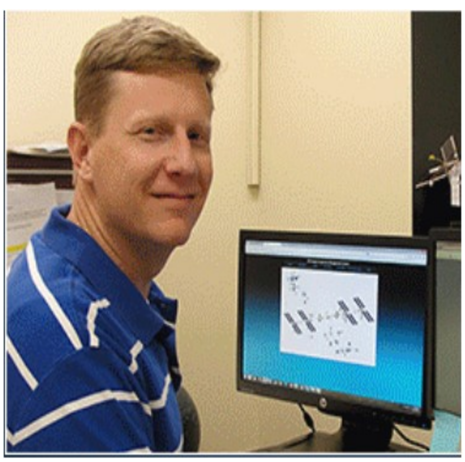
Background: Michael Rollins is an image analyst with Jacobs Technology, supporting ISAG at NASA Johnson Space Center. Since receiving PhD in Electrical Engineering in 1992, Michael has worked as an image analyst, starting with Science and Technology Corporation, and has supported JSC since 1998. Principal areas of work have included smoke and obscurant feature tracking, optical-correlator–based pattern recognition, crewed mission imager planning and testing, on-orbit spacecraft inspection and separation event analysis, and interferometry experiments.

Background: Gary Kilgo is an image analyst with Barrios Technologies, supporting the Image Science and Analysis Group at NASA Johnson Space Center. Previously, he was the lead Photographic and Video trainer for 22 Space Shuttle missions while employed with United Space Alliance (USA). Since joining Image Science and Analysis Group four years ago, he has been responsible for coordinating and analyzing the photographic surveys of the International Space Station.

Session: 4a-2
"ISS SA Mast Inspections"
Demo: No
Poster: No
One-on-One Table: No

Gary Kilgo
Barrios Tech
gary.w.kilgo@nasa.gov
281-244-7926

Abstract: (ISS Solar Array Mast Inspection) Solar Array Mast have been on orbit for the life of the International Space Station. The Image Science and Analysis Group (ISAG) works with the ISS program to develop and improve inspection capabilities for finding micrometeoroid and orbital debris (MMOD) impacts to the Solar Array Mast. Techniques used to date have involved use of fixed-mount external cameras as well as imaging with high resolution digital still cameras through ISS windows.

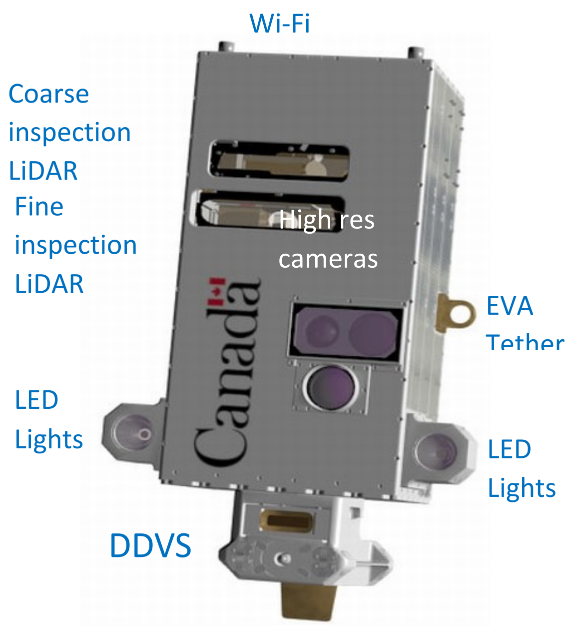


Background: Gary Kilgo is an image analyst with Barrios Technologies, supporting the Image Science and Analysis Group at NASA Johnson Space Center. Previously, he was the lead Photographic and Video trainer for 22 Space Shuttle missions while employed with United Space Alliance (USA). Since joining Image Science and Analysis Group four years ago, he has been responsible for coordinating and analyzing the photographic surveys of the International Space Station.

Session 4a-3
'Dextre Deployable Vision System(DDVS)"
Demo: No Poster: No
One-on-One Table: No

Sebastien Gemme
Canadian Space Agency
sebastien.gemme@canada.ca
450-926-5066

Abstract: Dextre Deployable Vision System (DDVS) will be a MSS payload used for inspecting the external surfaces of the ISS. It will be equipped with high resolution cameras, two LiDARS: one used for focused inspection and another one used for coarse, longer range, inspection. It will also be composed of illuminators and a long-wave infrared camera. DDVS will be operated from Dextre (SPDM), thus providing a mobile inspection capability to the ISS. The DDVS will be ready in the 2020-2021 timeframe.



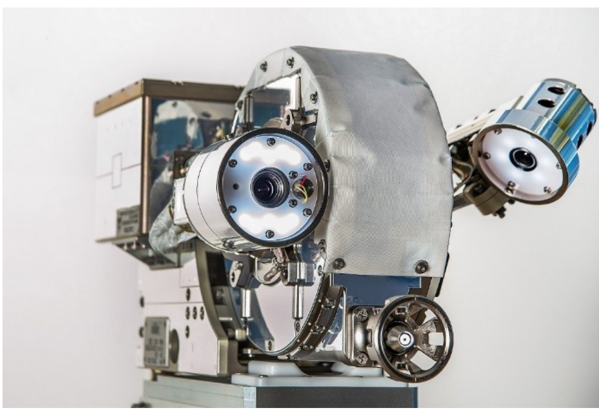
Background: Sebastien Gemme is a Robotics Engineer at the Canadian Space Agency, with strengths in computer science and computer vision. Sebastien has worked on R&D and flight projects involving cameras and LiDARs, targeting inspection and guidance navigation and control (GN&C) applications for space. He also has an interest in planetary exploration and low power processing platforms for space.

Session: 4a-4
"VIPIR and RAVEN On-Orbit Tests for Spacecraft Servicing"

Justin Cassidy
NASA GSFC (Leidos)
Justin.cassidy@nasa.gov
301-286-8515

Demo: No
Poster: No
One-on-One Table: No

Abstract: An overview will be provided of the Satellite Servicing Projects Division on-orbit results of the Visual Inspection Poseable Invertebrate Robot (VIPIR) and the features of the 2nd generation VIPIR2 and the capabilities of the ISS RAVEN payload.



VIPIR

ISS RAVEN

Speaker Bio: Justin Cassidy is a mechanical engineer with more than 25 years of experience in satellite servicing. He worked on four Hubble Sepace Telescope servicing missions supporting the design of specialized tools. He served as hardware manager for the International Space Station Robotic Refueling Mission Payload. A payload consisting of robotic tools that will be used to demosntrate disassembly and re-assembly of satellite components and associated inspection tasks using the on-board ISS SPDM robot. Mr. Cassidy currently serves as the Space Robotics Applications Office Deputy for the Satellite Servicing Project Division (SSPD) at NASA GSFC.

Session 4b-1
"Free Flying Inspector"
Demo: No
Poster: No
One-on-One Table: No **www.aerospace.org**

David Hinkley
The Aerospace Corporation
david.a.hinkley@aerospace.org
310-336-5211

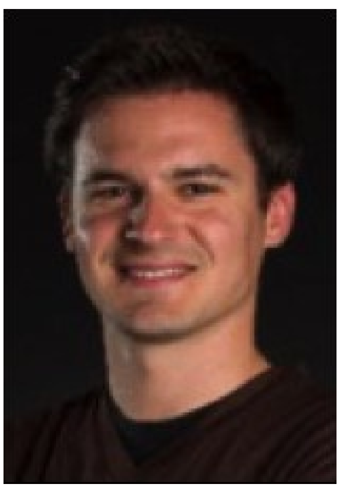
Abstract: Aerospace began studying kg-class miniature spacecraft in 1995 and began flying them in 2000. Although many applications of spacecraft in this class have been developed in the past decade, one of the early concepts identified by Aerospace, that of a free-flying satellite inspector, has been an area of active research for most of the past decade. The MEPSI program, which involved two flights from the Space Shuttle, was an early investigation of technologies that would be required to enable free-flying satellite inspectors. Several requisite capabilities were identified, including propulsion, sensors, local communication, direct ground communication, high resolution imaging, multispectral imaging, autonomous operations, and rendezvous and docking. Since completing the MEPSI flights, Aerospace has flown more than fifteen miniature spacecraft in the 1 to 5 kg class, predominantly designed for other applications, but each advancing the necessary technologies for the inspector mission. Many of these capabilities have reached a stage of maturity where the free-flying inspector begins to be practical. This presentation will explore a path to a successful free-flying CubeSat-based satellite inspector.

Background: Mr. David Hinkley is a senior project engineer supporting the Picosatellite effort at The Aerospace Corporation, called the PICOSAT Program. He joined the PICOSAT Program at the beginning in 1999 as a mechanical engineer and now is a principal engineer. In total, the PICOSAT program has delivered miniature satellites for more 10 missions including 4 that used the space shuttle as a launch platform, with the help of the USAF Space Test Program.

1983-1989: B.S. Mechanical Engineering UCSD
1989-1991: M.S. Mfg. Engineering (Robotics) UCLA
1987-Present: The Aerospace Corporation

Session 4b-2
"The Evolution of Nano-Satellite Proximity Operations" **Austin Williams**
Demo: No **Tyvak Nano-Satellite Systems, Inc.**
Poster: No **Austin@Tyvak.com**
One-on-One Table: No **www.tyvak.com** **310-956-5973**

Abstract: The CubeSat Proximity Operations Demonstration (CPOD) program is an ambition mission to perform rendezvous and docking of two 3U CubeSats on orbit. The flight vehicles are completed, and in storage awaiting launch in Q3 of 2017. Through the hardware and software development of the platform and proximity operations sensors, Tyvak learned a great deal about the performance and limitations of the platform. Since the completion of the CPOD vehicles, Tyvak has investigated areas for platform improvement, and scaling the system to a slightly larger platform for additional capabilities. This presentation discusses some of our findings, and plans for improving the systems capabilities.



Background: Austin Williams has been with Tyvak Nanosatellite Systems Inc. since 2011 and currently serves as a Vice President of Program Management. As a cofounder of Tyvak, Austin's primary responsibilities includes overseeing the design, fabrication, test, and integration of Tyvak's advanced nano-satellite programs. Austin has held roles as Lead Electrical Engineer and Lead RF Engineer prior to his role as Vice President. In his time at Tyvak, Austin has delivered 75+ Intrepid units to customers, generating 30+ Flight units and has served as the Principal Investigator for Phase I and II SBIR: *Flexible Low Cost Avionics for Nanosatellite Launch Vehicle Control and GPS Metric Tracking.*

Austin holds 9 years experience working with CubeSats, beginning with the successful launch of Cal Poly's CP6 CubeSat. With the experience gained from that launch and operations, Austin led the complete re-design of Cal Poly's avionics system with the support of fellow student colleagues and faculty. The new avionics architecture has since been designed into 5 Cal Poly CubeSats, and subsequently spun off from the University to be made available to the small satellite community with the formation of Tyvak.

Session 4b-3
"Astrobee/SPHERES Experiment Platform on ISS"
Demo: No   Poster: Yes
One-on-One Table: Yes

Darryl LeVasseur
NASA Ames Research Center, TI
darryl.w.levasseur@nasa.gov
650-604-1006

Abstract: SPHERES is a facility of the ISS National Laboratory with three IVA nano-satellite robotic systems designed and delivered by MIT to research estimation, control, and autonomy algorithms. SPHERES are complimentary predecessor which will soon (2018) be phased out in favor of the Astrobee free flyer platform which offers expanded research capability beyond the scope of SPHERES. The SPHERES Program Office is located at NASA Ames Research Center oversees SPHERES related research and STEM activities on-board the International Space Station (ISS), as well as, current and future payload development. The SPHERES satellites work aboard ISS is under crew supervision, they provides a risk tolerant Test-bed Environment for Distributed Satellite & Free-flying Control Algorithms. Both SPHERES and Astrobee platforms offer a payload expansion for additional science payloads. NASA has fully utilized the potential of the SPHERES platform by making the capability available to other U.S. government agencies, schools, commercial companies and students to expand the pool of ideas by implementing a Guest Scientist Program (GSP). For many of the researchers, SPHERES offers the only opportunity to do affordable on-orbit characterization of their technology in the microgravity environment.

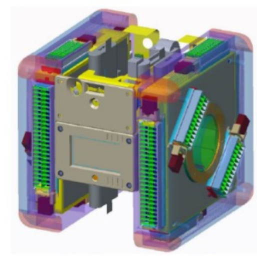


Figure 1: Free flyer front view

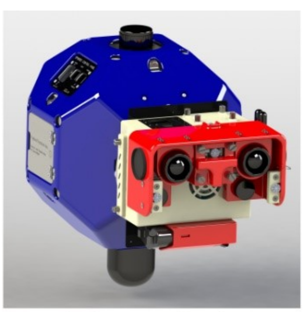


Figure 2: SPHERES with Vertigo

Astrobee will offer similar opportunities and abilities comparable with SPHERES including inheriting the GSP program to further continue advancement in science, technology development, and education. This compact, 1 foot by 1 foot by 1 foot cube is designed to: help scientists and engineers develop and test technologies for use in zero-gravity; help the astronauts do their routine chores; and give flight controllers in Houston additional eyes and ears on spacecraft all without astronaut supervision. Astrobee can operate either in fully automated mode or under remote control from Houston, without wasting valuable astronaut time. That allows it to run more often and provide more time for testing new technologies in "zero g".

Bio: Darryl Levasseur has been a part of SPHERES Engineering since 2012 at NASA Ames Research Center. He has a Bachelors degree in Aerospace Engineering from San Jose State University where he is also an adjunct professor for the Engineering Department. His flight products emphasize development or consulting on battery systems within robotic platforms or small satellite systems such as SPHERES, TechEdSat, BioSentinel, and Adept. His Research interest include metrology, embedded systems, rapid prototyping, test engineering, & battery systems.

Session: 4b-4
"Seeker: An IVA/EVA Cubesat for In-flight Inspection and Anomaly Resolution"
Christopher Radke; Vienny Nguyen
NASA JSC/EP4/ER4
Demo: Yes
Poster: No
Christopher.D.Radke@nasa.gov; Vienny.N.Nguyen@nasa.gov
281-483-5878; 281-483-0158

Abstract: A Robotic EVA Free Flyer enables low cost inspection and health checks of ISS, visiting vehicles, and vehicles designed for beyond LEO exploration. Robotic inspection and remote viewing of spacecraft is required to replace current inspection methods (large arms) which are impractical on exploration focused vehicles. Current flight programs (CCP, ISS) have Loss-of-Crew (LOC) risk due to MMOD impacts which robotic inspection technology can address near term and carry forward for exploration missions.

Within the past year, internal to the Engineering Directorate at the Johnson Space Center, our team has undertaken an effort to design, build and test an EVA-Free flyer demonstration vehicle. The vehicle, known as Seeker, contains all major subsystems required for EVA inspection including multiple cameras, a full 6-DOF propulsion system, and command and data transfer over Wi-Fi. Following this year's effort to design and build the system, the team hopes to extend on this work with a near term demonstration flight and with the long term goal to provide a rapidly deployable capability for inspection and in-flight anomaly resolution at ISS and for future exploration vehicles.

Background: Chris Radke is a propulsion systems engineer for NASA at the Johnson Space Center. In his current role, he works to support the development, maturation, and certification of propulsion systems for human spaceflight applications. During his tenure at NASA, he has worked in support of the Commercial Crew Program, the Advanced Exploration Systems Project Morpheus, and has also been involved in the development of IVA/EVA compatible miniature propulsion systems. His academic research has focused on the utilization of synchrotron x-rays for the study of optically dense, multiphase flows. He holds a B.S. (2011) and M.S. (2012) both in Mechanical Engineering from Iowa State University.

Background: Vienny Nguyen is a robotics systems engineer for NASA at the Johnson Space Center. She currently supports the Robotic Systems Branch as a mechanical designer and applications developer for robotic operations. During her time at NASA, she has worked manipulation-based robotic projects including Robonaut 2, Valkyrie, and the Autonomous Systems and Operations program in Advanced Exploration Systems. She has a B.S. (2010) and M.S. (2012) in Mechanical Engineering from the Ohio State University where she studied machine and product design and material properties of biomaterials.

Session 4c-1
"Real-Time 3D Microwave Camera"
Demo: Yes
Poster: No
One-on-One Table: No

Mohammad Tayeb Ghasr and Reza Zoughi
Missouri University of Science & Technology (S&T)
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573-341-4728 573-341-4656

Abstract: The need to perform real-time imaging in nondestructive testing (NDT) applications has been desirous for several decades. Depending on the inspection modality, criticality of the need and availability of technologies to create such imaging systems, different paths have been followed for each modality. Microwave or millimeter wave imaging is an ideal inspection solution for many aerospace and space materials. Furthermore, the fundamental physics, the legacy of radar, and the recent technological advancement fueled by wireless communications makes the development of real-time, 3D millimeter wave imaging systems a reality. Development of real-time microwave imaging systems dates back to the 1980s. Those systems were great technology demonstrators but suffered from several limitations including relatively low computing power and operating at relatively low microwave frequencies. Much of these limitations have been overcome recently, facilitating the opportunity to develop such systems at higher microwave and millimeter wave frequencies which are more suitable for space and aerospace NDT applications. To this end, several such systems have been designed and developed in that past decade culminating in the current real-time 3D microwave imaging system operating in the 20-30 GHz frequency range. This system was made to be technology readiness level demonstrator for producing real-time and 3D images while being reasonably portable. This presentation steps through the critical required important design steps that have culminated in this system. Several indicative examples, showing the potential capability of this system will also be presented.

Mohammad Tayeb Ghasr received his Ph.D. degree in electrical engineering from Missouri University of Science and Technology (Missouri S&T), in 2009. Currently, he is an Assistant Research Professor in the Applied Microwave Nondestructive Testing laboratory (*amntl*), Electrical and Computer Department, Missouri S&T. His research interest is in the area of microwave and millimeter-wave systems and their application nondestructive testing and 3D SAR imaging. He is a recipient of the 2013 H. A. Wheeler Prize Paper Award of the IEEE Antennas and Propagation Society for the paper titled "Portable Real-Time Microwave Camera at 24 GHz". He is also the recipient of the 2013 I&M Outstanding Young Engineer Award of the IEEE Instrumentation and Measurement Society, the 2014 IEEE J. Barry Oakes Advancement Award, and the 2015 ASNT Research Award for Innovation.

Session 4c-2
"In-Space NDE for Screening"
Demo: No Poster: Yes
One-on-One Table: Yes

Jay Fisher
Southwest Research Institute(SwRI)
jay.fisher@swri.org
210-522-2028

Abstract: Southwest Research Institute is an independent nonprofit applied engineering and physical sciences research and development organization. We have been involved in the NASA space program for over 35 years, in areas including instruments for space physics, planetary missions, and astrophysical phenomena. SwRI has developed processors, command and data handling systems and related space flight electronics, and has conducted system and subsystem design, fabrication, and testing. SwRI leads the science mission, payload operations, and encounter science planning for the New Horizons mission. SwRI maintains facilities for thermal, vacuum, and vibration environmental testing and qualification for in-space use. SwRI has also developed multiple NDE-based systems to inspect equipment used in manned space flight. These systems include the Orbiter APU turbine blades and flextube and the ISS battery canisters. More recently, SwRI has been developing nondestructive evaluation (NDE) methods that could be adapted to in-space applications. A primary example is ultrasonic guided wave technology that allows for long term, remote monitoring using sensors capable of withstanding extreme temperatures. These new technologies will be described, examples of recent uses given, and steps needed to adapt the technology for in-space use will be described.

Bio: **Dr. Jay Fisher** has B.A., M.EE, and Sc.D. degrees. At SwRI, he is responsible for program development and project management for nondestructive evaluation (NDE) systems and advanced electromagnetic nondestructive evaluation techniques. He has managed projects in the development and application of specialized electromagnetic techniques for flaw detection and material characterization, pulsed eddy current, remote field eddy current, miniature probe development, electromagnetic field modeling, dielectric measurements for flaw detection, advanced flaw imaging and signal processing techniques, guided waves, and electromagnetic acoustic transducer (EMAT) technology. He participated in development of inspection systems for the Orbiter APU turbine wheel and flextube, ISS battery canisters, the Orbiter face sheet through Thermal Protection System tiles, and carbon-carbon panels intentionally damaged in the Columbia accident investigation.

Session: 4c-3 – Remote Speaker
"Defect Detection by way of Dual Tuned Resonant Sensor"
Kevin McGushion
Excel Orbital Systems Inc.
kevinm@exelorbital.com
(301) 266-1505
Demo: No
Poster: No
One-on-One Table: No
http://exelorbital.com/

Abstract: Most materials are effected by or can be affected by a magnetic field even if only slightly. Materials considered to be insulators or having high dielectric constants can not only be detected using magnetic fields, but also their properties may be characterized. Insulators in the presence of conductors or conductors in the presence of insulators can be detected, and slight variations in their state can be quantified and qualified by carefully shaped magnetic fields. By oscillating a current through a specially designed coil at resonance, a magnetic field may be induced onto a second specially designed coil at resonance and at certain frequencies, otherwise undetectable anomalies, defects, or discontinuities may be seen. The physical and electrical characteristics of the entire circuit work hand in hand to disrupt the mutual resonance of the entire circuit; therefore, making things like paper or poly FOD visible even when it is under several layers of conductive composite laminate. Testing reveals that kissing bonds may be detectable in composite, as well as heat damage, damage under low observable coatings and of course delamination and fiber breakage. It is also possible to scan through a first composite wall into another composite wall, not in intimate contact with the first wall to characterize the second wall. This scanning is accomplished without the use of coupling and without the need for direct contact, although standoff distances need to be held within a tolerance depending on many factors. Currently, Exel Orbital Systems is commercializing this sensor technology by packaging it into a hand-held, self-contained imaging system, which is highly portable in order to image graphite composite structures both during and after manufacture. Because the system is highly sensitive to materials other than composites, it is possible to image or inspect metals, plastics and hybrid compounds.

Background: Kevin McGushion founded Exel in 1989 on an invention which brought ultra high purity orbital welding to the Semiconductor, Biopharmaceutical and Aerospace industries. This invention lead to many other developments ranging in application from fluid handling components in the Semiconductor and Biopharmaceutical Industries to a magnetic imaging system and a novel manufacturing method for aircraft structural beams. One of the premiere inventions (The Exel Imaging System) has been recommended for use by Boeing, in its RS68 Rocket Engine as well as passing 90/95 POD/CL acceptance criteria. Additionally the imaging system has proved to be a superior device for imaging graphite composite for Northrop Grumman's F-35 Program and is currently being evaluated by Spacex for their Falcon Rocket program. In 2008, Kevin sold the Orbital Welding Division of Exel to Arc Machines, Inc. and today Exel is dedicated to developing and commercializing its new M-Wave Imaging Technology.

Session: 4c-4 - Remote Speaker

"Differential Terahertz Imaging Methods for Enhanced Detection of Subsurface Features, Flaws, and Damage"

David Zimdars/Steven Williamson
Picometrix, a Division of Luna, Inc.
dzimdars@picometrix.com
734-864-5639

Demo: No Poster: No
One-on-One Table: No

Abstract: Differential time domain terahertz (THz) imaging methods are demonstrated to enhance the contrast and detectability of subsurface features such as voids and disbonds. The methods of shearographic loading of the samples, and the use of penetrating THz pulses to detect the subsurface deformation of the defects is presented. Differential THz images of these features are shown to have better contrast than traditional THz imaging. Thermal differential imaging is shown to detect disbonds and other features in Avcoat bonding, and a low durometer thick coating. Acoustic differential perturbation is shown to detect disbonds and other features in a low durometer thick coating, thin stiff laminate sheets, and Avcoat bonding. Vacuum pressure differential loading is shown to detect physical sub-surface deformation of disbond regions in a low durometer thick coating. Very thin or "kissing" disbonds and cracks may only weakly reflect the THz pulses in conventional THz imaging. In a disbond there is a region where the two sides of the material are not adhered, and the space between the two sides are essentially so close that THz interface reflection pulses from the non-adhered region may be partially cancelled out. The defect signature may be only weakly detectable compared to when the spacing is greater than the minimum THz wavelength. The differential images null background clutter and highlight the subsurface distortion of the defects under loading.

Background: Dr. Zimdars is the Manager of Terahertz Research and Development at Picometrix. Since 2001, Dr. Zimdars has been the research and development manager for all THz scientific, industrial and homeland security product development contracts, commercial T-Ray® analytical/imaging system development, and THz manufacturing quality control applications development. As a scientist on the THz project, he supervised and implemented the telecom fiber-optic packaging of the T-Ray® antenna modules, which are integral to Picometrix's compact THz technology. He received his BS. Degree in chemistry from Rocky Mountain College in 1989 and his Ph.D. in Chemistry (specializing in Chemical Physics) from Stanford University in 1996. From 1996 to 1999 he was a post-doctoral researcher at Columbia University. His research work centered on ultrafast femtosecond laser spectroscopy.

Invited Speaker
"Remembering Columbia"

Professor Bonnie J. Dunbar
PhD NAE RSEcorr
TEES Distinguished Research Professor
Director, Institute for Engineering Education and Innovation(IEEI)
Texas A&M University, College Station, TX

Dr. Dunbar is a retired NASA astronaut, engineer and educator, currently with Texas A&M Engineering as a Texas A&M Engineering Experiment Station (TEES) Distinguished Research Professor in the Department of Aerospace Engineering. She also has a joint appointment as the Director of the TEES Institute for Engineering Education and Innovation (IEEI).

Dunbar, who is a member of the prestigious National Academy of Engineering, came to Texas A&M from the University of Houston where she was an M.D. Anderson Professor of Mechanical Engineering. There she provided leadership in the development of a new integrated university science, technology, engineering and mathematics (STEM) center and was Director of the Science and Engineering Fair of Houston. She also directed the SICSA Space Architecture and Aerospace graduate programs. She has devoted her life to furthering engineering, engineering education, and the pursuit of human space exploration.

Dunbar worked for The Rockwell International Space Division Company building Space Shuttle Columbia and worked for 27 years at NASA, first as a flight controller; then as a mission specialist astronaut, where she flew five space shuttle flights, logging more than 50 days in space; and then served for 7 years as a member of the Senior Executive Service (SES). Her executive service included assistant NASA JSC director for university research; deputy director for Flight Crew Operations; Associate Director for ISS Mission Operations development, and as NASA headquarters deputy associate administrator for the Office of Life and Microgravity Sciences and Applications (OLMSA).

After retiring from NASA, Dunbar became president and CEO of The Museum of Flight in Seattle, where she established a new Space Gallery and expanded its K12 STEM educational offerings. She has also consulted in aerospace and STEM education as the president of Dunbar International LLC, and is an internationally known public speaker. Dunbar holds bachelor and master degrees in ceramic engineering from the University of Washington and a Ph.D. in mechanical/biomedical engineering from the University of Houston. She is a Fellow of the American Ceramic Society, the American Institute of Aeronautics and Astronautics, and the Royal Aeronautical Society. She has been awarded the NASA Space Flight Medal five times, the NASA Exceptional Leadership Medal and the NASA Distinguished Service Medal. Dunbar was inducted into the Royal Society of Edinburgh, and in 2002 was elected to the US National Academy of Engineering. In 2012, she was elected into the ASE international Executive Committee and in 2013 she was selected into the Astronaut Hall of Fame.

Session: 5a-1
"Propulsion System Inspection and Monitoring Needs"
Demo: No
Poster: No
One-on-One Table: No

Chris Radke /Eric Hurlbert
NASA JSC EP4 Propulsion Systems
eric.a.hurlbert@nasa.gov
christopher.d.radke@nasa.gov
281.483.5878 / 281-483-9016

Abstract: In Space Propulsion Systems for future NASA human exploration missions that operate for longer durations and more operational cycles will rely on inspection and monitoring. The shuttle orbiter propulsion system engineers were able to inspect the hardware back on earth. For future missions, the hardware will most likely never come back. Operators and engineers will rely on data that can be gathered in space to verify that the systems are safe to start the next phase of operation, such as ascent off the Mars surface or a trans-Earth injection burn. These inspection and monitoring technologies will need to be reliable, lightweight, and easy to operate. The presentation discusses the specific need for sensors and tools.

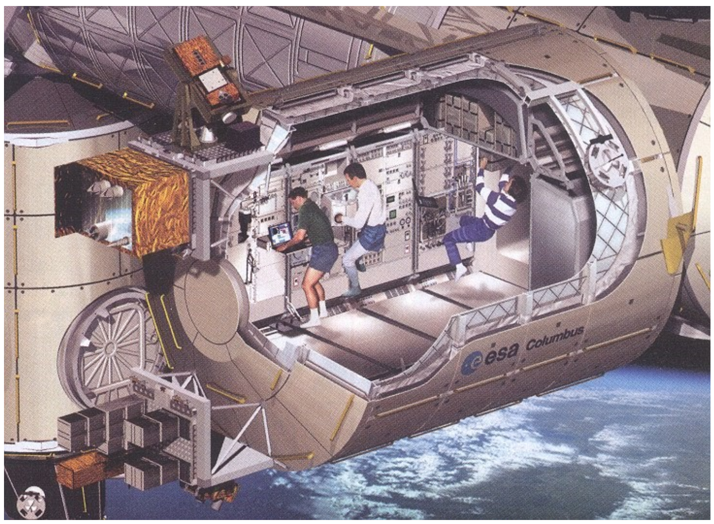
Background: Chris Radke is a propulsion systems engineer for NASA at the Johnson Space Center. In his current role, he works to support the development, maturation, and certification of propulsion systems for human spaceflight applications. During his tenure at NASA, he has worked in support of the Commercial Crew Program, the Advanced Exploration Systems Project Morpheus, and has also been involved in the development of IVA/EVA compatible miniature propulsion systems. His academic research has focused on the utilization of synchrotron x-rays for the study of optically dense, multiphase flows. He holds a B.S. (2011) and M.S. (2012) both in Mechanical Engineering from Iowa State University. He has published several technical articles in the fields of combustion instability and optical and x-ray flow diagnostics, and is a member of the AIAA Liquid Propulsion Technical Committee.

Background: Eric Hurlbert joined NASA Propulsion and Power Division in 1984 specializing in the area of propulsion system design, development, qualification, and flight for the Space Shuttle, Space Station, and advanced program activities at NASA including the Next Generation Launch Technology (NGLT), Constellation, and Advanced Exploration Systems. He recently was the propulsion systems lead for Project Morpheus which flew Liquid Oxygen and Methane propulsion system. Currently he is Technical Discipline Lead for Propulsion supporting Orion, Commercial Crew, and advanced technologies.

Session: 5a-2
"ISS Internal Maintenance Experience and its Needs"
Demo: No
Poster: No
One-on-One Table: Yes

Nick Robbins
NASA/FOD/CX42 (OSO)
nicholas.j.robbins@nasa.gov
281-483-0550

Abstract: Maintenance on the International Space Station (ISS) is continuous and complex. We will walk through what it's like to work onboard the ISS and discuss the issues that complicate the process. The goal is to provide an understanding of what makes in-space maintenance tasks difficult so that potential improvements can be identified.

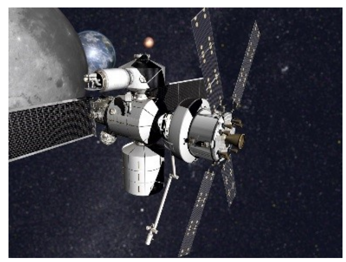


Background: Nick Robbins has worked as an Operations Support Officer (OSO) Flight Controller at NASA Johnson Space Center for 2 years, supporting maintenance and mechanism operations on the ISS. He specializes in leak repair and life support systems maintenance. Before NASA, Nick completed his Mechanical Engineering B.S. at Rice University.

Session: 5a-3
"Overview of Current Advanced Human Mission Studies" **Joe Caram/Larry Toups**
Demo: No
Poster: No
One-on-One Table: Yes (Toups)

NASA JSC/XM
Jose.M.Caram@nasa.gov; larry.toups-1@nasa.gov
281-483-5365; 281-244-7974

Abstract: The Exploration Mission Planning Office is currently supporting various future human space exploration concept missions and systems. This discussion will provide an overview of the various activities ranging from Mars mission architectures, the asteroid robotic crew mission, and various scenarios and concepts being studied for initial system to be deployed to the cislunar proving ground. The discussion will also cover current plans for the study of alternative concepts for cislunar habitation.



Samples of Six NASA "Next Step" Concepts (www.**nasa**.gov/**nextstep)**

Bio: Mr. Joe Caram leads the Exploration Mission Planning Office at NASA's Johnson Space Center where his group works with an Agency wide team in defining the future of the Nation's human space exploration plans. His current focus is defining the operational concepts and spacecraft and surface systems needed to support sending humans to Mars in the 2030's. His work also includes defining the systems and missions needed in the Cislunar Proving Ground phase of the Journey to Mars. Prior to his current assignment, Joe has held key leadership roles in various projects, programs, and organizations including the lead Flight Dynamics Officer for the X-38 Project, Aerothermodynamics Team lead for the Columbia Accident Investigation, the Systems Engineering and Integration Chief Engineer for the Space Shuttle Return to Flight, Manager of the Integrated Systems Performance Office in Constellation SE&I Office, and held Deputy Manager positions in both the Systems Architecture and Integration Office and the Technical Integration Office in the JSC Engineering Directorate. He is the author or co-author of 23 technical papers. Joe earned his Bachelors of Science and Masters of Science degrees from Texas A&M University in1986 and 1989, respectively.

Session 5b-1
"Inspection Guidance with Visual Object Detection Support"
Demo: Yes Poster: Yes
One-on-One Table: No

Rafael Radkowski
Iowa State University
rafael@iastate.edu

Abstract: The talk will introduce a prototype system for inspection guidance. It can guide an inspector through an inspection task by automatically identifying the parts, handles, workpieces, etc. the operator has to work on and by demonstrating the tasks with the means of computer graphic. The system relies on visual object recognition and tracking. It is able to automatically identify the objects (i.e., hatches, handles, etc.) under inspection and to determine their location with respect to a camera. The object detection technology in place utilizes data from a range camera to identify pre-recorded objects by matching a statistical object signature. Here, matching means to associate signatures found in the camera image with a pre-recorded object signature. A statistical voting schema is employed for this purpose. Once the object(s) is identified and its position is known, visual widgets such as text, 3D models, and videos are used to convey procedural inspection information to an inspector. The visual widgets are co-registered with a video showing the physical object on interest. Hardware such as a tablet computer or head-worn devices (e.g. the Microsoft HoloLens) are used as output devices. Procedural information about the inspection task need to be prepared in advance. The system is a prototype, however, our studies show the superiority of our employed tracking technology for this use case and advantages when using this technology for task guidance. In the near future, we will be able to automatically identify whether an inspection task has been successfully completed.

Background: Rafael Radkowski is Assistant Professor in the Department of Mechanical Engineering at Iowa State University. He received his doctoral degree (with honors) from the University of Paderborn, Germany in 2006. After graduation, he became an acting leader of a research group in the Collaborative Research Center 614 at the Heinz Nixdorf Institute (Paderborn, Germany) and conducted his research for several years under the direction of Prof. Gausemeier. He joined Iowa State University in 2012 as a post-doc and 2014 in his current position.

Dr. Radkowski is a leader in advanced machine vision for augmented reality, with particular interest in fundamentals for 3D shape-based object recognition and tracking, statistical pattern matching, 2D/3D feature descriptors, and gesture-based interaction. His goal is to make computers better aides for people by advancing machine perception and human-computer interaction. Technologies from his lab are employed in areas such as assembly assistance and training, assembly verification, visual inspection, non-destructive evaluation, for instance.

Session: 5b-2
"Extended Kalman Filtering for Localization and Mapping Applications."
Demo: No
Poster: No
One-on-One Table: No

Manoranjan Majji, John Junkins
Texas A&M University
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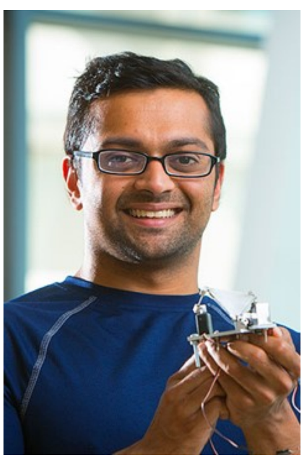
Junkins@tamu.edu 979-845-3912
https://lasr.tamu.edu/

Abstract: An image feature based localization and mapping software pipeline is presented in this work. Exploiting the continuity of image features across contiguous images, and building upon the feature correspondence established by feature tracking algorithms, an extended Kalman filtering solution is formulated for simultaneous estimation of the relative pose, angular and linear velocities of the sensor platform with respect to the scene. A generalized Dubin's kinematic model, when used in conjunction with the Cayley transform is shown to lead to a rigorously linear least squares solution for the parameters governing the relative motion derived solely from of the landmark locations. Considering simultaneously two or more overlapping images, we extract estimates for the relative pose and all measured features' relative object-space coordinates at the most recent epoch. Covariance analysis of the proposed solution is also presented; the covariance output from the local least squares can be used to define a more rigorous scene, geometry, and illumination-dependent "measurement-derived" covariance matrix for utilization in the recursive Kalman filter. The utility of estimation approaches presented in the paper is demonstrated using stereoscopic mapping and localization experiments carried out using mobile robots.




Bio: Dr. Manoranjan Majji (left) is Assistant Professor with his Ph.D. in Aerospace Engineering from Texas A&M University, (2009). His research interests are in: System identification, Computational Vision, Smart Sensing Technologies, Autonomous Systems, Guidance and Control.

Bio: Dr. John Junkins (right) is Distinguished Professor of Aerospace Engineering at Texas A&M. A Regents Professor, he is also Director of the TAMU Institute for Advanced Studies and Land, Air & Space Robotics Laboratory.

Dr. Junkins' research interests include: Dynamics and Control of Spacecraft; Guidance, Navigation and Astronautics; Analytical and Numerical Methods; and Smart Sensor Technology.

Session 5b-3

"Image Enhancement and Automated Inspection/Assessment"

Robert Habbit
Sandia National Laboratories
rdhabbi@sandia.gov 505-845-9492

Demo: No Poster: No
One-on-One Table: No

Abstract: A harsh environment, stringent requirements on size, weight and power, the need to minimize crew workloads, and very high reliability requirements combine with the life-critical nature of the inspection task to create unique challenges. An ideal inspection capability would automatically detect flaws in the thermal protection and flight surfaces and generate corresponding reports along with data about those flaws for human adjudication. In this presentation we discuss on-going work at Sandia National Laboratories based on lessons learned during and after flying the LOIS (Laser Dynamic Range Imager Orbiter Inspection System) system on the final 22 missions of the space shuttle. We can ameliorate these problems with a number of techniques discussed in this presentation. We exploit knowledge of the basic spacecraft shape to allow automated registration and differencing of quality sufficient to support subsequent algorithmic detection and classification of artifacts. Lighting differences and shadows can be effectively handled by supplying illumination as part of the image collection process for both *before* and *after* image data sets that is sufficiently brighter than other interfering lighting sources (similar to the methodology used in the LOIS System). The problems of parallax and occlusion require a sufficient diversity of viewpoints to achieve viable change detection. For example, the bottom of a narrow hole is occluded for all but a small range of angles. We propose automating not only the registration, differencing and detection of flaws but also the collection of the imagery itself using a small autonomous vehicle. On board processing allows the shape-aware image registration to provide navigation information, minimize communication bandwidth and automate the process of ensuring a complete inspection. In this presentation we discuss a concept system for accomplishing the aforementioned tasks as well as other, related imaging methodologies being developed at Sandia National Laboratories.

Background: Mr. Bob Habbit joined Sandia National Laboratories in 1986. Presently, Mr. Habbit is the Senior Manager for the Predictive Sensing Program. Bob's group is presently focused on developing exquisite remote sensing, analytics, and information aggregation systems. Throughout Bob's adventure at Sandia, he has the privilege of leading teams in the delivery of advanced mission solutions for the Nation. Some of his notable relevant accomplishments include, Laser Dynamic Range Imager Orbiter Inspection System for NASA's Space Shuttle Program, NGST (James Webb Space Telescope) Micro-mirror development, other Space Shuttle Systems including the Mechanics of Granular Material (MGM) and other Special National Security Projects.

Session 6a-1	**Michael D. Johnson**
"NanoRacks ISS Facilities"	**NanoRacks, LLC**
Demo: Yes Poster: Yes	**ISS US National Laboratory**
One-on-One Table: Yes	**mjohnson@nanoracks.com**
www.nanoracks.com	**832-573-7424**

Abstract: NanoRacks is a commercial payload provider to the ISS US National Laboratory Program. The company is a turnkey internal and external ISS payload provider that has conceived, developed, constructed, integrated, and operated various pressurized payloads, ISS satellite deployers and external payload facilities. Since its founding in 2009 NanoRacks has flown over 350 payloads including a record setting deployment of 147 CubeSats with over 100 payloads scheduled to fly in the next year. NanoRacks provides an extremely fast cycle time to design, build, test, and fly payloads (usually 6 to 9 months) to the ISS. The founders of NanoRacks have a long history of commercial space operations and are applying past lessons learned to provide the most cost and time effective means to fly payloads in space. By combining this experience base and leverage of the latest technology in electronics NanoRacks has a proven method of rapid mission performance. This presentation will provide an overview of the present and future NanoRacks satellite deployment capabilities.

Background: Mr. Michael D. Johnson is a co-founder and Chief Technology Officer of NanoRacks, LLC. He co-founded NanoRacks, LLC in 1999 and has continued his role as Chief Designer. In total, NanoRacks has delivered nearly 350 payloads to the ISS in less than seven years from the inception of the company. Mr. Johnson previously worked with SPACEHAB, Inc. in various capacities for over 18 years as well as founding two other startups.

1984-1989: B.S. Aerospace Engineering Univ of Minnesota, I.T.

1989-1991: Rockwell Space Operations, JSC Flight Controller

Session: 6a-3
"Addressing Challenges to the Design & Test of Operational Lighting Environments for the International Space Station"
Demo: Yes Poster: No
One-on-One Table: Yes

Toni Clark
NASA/JSC/SF/Leidos, Inc.
toni.clark-1@nasa.gov
281-483-0857

Abstract: The Habitability and Human Factors team at Johnson Space Center's Lighting Environmental Test Facility (LETF) assists customers to plan and evaluate systems and operations on the remote International Space Station and other space environments. Our experienced team helps users to evaluate functional, performance, safety and even aesthetic requirements with physical tests and computer based analysis. This presentation will showcase findings and toolsets our team is using to assist in the planning of tasks, and design of operational lighting environments inside and external to the International Space Station. It will also explain how our our lighting experts can perform the tests or host tests of new sensors, procedures or environments in the tightly controlled LETF environment and/or perform the computer simulations as requested.

Background: Toni Clark, P.E., is the contractor lead for Johnson Space Center's Lighting Environment Test Facility. Toni is a subject matter expert on space craft lighting systems and provides her expertise to assist customers in the development of requirements and testing of light sources. She is also active in the research community and has won several NASA and Johnson Space Center grants.

Session: 6b-1
"Railroad Track Inspection: The Need for Speed"
Demo: No
Poster: Yes
One-on-One Table: Yes

Jeb Belcher
Georgetown Rail Equipment
belcher@georgetownrail.com
512 818 9292

Abstract: Applying NDT technologies in the railway environment creates a unique set of obstacles that must be overcome. Revenue train service, maintenance equipment, and inspection vehicles all share the same path and are all critical to railroad business. Successful implementation of NDT technology means minimizing track occupancy and maintaining sufficient standoff distances. These challenging work conditions provide a unique perspective of the NDT industry and many opportunities for technology innovation. Target illumination, detection methods, collimation, and shielding all must be approached with a different goal in mind. Continued research and development of NDT technologies in user-friendly operating conditions benefit the NDT industry as a whole through partnership development and project funding.

Speaker Bio: Mr. Belcher serves as the Emerging Technologies Developer at Georgetown Rail Equipment Company (GREX) located in Georgetown, TX. He has ten years of experience with research and development of automated track inspection technologies focusing on advanced imaging techniques for sub-surface defect detection. His current responsibilities are identifying and developing advanced technologies for application to the rail industry. This includes working with industry experts, universities, and affiliated laboratories to accomplish research objectives that promote safety and efficiency of railroads. Previous roles with GREX included developing automated image-processing algorithms for tie inspection and the development of LiDAR-based ballast profiling systems. Mr. Belcher earned Bachelor's and Master's degrees in Mathematics from Texas A&M University. He is a principal inventor on the team at GREX that was recently named a 2016 R&D 100 Awards finalist for the development of the Aurora Xi system.

Session: 6b-2
Finding Product-Application Fit
for Inspection & SHM Technology
Demo: No **Poster: No**
One-on-One Table: Yes

James W. Hill
Aging Aircraft Consulting
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478-225-4044

Abstract: Research and development is critical to prove a new technology is viable and to define technical, physical capabilities. However, to commercialize a new technology it is necessary to identify a customer's need, with high enough priority, and available funding or financing. However, often it is difficult to identify who the customer is and what their needs are. Customer discovery activities can help survey the market of potential users and understand their needs. Once product-market fit has been discovered and defined, sales and marketing can be effectively applied to target the right market. Aging Aircraft Consulting has been applying customer discovery methodology within the military aviation environment to find the product-application fit for emerging technologies while solving critical customer needs, increasing performance and lowering costs. Aging Aircraft Consulting has been assisting Physical Optics Corporation apply their technology to detect and define C-130 corrosion issues at Robins AFB, GA.

Background: James Hill is an experienced aerospace engineering business executive with strong analytical skills and significant finance, operations and program management leadership experience, including P&L responsibility. Mr. Hill is currently Chief Executive at Aging Aircraft Consulting, an aerospace engineering and technical solutions company based in Warner Robins GA, serving U.S. DoD and Aviation clients. Previously, he worked for a small research and development company working on water desalination technology for the U.S. Navy. He has a Masters in Business Administration from Emory's Goizueta Business School and a B.Sc. in Biochemistry from Georgetown University.

Session: 6b-3 Remote Speaker
"Navy Ship and Sub NDT&E Needs"
Demo: No
Poster: No
One-on-One Table: No

Patric Lockhart
Navy Undersea Warfare Center
Patric.lockhart@navy.mil
401-832-4462

Abstract: The Department of the Navy (DoN) is the largest branch of the Department of Defense (DoD), and a significant part of the DoN budget is maintenance costs. Efforts to streamline, improve efficiency, and reduce costs are imperative at all times. A way to reduce maintenance costs is through nondestructive test and evaluation (NDT&E) alternatives to existing destructive inspection techniques. Existing NDT&E applications can be made more efficient through adoption of advanced NDT&E techniques which improve detection capability, speed of inspection, or NDT&E system longevity. Maintenance activities can be streamlined by utilizing fewer NDT&E systems with greater capability to accomplish the same maintenance tasks of existing inspection methods. This talk will outline a non-exhaustive list of existing DoN NDT&E needs for a variety of naval applications and discuss some of the design challenges when developing maritime equipment and some potential DON technologies of interest. Follow-up discussions of potential solutions are welcome.

Dr. Patric Lockhart, an electrical engineer at the Naval Undersea Warfare Center – Division Newport (NUWCDIVNPT) for 8 years, is a Lead Engineer for Advanced Nondestructive Test and Evaluation (NDT&E) Inspection Methods under the NDT&E Tech Warrant Holder (SEA05P2) and a subject matter expert (SME) on Terahertz (THz) technologies (12 years of experience) and active infrared thermography (including induction and flash thermography, 2+ years of experience). He has a Ph.D. in Electrical Engineering from the Rensselaer Polytechnic Institute.

Dr. Lockhart has been the PI, lead researcher, or mentor on numerous NDT&E projects. His research and efforts at NUWCDIVNPT have led to two patent submissions (1 awarded); multiple conference presentations and journal articles published or in progress, and development of in-house THz imaging & flash/induction IR Thermography capabilities. Dr. Lockhart is the NUWCDIVNPT POC for ongoing collaborative NDT&E efforts with multiple Defense and Government agencies, and he is the Technical POC for an ongoing THz Imaging NDT&E SBIR. Dr. Lockhart is also a long-time active council member of the NUWCDIVNPT New Professional Network, and he mentors at the collegiate level.

Session: 6c-1

"Internal Radio-Frequency Instrumentation System (IRIS)"

Demo: No
Poster: No
One-on-One Table: No

Raymond Wagner
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281-244-2428

Abstract: Wireless instrumentation has long been sought for spaceflight applications, but practical implementations capable of providing the utility of wired sensors have proven elusive. The power needed to drive transmitters/receivers in traditional "active" wireless sensor radios requires either frequent battery replacement or prohibitive duty cycling. This prevents installing such sensors early in a vehicle's integration and treating them as always-on throughout its operation. "Passive" solutions such as radio frequency identification (RFID) techniques provide an appealing alternative. Presenting results to appear in March at the 2017 IEEE Aerospace Conference, we detail the design, fabrication, and evaluation of the Internal Radio-frequency Instrumentation System (IRIS), an RFID-enabled instrumentation solution that integrates an EPC Global Class 1 Generation 2 interface with processor-based wireless sensors. IRIS thermocouple sensors can operate in a low-power hibernation state with instantaneous over-the-air wakeup for nearly a decade on a small (255 mAh) coin cell battery. In their active state, they can acquire and stream 10 Hz data for more than 200 days. This allows wireless sensors to be installed and powered on early in vehicle integration and continue to operate after launch through a lengthy mission, opening the vehicle design trade space to wireless sensing in a meaningful and unprecedented way.

Background: Raymond Wagner leads the wireless sensor network research and development program at NASA-Johnson Space Center, and he is involved in related programs for development of wireless communications systems for vehicle, habitat, and surface operations. He earned a Ph.D. in electrical engineering in 2007 as an NSF Graduate Research Fellow at Rice University in Houston, Texas with a thesis concerning distributed data processing algorithms for wireless sensor networks. His research interests include RFID, passive and active wireless sensor networks, low-power embedded computing, and distributed signal processing, and he is active in standards development for international space agencies within the Consultative Committee for Space Data systems. He is a winner of the NASA Exceptional Technology Achievement Medal for his work in wireless technologies enabling human exploration.

Session: 4c-2
"Recent Space-flight Applications of Standalone Structural Monitoring Systems"
Demo: No
Poster: No
One-on-One Table: No

Nathan Wells
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Avionics System Division
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281-483-1811

Abstract: Expandable modules offer a great opportunity for volume and mass savings in future space exploration missions. These type of modules can be compressed into a relatively small shape on the ground, allowing them to fit into space vehicles with a smaller cargo/fairing size than a traditional solid, metallic based module would allow. In April 2016, the Bigelow Expandable Activity Module (BEAM) was berthed to the International Space Station (ISS). BEAM is a NASA managed ISS payload project in collaboration with Bigelow Aerospace. BEAM is intended to stay attached to ISS for an operational period of 2 years to help advance the technology readiness for future expandable modules. BEAM has been instrumented with a suite of sensors systems which will help characterize the module's performance for thermal and radiation shielding as well as protection against Micro Metereoid/Orbital Debris (MM/OD). This presentation will provide an overview of how the sensors/instrumentations systems were developed, tested, installed and the current status as well as future planning.

Background: Nathan Wells currently serves as the Instrumentation Technical Discipline Lead for the Avionic Systems Division at the Johnson Space Center (JSC) in Houston, Texas. He is the JSC representative for the NASA Agency Sensors & Instrumentation Capabilities Leadership Team as well as the NESC S&I Technical Discipline Team. In 2006, he started working for NASA as the project manager for a Return to Flight project for the Shuttle Program called the "Wing Leading Edge Impact Detection System" (WLEIDS) which consisted of a system that measured impacts along the Reinforced Carbon-Carbon (RCC) panels in the wings during the ascent flight phase as well as on-orbit monitoring for indications of micro meteoroid/orbital debris (MM/OD) impacts. Since then, he has worked on numerous Space Shuttle, International Space Station & Orion instrumentation related projects. In 2016 Nathan received the NASA Exceptional Achievement Medal for his instrumentation related work.

Session: 6c-3
"SHM as an Enabler for Future AF Space Assets"
Demo: No Poster: No
One-on-One Table: No

Derek Doyle | Justin Bruh
AFRL/Space Vehicles Directorate
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justin.m.bruh@nasa.gov 281-244-1928

Abstract: The Air Force Research Laboratories, Space Vehicles Directorate, has been investigating the role Structural Health Monitoring (SHM) can play in the construction, testing, transportation and operation of our space assets since 2007. This talk will discuss our motivation for investing in this area and the efforts taken thus far at the labs. Our work covers basic lab research efforts, complex structural demonstrators for ground verification and has now moved into actual flight integration efforts for flights managed by STP and AFRL. Details of the integration efforts and mission goals for STP-H5 will also be provided.

Background: Dr. Derek Doyle is a research engineer, thrust lead and technical advisor with the Structures Team at AFRL/RVSV. With degrees in both mechanical and electrical engineering, he manages a diverse portfolio of several technologies related to integrated structural sensing, metamaterials, antennas, and advanced manufacturing. He has published over 65 papers/journals and is a co-author on a spacecraft SHM book currently under review with Wiley. He holds two patents related to his SHM research efforts and is the Principal Investigator for the SHM experiment on Space Test Program(STP)-H5 and on AFRL's EAGLE mission.

Background: Justin Bruh is the program manager for STP-H5 that hosts 13 experiments including the SHM mission. He is a 1st Lieutenant in the USAF assigned to manage the Integration of DOD Payloads.

Session 7a-1	**Frank Lafleur**
"Videoscopes Technology – Approaching physics limited resolution and operations; what next?"	**Olympus Corporation of the Americas**
Demo: Yes	**Product Manager – RVI Americas**
Poster: No	**frank.lafleur@olympusndt.com**
	(713)897-1424

Abstract: Remote Visual Equipment has grown leaps and bounds, especially in the last 10 years. Olympus has been at the forefront of RVI innovation and continues to seek out and provide cutting edge solutions to the most demanding markets. Most recently Olympus released the current highest resolution capable 6mm videoscope, the IPLEX NX, with many advances in technology. However, as we approach diffraction limitation, and modern material limits, where will the next great benefit to inspection come from?

Background: Mr. Frank Lafleur is the Product Manager for Remote Visual Inspection at Olympus Corporation of the Americas. With studies in Electro-Mechanical Robotics Engineering, and over 14 years in sales, operations and application support for capital equipment with intelligent control system, he strives to bring the market feedback into product advances. He is part of a team of very experienced professionals that gather information from all over the world, to direct an equally talented team of R&D Engineers to design and introduce the best technology to answer real world applications.

1999-2004 University of Ottawa/Algonquin College of Applied Sciences - ME/EM Robotics Eng.
2004-2009 Operations and Application Support Specialist – Walter Meier Climate
2009-2011 Operations Manager – PWM Electronic Price Signs
2011-Present Product Manager RVI Americas – Olympus

Olympus Displays:
Wayne Weisner, Director - Global Government Sales, NDT Products, a veteran in the aerospace structure NDT inspection market will display **Olympus's triple kit**. This kit boasts multiple NDT technologies intended to handle an array of the most common aerospace maintenance challenges.
Dusty Moore, Americas Systems Sales Manager, will be available providing integrated NDT inspection systems for aerospace manufacturing solutions. Displayed at our table will be the **Focus PX**, integrated and scalable inspection solution for aerospace applications that drives higher efficiency and productivity.

NASA Session 7a-2
"Fully Controllable Videoscopes" **Carlos Pairazaman**
Demo: No **United Western Technologies, NDT Program**
Poster: No **Carlos.Pairazaman@uniwest.com**
www.uniwest.com **405-313-9480**

Abstract: Digital Surgical Nondestructive Evaluation (SuNDE) tools needed to perform precise quantifiable material state inspections in hard to reach areas or areas that has to be access remotely are being developed by UniWest and OC-Robotics through programs sponsored by the Air Force Research Laboratories.

Background: Mr. Carlos Pairazaman is a Nondestructive Testing (NDT) Project Manager based at Tinker Air Force base in Oklahoma City, Oklahoma, U.S.A.. He has been active in NDT for the past 35 years. His professional experience includes Research and development of new NDT sensors, new inspection techniques and design and integration of NDI sensors with Robotics and videoscope equipment. Carlos has managed NDT programs worldwide, and specializes on "Inspection Based Life Management and Life extension" military programs. A graduate of engineering school from Ridge Water College

Session 7a-3

"Advancements in True 3D Surface Scanning and Analysis"

Demo: Yes

Poster: No

Paul Thompson
GE Inspection Technologies
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512-213-8369

Abstract: Using Remote Visual Inspection (RVI), inaccessible areas requiring visual inspection can be monitored for normal operation, condition of components, fault analysis and in making a determiniation if indications need further review and analysis.

RVI with True3D surface scanning allows for more precise and accurate measurements of indications using an xyz point cloud for surface visualization. XYZ point cloud visualization of indications allows for faster collection of more precise and accurate data. Recent advancements in True3D allows for examinations in areas with access as small as 0.158"/4mm.

Background: **Paul Thompson** is the RVI or Remote Visual Inspection Sales Leader for GE Inspection Technologies, a part of GE Oil & Gas Digital Solutions. He is responsible for supporting the North American Sales and Field Service team with RVI training as well as technical and commercial support. With more than twenty-three (23) years of aerospace, electrical and mechanical experience- primarily focused on avionics, and nineteen years (19) of Remote Visual Inspection experience in Aerospace, Power Gen and Oil & Gas, including RVI Services and Sales Engineering, Paul will bring practicle knowledge to the application of True3D Phase and True3D Stereo surface scanning & analysis, Menu Directed Inspection for Data Management and InspectionWorks for live inspection streaming & collaboration.

Session: 7a-4 – Remote Speaker	**Adam Mallion**
"Controllable Snake Inspectors and Applications"	**OC Robotics**
Demo: No	**adam@ocrobotics.com**
Poster: No	**www.ocrobotics.com**
One-on-One Table: No	**+44 117 314 4700**

Abstract: OC Robotics is a world leader in confined space automation – OC's snake-arm robots are designed specifically for remote handling operations within confined or hazardous spaces. Snake-arm robots excel in their long, slender and flexible design; snake-arm robots effortlessly fit through small openings and around obstacles.

Snake-like inspection tools have been around for many year; videoscopes and borescopes are useful tools for confined space visual inspection. Their weakness is poor controllability and ability to deliver practicable payloads.

Snake-arm robots are actively driven along their length and can be steered into complex shapes to avoid internal obstacles. Snake-arms can be configured to deliver a range of payloads including video cameras, laser scanners and other NDI tools.

This talk presents results from our latest developments, both commercial and developmental, together with recent significant projects.

Background: Adam Mallion is a senior project and business development manager at OC Robotics. After graduating from the University of Bath with a Masters degree in Electronic Engineering in 2008 he joined OC Robotics as an electronic engineer specializing in electromechanical control systems. More recently he has managed a wide range of projects delivering robotic systems to industries including; aerospace, construction, petrochemical and nuclear.

Session: 7b-1

"Compton Imaging Tomography for NDT of Spacecraft Thermal Protection Systems"

Victor Grubsky-Volodymyr Romanov
Physical Optics Corporation, Inc.
vgrubsky@poc.com
310-320-3088

Demo: No Poster: No
One-on-One Table: No www.poc.com

Abstract: We will present our new results of noncontact, one-sided in situ NDT of structural integrity of various thermal protection system (TPS) materials and structures: detection, identification, and precise spatial localization and measurements of internal and surface defects (cracks, voids, delaminations, porosity, and inclusions), and evaluation of bondlines and in-depth integrity. We used the new compact NDT tool based on POC-patented Compton Imaging Tomography (CIT) technique, and developed especially for NASA needs for testing and evaluation of Orion spacecraft TPS structure. The tool capability was demonstrated during recent joint NASA and POC laboratory experiments with Orion spacecraft TPS samples with various natural and simulated defects. As we can conclude, POC-developed NDT tool provides detection of all the simulated voids, and most of the natural voids of inside the samples and especially inside adhesive layers of the 3-in. thick Avcoat tiles, providing scanning speed about 8 min per sq. ft.

Background: Dr. Victor Grubsky is currently focused on the development of innovative x-ray and optical technologies, including non-destructive inspection and testing (NDI/NDT) systems based on x-ray scattering, terahertz sensors and components, lasers, and optical fiber devices and sensors. Another important area of his interest is the development of advanced image processing techniques, in particular for x-ray image enhancement. Before joining Physical Optics, Dr. Grubsky was involved in the development fiber-optic components and systems for the telecommunications and sensor markets. Dr. Grubsky has co-authored nearly 80 scientific publications and 8 U.S. patents.

Background:

Dr. Volodymyr Romanov is a Principal Scientist of Cyber-Physical Systems at Physical Optics Corporation (POC). He has been the PI and PM of multiple R&D projects, and is currently focused in design and development of industrial NDT systems, based on Compton Imaging Tomography (CIT) technique. Such systems are used for NDT of large multilayered non-uniform aircraft/spacecraft component and structures with complicated geometry, including NDT of bond lines of TPS, and also possible micrometeoroid damages of the ISS structures. He earned an M.S. in nuclear physics and engineering, and a Ph.D. in nuclear and elementary particle physics both from Kharkiv National University, Kharkiv, Ukraine, and an M.S. in computer science from Concordia University, Montreal, Canada. Dr. Romanov has coauthored 2 books and over 80 scientific publications, and also 4 U.S. patents.

Session: 7b-2	
"120kV Hand-Held Backscatter X-Ray Imager"	**Peter Rothschild**
Demo: No	**Heuresis Corp.**
Poster: No	**PRothschild@Heuresistech.com**
One-on-One Table: No	**617-467-5526**

Abstract: A wide range of backscatter x-ray imaging systems have been developed at American Science & Engineering (AS&E) and Rapiscan Systems over the last 25 years. These systems have been designed to scan baggage, people, vehicles, and cargo. AS&E recently developed the world's first hand-held backscatter x-ray imager, the Mini-Z™. Although useful for many applications, existing hand-held backscatter x-ray systems are not able to image effectively through steel, and are therefore unsuitable for inspecting most vehicles. We will be describing the first hand-held backscatter imager that can see through up to 2.5mm of steel.

Background: Peter Rothschild is the Co-Founder and Chief Technology Officer at Heuresis Corp. in Newton, Massachusetts. After completing his PhD in physics from MIT, he spent almost 20 years at American Science and Engineering developing novel systems for performing backscatter x-ray imaging. His most recent position at AS&E was Chief Scientist, before leaving to co-found Heuresis in 2013. Peter designed the original AS&E X-Ray Backscatter Van (ZBV) that sold almost 800 units world-wide. Peter holds 40 issued U.S. patents.

Session: 7b-3	**Martin Rommel | Aaron Couture**
"Versatile Detector for Scanning Beam X-Ray Inspection"	**American Science & Engineering**
Demo: Yes	**Martin.Rommel@as-e.com**
Poster: No	**Aaron.Couture@as-e.com**
One-on-One Table: No	**978-262-8700**

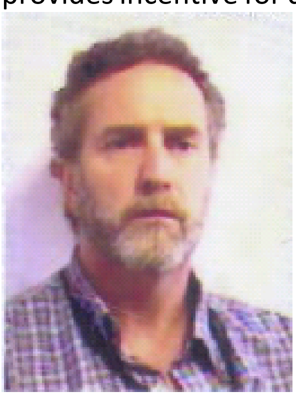
Abstract: Scanning X-ray beam imaging systems were first developed commercially by American Science and Engineering, Inc. (AS&E) in the early 1970s. Since then, these systems have found a wide range of applications with hundreds of systems deployed around the world. After a brief overview of the scanning beam method we compare it with pinhole scatter imaging. A new detector design recently developed by AS&E will be discussed next. It relies on wavelength shifting fibers (WSF) for light collection and enables the construction of thin large-area detectors. One application is a panel detector that can be used in conjunction with various AS&E imaging systems and proofs particularly useful with the handheld MINI Z. The value and versatility of this detector will be demonstrated.

Background: Martin Rommel is Principal Scientist at AS&E in Billerica, Massachusetts. After his PhD in physics he spent 10 years developing non-destructive metrology equipment for the semiconductor industry. Since 2007 he has worked at AS&E on advancing security inspection technology. His most recent project was the development of a fast high-power scanning beam X-ray source with electronically controllable focal spot. Martin holds eight granted and several pending patents.

Background: Aaron Couture joined AS&E as Chief Scientist in 2015, working on technology development for backscatter x-ray systems. Previously he was a Senior Scientist at GE's Global Research. He was responsible for multi-disciplinary teams developing innovative detection solutions for security, industrial, and medical applications using X-ray, computed tomography (CT), and other technologies. He holds fourteen patents and has five publications in the area of digital x-ray detectors, CT, and sensors for life-sciences

Session 7b-4		**Robert Woods/Eric Forsythe**
"Flexible Digital X-ray Development"		**Defense Threat Reduction Agency**
Demo: Display items: No		**Explosive Ordnance Disposal R&D**
One-on-One Table: Yes	**(910) 927-6058**	**robert.p.woods8.civ@mail.mil**
	(301) 830-3089	**eric.w.forsythe.civ@mail.mil**

Abstract: Application of man portable, light weight, flexible, radiography systems in extreme operating conditions and environments. Radiography used as a technique to enhance security or conduct industrial inspections has many challenges when conducted out of doors and in remote locations. Environmental conditions, power requirements, x-ray source requirements, and imaging requirements all affect capability, availability, cost, and employment of radiography systems. There are no perfect solutions. The ideal system would be thin, lightweight, rugged, quick, easy to use, have no moving parts, and provide real time high spatial resolution images without the need for processors. The system should also be applicable to all types of materials and densities as well as a variety of imager to source standoff distances. All of these factors combined present a very unique challenge to using radiography for security and industrial applications in extreme environmental conditions or remote locations. The collaboration of extreme industrial radiography requirements with DOD security inspection requirements provides incentive for development of new technology and markets focused for these challenges.



Background: Mr. Robert Woods is a Defense Threat Reduction Agency Research and Development Program Manager focusing on technology, products and solutions for applications in Security and Explosive Ordnance Disposal (EOD). Mr. Woods is a retired USN Master Chief Petty Officer, Master EOD Technician with over 30 years of experience in military EOD requirements and R&D efforts. He has been with DTRA for over 16 years as a DAU Level III Certified Program Manager working with multiple government agencies and commercial vendors developing technology and solutions for unique EOD problems and mission sets.

Background: Eric W. Forsythe, Ph.D is the Team Leader for Flexible Electronics at the US Army Research Laboratory, Adelphi, MD. His responsibilities include; Program Manager for NextFlex | Americ's Flexible Hybrid Electronics Manufacturing Institute, PM the U.S. Army's Flexible Display Center that includes an Army Mantech flexible digital x-ray imagers for Army EOD, and PM for FlexTech Alliance. Prior to joining ARL in 2001, Dr Forsythe was a Research Associate at the University of Rochester and received his Ph.D in Engineering Physics at Stevens Institute of Technology.

Session 7c-1
"Propellant Tank Quantity in Zero-G Using Modal Analysis from Piezo-Patch Sensors."
Rudy Werlink-Nehemiah Williams
NASA KSC/NEM and JSC/EP
Demo: No
rudy.werlink-1@nasa.gov; Nehemiah.j.williams@nasa.gov
Poster: No
321-861-7327; 281-483-7648

Abstract: The challenges of accurately measuring propellant tank quantities in zero gravity have been investigated since spaceflight began. A miniature (NASA Patented) piezo-patch sensor pulse-receive system mounted to the exterior of several propellant tank configurations and the modal analysis methods applied show promising results, even on zero-g aircraft tests. Frequency Response Functions (FRFs) show changes to frequencies of peaks of tank vibrational mode peaks as the mass of the liquid changes. As the combined tank-liquid mass increases, resonant modes decrease. The PZT sensors also act passively, which may enable their use as MMOD impact sensors. An accuracy of 1-2% with tank water volumes of 20-80% were demonstrated during the many 20 second Zero-G aircraft parabolas flown from 2010 to 2016. Desired next tests include longer duration zero G experiments using larger tanks, nearly full to empty fluid volumes, and tests using liquid nitrogen.

Bio: Dr. Nehemiah Joel Williams is a Liquid Propulsion Systems Engineer at NASA Johnson Space Center supporting the spacecraft Modal Propellant Gauging system with development of finite element(FE) models. doctorate degree at the University of Tennessee the His interests include both chemical and advanced rocket engine research and development, computational fluid dynamics and turbulence modeling, testing and evaluation (related to propulsion) and learning new numerical software.

Bio: Rudy Werlink is currently PI and Project Manager for NASA, KSC future Projects, with funding from Advanced Exploration Systems and Orion. Rudy has been developing and testing PZT Tank health monitoring and modal mass measurement technology at KSC since 2005. This has resulted in a USPTO Provisional Patent in 2016. From 1998 to 2005, Rudy was assigned to NASA Langley and received his Master's of Science degree in Physics-Materials Science at William and Mary. Mr. Werlink has a BS in Chemistry from the University of Washington and a BS in Mechanical Engineering from the University of Central Florida. He has been married since 1980 with 4 offspring.

Session: 7c-2	**Dan Xiang, Ph.D.**
"SHM for Long Duration Spaceflight Habitats"	**Director for R&D**
Demo: No	**X-wave Innovations, Inc.**
Poster: No	**dxiang@x-waveinnovations.com**
One-on-One Table: No	**301-200-8128**

Abstract: X-wave Innovations, Inc. (XII) is a research and development (R&D) firm, specialized in R&D of advanced nondestructive evaluation (NDE) and structural health monitoring (SHM) technologies. Thanks to the support of NASA, DOD, and DOE, XII has developed a Multi-Functional Sensor Network System (MFSNS) technology, which uses an array of piezoelectric sensors along with a set of advanced signal processing algorithms, to achieve accurate precursor/ damage diagnostics and remaining useful life (RUL) prognostics for large, complex structures. In this presentation, we summarize the application of this MFSNS technology to SHM of the softgoods structures in long duration spaceflight habitats. With its multi-functional sensing capabilities, the MFSNS has been demonstrated for not only detecting material state or degradation, such as creeping, but also characterizing damage and estimate the RUL of softsgoods structures. Furthermore, the MFSNS has the self-diagnostics capability to assess of the health of sensors themselves. This unique feature makes MFSNS suitable for long-duration, accurate condition/heath monitoring of critical components/structures such as the softgoods space habitat structures.

Background: Dr. Dan Xiang received both his B.S. and Ph.D. degrees in 1985 and 1991 in Mechanical Engineering from Tsinghua University, the most prestigious university in China, where he joined the faculty and was promoted as the university's youngest associate professors in 1992. He moved to the US in 1994, and received a Master's degree in Computer Science from Johns Hopkins University in 2002. He is the founder and Director for R&D of X-wave Innovations, Inc. (XII). He is also serving as an associate editor of IEEE Transactions on Ultrasonics, Ferroelectrics, and Frequency Control. Prior to XII, Dr. Xiang had worked with different government agency (e.g., NASA, National Institute of Standards and Technology (NIST)), Universities (Tsinghua University, Johns Hopkins University, University of Maryland), and several commercial companies over a variety of projects from materials to NDE, SHM to sensor technologies. He holds 2 patents, and has over 60 publications in the field of sensor technologies and NDE/SHM.

Session: 7c-3 **Amrita Kumar[1], Jeffrey Bergman[1], Franklin Li[1], James Min[2]**
"Expandable Sensor Networks for Structural Health Monitoring" **Acellent Technologies Inc, NASA**
Demo: No **akumar@acellent.com; jeffb@accellent.com**
Poster: No **franklin_Li@accellent.com; james.b.min@nasa.gov**
One-on-One Table: No **408 745 1188**

Abstract: Current Structural Health Monitoring (SHM) systems have demonstrated the ability to detect, locate, and determine the size/severity of structural damage in metal and composite structures. However, there currently are no long duration flexible hybrid multifunctional devices that can conformably distribute sensors over very large surfaces enabling the availability of instantaneous information on the structural integrity of the structure while adding minimal weight. This presentation will showcase recent work conducted by Acellent to build expandable sensing capabilities and integrate flexible structural health monitoring into space materials such as state-of-the art thin-ply composites and soft-goods materials for expandable habitat structural concepts, during or after fabrication, to enable evaluation of structural properties and failure prediction over the duration of the habitat's operational life.

Background: Dr. Amrita Kumar is Executive Vice President at Acellent Technologies, Inc. She is well versed in Structural Health Monitoring systems for metal and composite structures having worked in this field for over two decades. She has been with Acellent from its inception and handles Acellent's business related activities. Dr. Kumar is a Member of the organizing committee for the International Workshop on Structural Health Monitoring held at Stanford University, Program committee member SPIE Smart Structures / NDE, Industrial & Commercial applications. Dr. Kumar received her M.S. and Ph.D., both in ME & Mechanics, from Drexel University, Philadelphia.

Background: Jeffrey Bergman is the Director of Engineering Marketing at Acellent Technologies Inc. He received a BSE from Calvin College and MSE degrees in both Civil and Electrical Engineering from the University of Michigan where he pursued graduate research in the field of Structural Health Monitoring (SHM) for bridges.

Background: Franklin Li is the Vice President of Sensor Development at Acellent. He received his M.S. in Engineering Physics from Stevens Institute of Technology. He was formerly the CEO at Bek-Tronic Technology, Inc., Pompton Plains, N.J. Mr. Li works primarily on sensor development and is instrumental in the development of the expandable sensor network at Acellent.

Background: Dr. James Min is the Active Structures Technical Lead and a senior researcher in structures and materials at NASA Glenn Research Center. Prior to joining GRC, he worked at NASA MSFC in advanced rocket launch vehicles development, and at NASA Langley in aircraft impact and crashworthiness. He earned his PhD degree in ME and MS degree in Civil Engineering from University of Illinois. He received NASA Exceptional Achievement Medal.

Session 8a-1
"Contact Point Corrosion on Carbon Steel"
Demo: No Poster: No
One-on-One Table: No

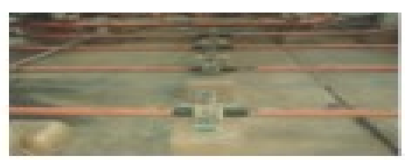
Brian K. Beresford "Bear"
VIR Inspection LLC
832.943.0979
bear@vir-inspection.com

Abstract: <u>What is "Contact Point Corrosion":</u> VIR Inspection is the owner and the inventor of VIR contact point corrosion test method. A NDE to inundate the conductive material being inspected with AC or DC current. It's a two-position contact point corrosion test method.

<u>Industry Wide Issues:</u> Leading cause of facility releases belongs to equipment failure (53%), followed by operator error (17%) and then corrosion (16%). However, corrosion related spills in facilities account for the largest average spill volume of all release types in facilities. In addition, both the number and size of corrosion related spills in facilities are on an upward trend. Facility piping supports or other metal-to-metal contact may increase the potential for external corrosion. Use of non-metallic separation barriers (such as high density polyethylene I-rod) can mitigate the potential for external corrosion at pipe supports and other metal-to-metal contact points.

<u>How VIR Contact Point Corrosion Started:</u> A major plant was looking for a solution to inspect their High-Pressure Piping (HPP) for corrosion at the clamps. There are 6 lines with 386 clamps in each line. Each HPP carries 27,000 pounds of gas through the pipe. Multiple techniques such as Guided Wave, Digital Radiography and Eddy Current were used; but were unsuccessful because of different variables such as the temperature of the pipe, pipe vibration and pipe configuration.

Pipping at supports I-Beams



High Pressure Piping

T-Pipe

Background: Brian Beresford "Bear" started his heat exchanger tube inspection career in 1983 with Zetec Incorporated in Issaquah, Washington. Throughout his thirty-three years of service Bear has worked in nuclear power facilities, petrochemical facilities, nuclear naval submarines and of course the oil refining business. His job functions have included strategic business development, new product design, new product testing, probe development and field services. Bear is a functioning level III analyst in accordance with ASNT-TC-1A.

Session: 8a-2
"Field-Portable Electron Microscopy in Space"
Demo: Yes
Poster: No
One-on-One Table: No

Dr. Christopher S. Own
CEO, Voxa (Seattle, WA)
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415-858-0393

Abstract: *Mochii™* is a new portable and remote operable electron microscope (EM) capable of high resolution imaging that can be augmented with an integrated spectrometer to acquire point spectra and element specific maps. It can demonstrate real-time, *in situ* imaging and compositional measurements in the field, accelerating many scientific inquiries and mission-critical decisions.

Mochii, just 260 mm tall and weighing <13kg, will enable NASA to address a current blind spot in its manned-flight detection toolset by combining imaging and spectroscopy with outstanding mobility and easy remote operation. Important applications include spacecraft health monitoring and planetary science on manned missions beyond Low Earth Orbit (e.g., in-flight inspection of microscopic mission threats and forensic failure analysis), and remote sensing/robotic missions.

Bio: Dr. Christopher S. Own is founder and CEO of Voxa. He has founded three companies and worked with multiple startups commercializing novel charged-particle nanoscale imaging technologies and science instruments. In addition to experience designing the world's highest-performance commercial EM systems, Dr. Own has also worked in thin films research, electron crystallography, materials characterization, DNA patterning, and genome sequencing. Dr. Own currently spearheads development of new scalable and automated nanotechnology systems at Voxa, which provides advanced equipment and multi-year contracts for domestic and international clients.

2001; B.S. Materials Science and Engineering, Northwestern University
2005; Ph.D. Materials Science and Engineering, Northwestern University

Session: 8a-3
"Thermography Modeling and Information Integration"
Demo: No
Poster: No
One-on-One Table: Yes

Stephen D. Holland
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Abstract: A mission to Mars represents unique challenges for investigation and evaluation of possible damage to a spacecraft, whether accidental, from micrometeoroid impact, or from some other source. In particular, bandwidths to Earth are low and latency is very high, even assuming regular communications have not been interrupted. So it is very desirable for any onboard inspection system to be able to operate independently, to be able to automatically relate new information to prior knowledge, and to render information in as clear a way as possible for interpretation by astronauts.

Thermography is one of the few nondestructive evaluation techniques for finding hidden damage that is safe and practical in space. In-space thermography was a primary means to inspect the Space Shuttle thermal protection system post-Columbia. Unfortunately, thermography tends to work best at shallow depths from free surfaces, and resolution is limited by thermal diffusion, so additional information from other sources can be very helpful in interpreting a measurement. We discuss some of the challenges of fusing data from different sources and new thermography inversion techniques that create concrete representations of defect structure from thermography NDE data for interpretation in the context of prior information.

Background: Stephen D. Holland is an associate professor of aerospace engineering at Iowa State University's Center for Nondestructive Evaluation (CNDE). He leads ISU CNDE's research programs in thermographic NDE and NDE data integration. Prof. Holland holds a B.S degree in Electrical Engineering and a Ph.D. in Theoretical and Applied Mechanics, both from Cornell University.

Session 8b-1
"Measurement of the Modulation Transfer Function for Backscatter Radiography System Used in NDE"
Demo: No Poster: No
One-on-One Table: No

James E. Baciak
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352-273-2131

Abstract: : Backscatter radiography by selective detection is a form of Compton backscatter radiography that collimates the dominant near-surface x-ray scatter signal to allow for sub-surface imaging of flaws and features of interest in applications in which traditional transmission radiography is impractical. While most backscatter imaging techniques use a highly collimated pencil beam of x-rays to provide position information, this limits acquisition speeds and reduces application space. The use of x-ray fan beam geometries and high frame-rate linear detector arrays allows one to overcome these challenges and produce images over large areas. We will discuss the concept and principals behind backscatter radiography by selective detection and present several examples of our research, including land mine detection, spacecraft components, aircraft components, and railroad cross-ties.

Background: Dr. James E. Baciak (Ph.D., 2004) is a Florida Power & Light Professor and the Director of the Nuclear Engineering Program at the University of Florida. His expertise areas include radiation detector development and radiation measurements, particularly for nuclear security and non-destructive examination (medical and industrial) applications. He has received funding from the Department of Defense, Department of Energy, Department of Homeland Security, National Nuclear Security Administration, Nuclear Regulatory Commission, Defense Threat Reduction Agency, and industry sponsors. In addition to his current position, Jim has also been a consulting engineer for the nuclear utility industry, and was an engineer at Pacific Northwest National Laboratory. He is also a co-developer and instructor of the Nuclear Security Summer School at Pacific Northwest National Laboratory. His has a PhD in Nuclear Engineering from the University of Michigan. He has authored or co-authored over 48 refereed publications, and has presented over 80 times at professional conferences. He a member of numerous professional societies, including ASNT, IEEE, SPIE, ANS, and AREMA.

Session: 8b-2
"MiniMax & MERAY X-Ray Systems, and Thermal Neutron Radiography of Gas"
Demo: No Poster: Yes
One-on-One Table: Yes

Scott Watson
Los Alamos National Labs
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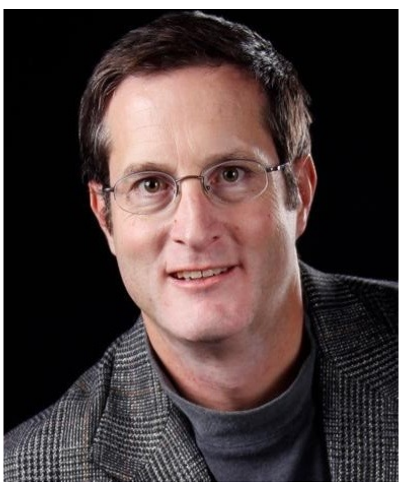
Abstract: Los Alamos has a long history of field-radiography as part of the Nuclear Emergency Search Team (NEST), the Joint Technology Operations Team (JTOT), and the nuclear Accident Response team (ARG). Each of these teams requires compact, low- and high- energy radiography that is well beyond the state-of-the-art available from commercial vendors. We discuss these challenges, some possible solutions, and a variety of applications.



Background: Scott Watson has been a staff scientist at Los Alamos for 30 years. He has been a project manager and operations manager for several large flash x-ray facilities including PHERMEX, Cygnus, and DARHT. Scott holds numerous patents in accelerator and x-ray technology and has won two R&D 100 awards for his work on the world's fastest camera, MOXIE, and the world's most compact x-ray scanner, MiniMAX.

Session: 8b-3

"Reflection, Transmission, Absorption, and Scattering at Submillimeter Wavelengths from Random Rough Surfaces"

Dr. Erich Grossman
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Demo: No Poster: No One-on-One Table: Yes

Abstract: I describe a number of recent measurements made at submillimeter wavelengths on samples with "realistic" (i.e. non-ideal) dielectric or geometric properties. First, transmission measurements on a ceramic shuttle tile are presented, indicating an average attenuation of approx. 2 dB/cm at 334 GHz, though with relatively large spatial variations of uncertain origin. Next, the results of a large. DHS-sponsored study of bistatic scattering from rough dielectric surfaces are presented. Comparisons to two state-of-the-art, rough surface scattering theories (based on the Integral Equation Method of Fung, 2010 and the Generalized Harvey-Shack treatment of Krywonos et al. 2011) indicate reasonable agreement over only a small region of parameter space. When the autocorrelation length is short compared to a wavelength, as it is for most of the samples, a purely empirical model of Lambertian scattering provides the best match to the measurements. I illustrate, via detailed simulation, the application of such scattering data to personnel screening (concealed weapon detection) using actively illuminated submillimeter imaging. Finally, I describe an ongoing study of propagation through metallic waveguide devices built with additive manufacturing (AM), which yields surfaces with roughness of order 10 micron.

Background: Erich N. Grossman (M '88, SM '06) received the A.B. in physics from Harvard College in 1980, and Ph.D., also in physics, from the California Institute of Technology in 1987. From 1988 to 1989, he was a postdoctoral fellow at the Univ. of Texas at Austin, and in 1989, he joined the National Institute of Standards and Technology, Boulder, where he is a physicist in the Physical Measurement Lab. His work at NIST focuses on infrared and submillimeter system development. Notable accomplishments include demonstration of the world's highest frequency, high efficiency lithographic antennas, the world's highest frequency Josephson junctions, (awarded a Dept. of Commerce Gold Medal in 1993), and the original conception and early development of the SQUID multiplexer, first enabling large monolithic arrays of superconducting detectors.. More recently, he has developed several 0.1-1 THz cameras for security applications. He received the Allen V. Astin Measurement Science Award in 2010.

Session 8c-1

"Automated Interpretation of In-space NDT Data of Carbon Composite Damage"

Dr. Carl W. Magnuson
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785-766-8896

Demo: No Poster: No
One-on-One Table: No

Abstract: With the increase in duration of space missions, there is a greater need for in-space nondestructive testing (NDT) to guarantee the safety of astronauts and ensure mission success. Two challenges associated with in-space NDT are the extremely large data sets associated with modern NDT techniques and the need for non-experts to be able to quickly and accurately interpret the data. Limited bandwidth makes transmitting the raw inspection data for ground based expert analysis impractical. Astronauts will be required to quickly interpret the data to detect the presence and assess the severity of any damage condition.

Additionally, the NDT equipment available in space is limited and may not have the resolution and capabilities of corresponding ground based systems. To help overcome these limitations, we utilize data taken on ground (design data, production data, manufacturing NDT, etc.) to supplement the in-space data for defect assessment. Our Automated Defect Analysis (ADA) algorithms automate this data correlation and interpretation to generate a digital assessment of damage. This digital damage assessment is input into finite element method (FEM) simulations to determine its effect on structural integrity.

Background: **Dr. Carl W. Magnuson** earned a BS degree in Electrical Engineering from the University of Southern California in 2005. He then worked on Space Based Infra-Red Systems at Northrop Grumman while pursuing a Masters degree in Computer Science at USC until 2008 when he moved to Austin to attend the University of Texas. He completed his PhD in Materials Science and Engineering at UT Austin focusing on carbon thin films and graphene synthesis in 2014. He is now an NDE specialist at TRI-Austin.

Session 8c-2
"Enhanced Attribution of Spacecraft Malfunctions"
Demo: No
Poster: No
One-on-One Table: No

Douglas L. Goodman, CEO
Ridgetop Group, Inc.
DGoodman@RidgetopGroup.com
520-742-3300

Abstract: Spacecraft are subjected to orbital debris, and subjected to intense radiation and extreme temperatures. It is important to improve the attribution of faults while the spacecraft is in space far from Earth. This improvement will support Condition-based Maintenance (CBM) invocation of rapid fault mitigation protocols, and support the service and repair of the spacecraft while in space. Space systems comprise inter-related structural and electronic subassemblies that are parallel- and series-connected at nodes within a system, and those assemblies are subject to a multiplicity of failure modes including, but not limited to, structural damage, fatigue-induced failure, avalanche-mode failure, and environmental-stress failures. Detecting the onset of such failures and attributing the cause and location of those failures to specific failure modes in specific assemblies is challenging. Challenges include adequate observability and the desire to minimize any additional weight to the spacecraft. Successful fault isolation requires understanding of failure modes; how they are manifested as changes in measureable signals; selecting and using sensors and processing to capture signals, and how to condition, transform, and characterize changes in signals or sensors, especially leading indicators of failure, into signature data for input to a health- and fault-management framework.

Background: Mr. Douglas Goodman is the CEO of Ridgetop Group, Inc. a leader in advanced diagnostic, prognostic and health management (PHM) tools, and precision instrumentation for semiconductor test / metrology applications. Doug's background encompasses low-noise instrumentation design, design-for-test (DFT), mixed signal IC design, fault simulation techniques, and design tool development. He was part of the team at Tektronix that developed the first DSP-based IF processing for spectrum analyzers. At Honeywell, he helped design fault-tolerant flight control systems for commercial aircraft. Doug was VP for engineering at Analogy Inc., which does electromechanical design simulation tools. Ridgetop Group has shipped over 900 instruments to its customers worldwide. Mr. Goodman serves on the Industrial Partners Board for the University of Arizona, College of Engineering. He holds a BSEE from California Polytechnic State University, and an MBA from the University of Portland, in Oregon and has a number of patents involving signal processing, prognostics and semiconductor technologies.

Session: 8c-3
"Next Generation Phased Array Ultrasound: Advancements in Total Focusing Method and Full Matrix Capture Techniques"
Demo: Yes Poster: Yes
One-on-One Table: No

Gavin Dao
Advanced OEM Solutions
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Abstract: Total Focusing Method (TFM) imaging is revolutionizing phased array ultrasound. TFM is a post-processing technique that can be implemented real-time using data acquired by the Full-Matrix capture (FMC) and other technological advancements. TFM provides several benefits over conventional Phased Array in terms of a real-time high resolution reconstruction grid, view several wave modes from one setup, improved vertical and lateral resolution, higher signal to noise ratio, improved flaw characterizing and sizing and reduced misinterpretation of geometry echoes versus defects. Saving the FMC data allows re-processing at a later time with improved signal processing algorithms. One known characteristic of FMC is that it requires large amounts of raw data to compute a TFM image. The instrument used for the experiments has more than enough data transfer capability over 140 MB/s. This paper will present improvements to speed up and optimize both FMC and TFM while keeping and in some cases improving signal-to-noise ratio. Furthermore, with a small form factor, advanced high resolution imaging capabilities that were once only lab capable can now be industrialized and even automated using scanners and robots.

Background: Gavin Dao is the Director of Business development for Advanced OEM Solutions in Cincinnati Ohio, a manufacturer of advanced phased array ultrasound instruments. His education background is in Electrical Engineering and Computer Science where in the last decade has worked on R&D of a few generations of ultrasonic instruments. His latest achievement has been bringing a new technology, Full-Matrix Capture, to the market on a commercial basis.

Session: 9a-1
"Penetrating Imager Technologies"
Demo: No
Poster: No
One-on-One Table: Yes

Doug McMakin
Pacific Northwest National Lab
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509-375-2206; 509-942-4055

Abstract: Pacific Northwest National Laboratory (PNNL) has been on the forefront of developing novel non-destruction evaluation (NDE) technologies for more than 50 years. Starting in the 1960's, PNNL pioneered the development of holographic acoustic inspection technologies for the nuclear industry. In succeeding years, PNNL expanded its NDE capabilities across variety of sensor platforms including optics, infrared, ultrasonic, electromagnetics, and millimeter-wave radar. PNNL has conducted more than 120 research projects for NASA since 1985 to the present, including the application of airborne radar technologies. This talk will describe PNNL's unique NDE capabilities and highlight one of its signature NDE technologies - holographic radar imaging--which is used in a variety internal structure inspection applications of optical opaque low-dielectric barriers. The talk will include an overview of how the technology works and will show through barrier imagery from a variety of applications.

Background: Doug McMakin has more than 30 years of experience at Pacific Northwest National Laboratory in conceiving, developing, and transferring practical electronic instrumentation for real-world government and commercial applications using radio frequency, radar, and terahertz technologies. He was the project manager and one of the lead inventors of the millimeter-wave Advanced Imaging Technology that has had worldwide impact on aviation security, with more than 1,300 ProVision systems deployed at more than 250 airports worldwide since the original license in 2002. He won the national Christopher Columbus Fellowship Foundation Homeland Security Award and national awards for two technology innovation and transfer. He has received 19 patents, authored or co-authored more than 50 publications, and has been an invited presenter at numerous events including the National Research Council's Committee on Assessment of Security Technologies for Transportation. Mr. McMakin was acknowledged by the White House Commission on Aviation Safety and Security for providing technical advice and special support to the Commission. He has a B.S. in Electrical Engineering from Washington State University and an MBA from the University of Phoenix.

Session: 9a-2
"Iowa State University Center for NDE "
Demo: No
Poster: No
One-on-One Table: Yes

Steve Holland
Iowa State University
Center for NDE
sdh4@iastate.edu

Abstract: Iowa State's Center for Nondestructive Evaluation (CNDE) is the nation's leading center for multi-modality and multi-disciplinary NDE research. CNDE was established in 1985 as a NSF Industry/University Cooperative Research Center and works with industry and government to address NDE problems for a variety of industrial sectors. CNDE has research programs in most major NDE modalities including X-ray radiography, ultrasonics, eddy current, terahertz, thermography, fluorescent penetrant, and magnetic particle testing. We also have research in structural health monitoring and embedded sensors. We are collaborating with researchers in other disciplines to advance the capabilities in NDE, for example tracking objects to facilitate data registration, and "digital twin" data integration efforts. NASA is a center sponsor and funds several current research efforts focused around NDE of composite materials for both terrestrial and space applications.

Background: **Stephen D. Holland** is an associate professor of aerospace engineering at Iowa State University's Center for Nondestructive Evaluation (CNDE). He leads ISU CNDE's research programs in thermographic NDE and NDE data integration. Prof. Holland holds a B.S degree in Electrical Engineering and a Ph.D. in Theoretical and Applied Mechanics, both from Cornell University.

Session: 9a-3
"Guided Acoustical Wavefield Imaging for Damage Detection Structural Characterization, and Transducer Design"
Demo: No
Poster: No
One-on-One Table: Yes

Dr. Massimo Ruzzene
Georgia Tech
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Abstract: The application of wave-based inspection methods for the analysis of the state of health of structural components has received significant attention in recent years. The propagation and GUW, together with the application of Scanning Laser Vibrometry for full wave field measurement enables the introduction of novel damage detection techniques which are based on the application of filtering techniques in the frequency/wavenumber space. Goal of these techniques is to separate the contribution of damage from the overall response of the structure, thus highlighting its presence and location. This presentation will provide an overview of techniques developed for the analysis of guided wave field, and their application for damage detection, structural characterization, and for the design of novel transducers for Structural Health Monitoring. These transducers feature patterns that enable wave steering through the selection of the excitation frequency, and the measurement of multiple strain components for surface acoustic wave-based sensing of strain.

Background: Massimo Ruzzene is the Pratt and Whitney Professor of Aerospace and Mechanical Engineering at Georgia Tech, and he is currently the Program Director for the Dynamics, Control and System Diagnostics Program of CMMI at the National Science Foundation. His work focuses on solid mechanics, structural dynamics and wave propagation with application to structural health monitoring, metamaterials, and vibration & noise control. Dr. Ruzzene is author of 2 books, 135 journal papers and about 180 conference papers, and has participated to projects funded by the AFOSR, ARO, ONR, NASA, US Army, US Navy, DARPA, and NSF, as well as numerous companies. M. Ruzzene is a Fellow of ASME, an Associate Fellow of AIAA, and a member of AHS, and ASA.

Session: 9a-4
"Integrity Assessment of Difficult to Inspect Pipelines Evaluating Select Areas Using High Resolution NDE"
Demo: No Poster: No
One-on-One Table: Yes

Hans Deeb
Pipeline Research Council Int'l (PRCI)
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281-846-7568

Abstract: As buried transmission pipeline systems in the U.S. continue to age, operators are mandated to monitor and assess the condition of pipe segments that approach or pass though High Consequence Areas (HCA). To that end, PRCI has funded and executed a number of research projects aimed at advancing the state-of-the-art for integrity management of difficult to inspect pipelines by examining technologies that can be applied to screen the condition of the pipe wall for its full length. The research focuses on direct inspection technologies with capability for obtaining high resolution wall thickness measurements at locations indicated from the application of screening technologies. The research is examining external technologies that can scan through coatings, but also is considering internal technologies that are not currently associated with in-line inspection. The purpose of this presentation is to provide an overview of PRCI's research efforts in this area, and to introduce the Technology Development Center in Houston, TX where these research projects are currently being conducted.

Background: Hans Deeb began working for PRCI in 2007 as a Project Manager. His initial duties included managing research projects on the Measurement, Compressor and Pump Stations, and Underground Storage Technical Committees. In 2010, Hans transitioned to Program Manager on the Corrosion Technical Committee. He is now a Program Manager on the Integrity and Inspection Technical Committee. Hans is involved in a number of organizations that support the pipeline industry, including active participation in SGA. Hans holds a Bachelor's degree in Mechanical Engineering from the University of Maryland, College Park, and a Master's degree in Business Administration from the Robert H. Smith School of Business at the University of Maryland.

Session: 9b-1

"Multi-Spectral Measurements for Detection, Location, and Evaluation of Impacts to Space Structures"

Demo: No Poster: No

One-on-One Table: No

Aaron Trott
Invocon, Inc.
atrott@invocon.com
281-292-9903

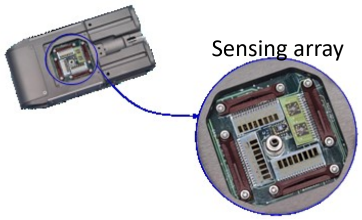
Abstract: Impacts to space structures can have devastating consequences. Invocon has spent the last several years developing methods to mitigate these consequences by detecting, locating, and evaluating impacts using several different techniques across a broad range of the frequency spectrum. Mechanical (vibration), acoustic emissions, radio frequency, and light all provide different pieces of information that can aid in a comprehensive approach to improving the outcome of space impacts. This presentation discusses some of the techniques that Invocon uses along with examples of where they have been useful. It will also discuss a novel optical approach that can aid in monitoring the thermal protection system (TPS) on deep space and crew return vehicles.

Background: Aaron Trott is a Program Director who has been employed with Invocon, Inc. for over twenty years. His present responsibilities at Invocon include business development, program management, and systems engineering. Specific areas of focus include instrumentation system developments for applications in the aerospace and defense industries. He earned his Bachelor's and Master's Degrees in Electrical Engineering from Mississippi State University, during which time he participated in the cooperative education program at NASA Langley Research Center. During his graduate studies, he also worked at the National Science Foundation Engineering Research Center for Computational Field Simulation. Outside of work Aaron enjoys spending time with his family, creating unique pieces from wood, and beekeeping.

Session: 9b-2
"Chemical Sensing Array Platform for Continuous and Autonomous Event Monitoring"
Demo: No Poster: No
One-on-One Table: No

Abhijit V. Shevade
Jet Propulsion Laboratory (JPL)
Abhijit.Shevade@jpl.nasa.gov
818-393-6356

Abstract: The JPL Electronic Nose (ENose) is an array–based sensing system which is designed to run continuously and to monitor for the presence of selected chemical species in the air at parts-per-million (ppm) to parts-per-billion (ppb) concentration ranges. It is an event monitor designed and built for near real time air quality monitoring in crew habitat aboard the space shuttle/space station. In this talk we will discuss a few application cases of the JPL ENose: (i) monitoring air quality aboard ISS, (ii) experiment on MSFC Regenerative ECLSS Module Simulator (REMS) and (iii) monitoring Lithium-ion battery operational safety. It has potential for other in space and ground base applications that will be discussed.



(b)

Figure: (a) The Third Generation JPL ENose used for the ISS Technology Demonstration (b) Sensing Chamber of the Third Generation JPL ENose sensor unit. Seen are sensor array on 4 substrates (8 sensors per substrate) optimized for ISS target analytes.

Background: Abhijit V. Shevade is a Technologist at JPL. He received his Ph.D. in Chemical Engineering from Kansas State University in 2001. His research interests include: development and application of molecular/multiphysics modeling and simulation tools combined with experimental approaches for design and characterization of materials, including organic/inorganic/biomimetic materials for applications in micro/nano chemical /biological sensors, energy conversion and storage devices for future NASA missions and commercial applications.

Session: 9b-3 - Remote Speaker
"MMOD Hypervelocity Impact Test & Piggyback Sensing"
Demo: No
Poster: No
One-on-One Table: No

Kevin Poormon
Univ. of Dayton Research Institute
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937-229-2263

Abstract: The threat of micrometeoroid and orbital debris (MMOD) impacts to spacecraft is an ongoing problem. These impacts occur over a range of velocities up to 15 km/s. To determine the resistance of spacecraft structures to these threats, the materials are typically tested using light-gas guns at velocities up to 10 km/sec. A description of UDRI's two-stage and three-stage, light-gas guns and their operations will be presented along with descriptions of the target chambers, testing environment, and available space/positioning for potential impact sensor instrumentation. These tests can be costly so "piggybacking" sensor experiments on hypervelocity impact tests is a way to minimize the cost of evaluating various impact sensing methods/instrumentation without paying for the test.

Background: Kevin Poormon is a Distinguished Research Engineer at the University of Dayton Research Institute (UDRI). He manages the UDRI Impact Physics Group and conducts research and testing in the fields of Foreign Object Damage (FOD), penetration mechanics, hypervelocity impact, and terminal ballistics in general. He has performed bird and hail strike testing of numerous aircraft structures and aircraft engine components. He evaluates the containment capabilities of turbine/fan cases against blade out conditions. He also investigates the impact response of spacecraft structures, thermal protection systems, micrometeoroid and orbital debris shields used to protect spacecraft from impacts of particles traveling at velocities up to 10 km/s.

Session: 9b-4 - Remote Speaker
"Hypervelocity Impact Testing at NASA White Sands Test Facility"
Demo: No
Poster: No
One-on-One Table: No

Karen Rodriguez
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Abstract: Man-made space debris and natural meteoroids moving at the speed of sound are the number one threat to spacecraft, satellites, and astronauts. Hypervelocity impact testing is used to determine the effectiveness of spacecraft shielding and assist in the development and qualification of materials and components that can withstand hypervelocity impacts. The Remote Hypervelocity Test Laboratory at White Sands Test Facility is equipped with two-stage light gas guns that simulate hypervelocity orbital debris impacts and are capable of firing projectiles at speeds up to 24,000 feet per second, fast enough to travel from the east to the west coast in under 10 minutes. Our team is on the cutting edge of hypervelocity impact testing, creating new and innovative test protocols and handling new challenges as requested by our customers. This includes combining hypervelocity impacts with specialized tests such as thermal environment conditioning and explosive targets. Our high-speed data and imaging equipment provides our customers with high quality data. This talk will overview the WSTF Hypervelocity Test Laboratory, the accommodations for instrumentation and sensing a comments about the process for help you with your hypervelocity testing needs.

Background: **Karen Rodriguez** is currently the Project Manager for the NASA White Sands Test Facility Remote Hypervelocity Test Laboratory, where she has resided for 17 years. She has a Bachelor's of Science in Mechanical Engineering from New Mexico State University.

https://www.nasa.gov/centers/wstf/testing_and_analysis/hypervelocity_impact

Session: 9c-1 – Remote Speaker
"Self-Healing Polymers and Composites"
Demo: No
Poster: No
One-on-One Table: No

Nancy Sottos
Materials Science and Eng.
University of Illinois Urbana
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217-333-1041

Abstract: Polymeric materials programmed with biologically inspired autonomous functions to protect from and limit damage, or even reverse damage and regenerate in response to environmental stress, offer one possible route to expand the material lifecycle, increase reliability and reduce waste. This talk will describe recent developments in self-protection to guard against environmental factors such as mechanical stress, chemical corrosion, or extreme temperatures; self-reporting capabilities to ensure that loss in performance caused by a specific event is registered and communicated; and self-healing to recover structural performance once the system has been damaged. The practical application of these systems still faces challenges, but polymeric materials with autonomous functions are on the horizon and promise enhanced, safer and more efficient performance.

Background: Nancy Sottos is the Donald B. Willet Professor of Engineering in the Department of Materials Science and Engineering at the University of Illinois Urbana-Champaign. She is also a co-chair of the Molecular and Electronic Nanostructures Research Theme at the Beckman Institute. Her research group is part of a collaborative interdisciplinary team at the Beckman Institute that is at the forefront of developing polymers and polymer composites that possess biologically inspired functions, such as self-healing and regeneration to extend material lifecycle. She has co-authored over 185 archival papers and has been awarded 12 patents on her research.

Session 9c-2
"In-Space Manufacturing and Verification"
Demo: No Poster: No
One-on-One Table: Yes

Dr. Derek Thomas
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Abstract: Made In Space has been exploring and developing technologies needed for in-space fabrication and construction of the next generation of large space structures. This capability enables advanced spacecraft and structures to be produced in the space environment, reducing the impact of launch vehicle capabilities on deployed space assets. Additionally, this capability can provide maintenance services for customers to extend the life of existing hardware and to bring forth critical new infrastructure to the future of space exploration.

The next generation of space structures will include complex large-scale assembled configurations with polymer, metal, and composite components including integrated electronics subsystems. During manufacturing operations, non-destructive verification subsystems may occasionally verify that manufacturing is proceeding nominally. This includes weld quality identification and may even include grain structure analysis. Furthermore, for maintenance operations, pre-manufacturing entails substrate identification, which is essential to adhesion of new structures to eliminate the risk of weld cracking. For this complex task, Made In Space has been exploring spectroscopy solutions, including hyperspectral imaging and x-ray fluorescent technologies, to meet the grueling requirements of in-space manufacturing, while simultaneously fabricating novel structures in the space environment.

Background: Dr. Derek Thomas is an expert in the field of nanoscale materials science with a focus on computational and theoretical materials modeling. At Made In Space he developed and performed the experimental analysis and proof of efficacy for recycling 3D printing materials towards in-space recycling and additive manufacturing. He is also currently leading the study of materials and verification equipment to reflect the current and future needs of manufacturing and assembling advanced metals, thermoplastics, and composites in the space environment.

Session 9c-3
"How to Create a 3D Model from Scanned Data in 5 Easy Steps"
Demo: Yes
Poster: Yes

Richard Hagan
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(281) 244-0355

Abstract: Additive manufacturing is a cost effective way to generate copies of damaged parts for demonstrations. Integrating a scanned data file of a damaged area into an existing model that can then be printed may be challenging. However, using the relatively inexpensive Netfabb software one can generate a "watertight" model that is easily printed.

Background: **Richard Hagen** is a mechanical design engineer at NASA Johnson Space Center in the Structural Engineering Division. As the Additive Manufacturing Lab Lead for the past 9 years, primarily using fused deposition modelers (Stratasys Fortus 3D printers), he has produced 1,000s of parts for numerous projects at JSC. However, his primary responsibility has been working as a mechanical design engineer in support of Space Station projects. Richard graduated from Texas A&M University in 1992 with a Bachelor's of Science Degree in Mechanical Engineering. He then worked 4 years in the natural gas industry before changing course to work in the space industry in 1996.

Session 9c-4	**Mike Fowler**
"In-Situ Repair of TPS"	**NASA-JSC/ES4**
Demo: No Poster: No	**Michael.e.fowler@nasa.gov**
One-on-One Table: No	**281-483-8918**

Abstract: After the Columbia accident, on-orbit repair of the Thermal Protection System elements became a requirement for return-to-flight. Two separate efforts, one for the leading edge structures and the other for the silica tiles, were developed. The tile repair material required the capability to form unusual shapes due to the random nature of potential damage. This presentation will give an overview of the material and equipment used during return-to-flight, and offer options for future vehicles.

Background: Mike Fowler has a B.S. in Chemistry and Applied Mathematics and a Ph.D. in Chemical Engineering. Some of the work Johnson Space Center he has been involved with since 1987 includes Space Shuttle Orbiter TPS, X-38 composites and TPS lead, the Orbiter Tile Repair Material lead, and the Orion Heat Shield M&P lead.

Session 10a-1	**Charles T. Nichols**
"Systems for COPV Quality Assurance and MMOD Impacts"	**NASA JSC WSTF**
Demo: No Poster: No	**NESC NDE & OSMA NDE**
One-on-One Table: No	**charles.nichols@nasa.gov**
www.linkedin.com/in/charlestnichols	**575-524-5389**

Abstract: This project presents the top inspection and monitoring needs of NASA and Commercial Spaceflight partners based on one-on-one interviews and support calls. To date, three fatalities due to composite overwrapped pressure vessel (COPV) failures have occurred in the U. S. transportation sector. Most failures in the aerospace arena seem to be confined to non-human cargo. An exception to this are two COPV failures resulting in injury during a U.S. Air Force program in 2003, and at Kennedy Space Center in 2008. Two commercial spacecraft launches carrying commercial payloads were scrubbed in 2014 due to COPV related failures. A September 2016 on-pad explosion was also traced to a COPV failure; the details of which will not be discussed. This project specifically addresses and fills these gaps through multi-year efforts spanning multidisciplinary teams throughout NASA and the nondestructive evaluation (NDE) industry. An overview of systems being developed to target these needs is provided.

Background: A former U.S. Marine and combat veteran, Charles Nichols succeeds Regor Saulsberry as the Johnson Space Center White Sands Test Facility (WSTF) representative to NASA's Nondestructive Evaluation (NDE) Capability Leadership Team, NASA Engineering and Safety Center (NESC) NDE Technical Discipline Team, and Office of Safety and Mission Assurance (OSMA) NDE Program (formerly called the NNWG). Teams led or assisted by Charles investigate material property changes resulting from deep space radiation, mature inspection technologies for Composite Overwrapped Pressure Vessels (COPVs), and further international certification standards for COPVs and 3D-printed parts.

2001-2005: Military Police & Convoy Security, United States Marine Corps
2006-2007: Bridge Inspector, NMSU Center for Transportation Research / NMDOT
2008: Student Project Engineer, Chevron Phillips Chemical Company
2009-2010: Student Researcher, New Mexico Space Grant Consortium
2010: B.S. Mechanical Engineering with Honors, NMSU
2011-Present: NASA

Session: 10a-2
"Damage Detection in Composite Materials and Quantitative Structural Integrity Assessment"
Demo: No
Poster: No
One-on-One Table: No

Michael R. Gorman
Digital Wave Corporation
mgorman@digitalwavecorp.com
303 790 7559 (company)
303 517 9472 (mobile)

Abstract: Damage Detection in Composite Materials and Quantitative Structural Integrity Assessment, Michael R. Gorman – Modal acoustic emission (MAE) is shown to provide quantitative measurements of fiber tow ruptures and debond area as inputs to damage tolerance models. Composite inspection and repair applications are mentioned along with a brief discussion of a successful composite pressure vessel life extension program.

Background: Digital Wave Corporation, formed in 1992 by Dr. Michael Gorman, focused on designing acoustic emission equipment. It was a result of his research involving the relationship between source, material and the wave modes excited in typical engineered structures that led to his discovery of the importance and usefulness of plate waves in acoustic emission. He named this field Modal Acoustic Emission (MAE). MAE is much like seismology, where the wave modes produced by earthquakes are used to infer the type of source. Today, the waveforms and frequency spectra of more metals have been identified and catalogued for use in nondestructive inspection and monitoring. These advancements have put Digital Wave at the forefront of the acoustic emission industry. Primary MAE focus in recent times has been in the metallic and composite pressure vessel industries.

Session: 10a-3

Acousto-Ultrasonics Based NDE Technique for Impact Damage Severity in Composite Materials

Demo: No

Poster: No

One-on-One Table: No

Ramesh Talreja

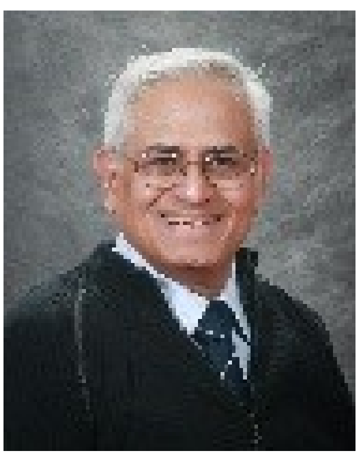
Dept. of Aerospace Engineering

Texas A&M University

talreja@tamu.edu

979-458-3256

Abstract: When the impact damage on a composite structure is in the range of being barely visible and not having penetrated through the thickness of the part, it is important to know how severe it is so that appropriate decision concerning repair or replacement can be made. To determine the impact damage severity an NDE technique must therefore not only inspect to find the extent of damage, but also relate the measured variables to some performance metric. A technique with the potential to provide this capability is acousto-ultrasonics (AU), which combines features of acoustic emission and ultrasonic wave based analysis. Using a transmitter and receiver on the same surface of an impacted part, the received wave can be analyzed in the frequency domain to provide the so-called stress wave factors (SWFs). Invoking stochastic signal analysis, five SWFs are calculated and their relationship with the severity of the impact damage is analyzed. Results of the ongoing work will be presented.



Background: Dr. Ramesh Talreja holds an endowed Tenneco Professorship in the Department of Aerospace Engineering at Texas A&M University, College Station. He has taught previously at Georgia Tech (1991-2001) and at the Technical University of Denmark. He has over 30 years of research background in composite materials with focus on damage and failure analysis. He was recognized recently by the International Committee on Composite Materials as ICCM World Fellow and Life Member.

Session: 10b-1 **Jonathan Goff**

"EPM Grippers, DogTags, and LISA Arms for In-Space Inspection and Servicing"

Demo: Yes
Poster: No
One-on-One Table: No

Altius Space Machines, Inc.
jongoff@altius-space.com
801-362-2310

Abstract: Altius Space Machines has been developing a family of robotic capture systems for applications including space station assistive robotics, space debris cleanup, satellite servicing, on-orbit construction, and orbital propellant depots. In this presentation, Altius will describe some early work investigating a range of non-cooperative capture mechanisms (electroadhesion, gecko adhesion, universal jamming grippers, etc), as well as its latest work on electro-permanent magnetic (EPM) grippers using lightweight "DogTag" robotic capture interfaces, and Low Inertia STEM Arm (LISA) deployable manipulators for use on free-flying space and terrestrial robots. Altius will discuss a commercial application it is currently developing these technologies for, as well as providing a brief discussion of other potential terrestrial and in-space inspection and servicing applications.

Background: Jonathan Goff is the President and CEO of Altius Space Machines, a Colorado-based space robotics and technology startup. Jonathan is an inventor, entrepreneur, and space technologist, and has led efforts at Altius to design robotic capture systems, assistive robotic manipulators, launch vehicle and spacecraft mechanisms, and in-space refueling couplings. Prior to founding Altius, Jonathan was a founder and lead propulsion engineer at Masten Space Systems, a Southern California-based reusable rocket developer. Jonathan has a BS in Manufacturing Engineering and an MS in Mechanical Engineering from BYU, and 13 years of experience in the entrepreneurial aerospace world, and holds two patents.

Cosponsored by

Session: 10b-2	**Ian D Walker**
"Thin Cable-like Robots for Inspection"	**Clemson University**
Demo: No	**Electrical and Computer Eng.**
Poster: No	**iwalker@clemson.edu**
One-on-One Table: No	**864-656-7209**

Abstract: This talk will provide an overview of research at Clemson University in long, thin, cable-like "tendril" continuum robots, sponsored by NASA. In particular, robots inspired by octopus arms and plants (vines) will be reviewed. Use of these robots for inspection operations, targeted towards Space Station operations, will be discussed.

Background: Ian Walker is a Professor in the Department of Electrical and Computer Engineering at Clemson University. His research interests are in robotics, particularly novel manipulators and manipulation. His group is conducting basic research in the construction, modeling, and application of biologically inspired "trunk, tentacle, and worm" robots.

Session: 10b-3
"Gecko Inspired Adhesives for Robotic Space Applications"
Demo: Yes
Poster: No
One-on-One Table: No

Arul Suresh
Stanford University, BDML
sasuresh@stanford.edu
408 565 5025 (cell)

Abstract: Several NASA initiatives require robotic manipulation in a microgravity environment. Whether assistive free flyers, external inspection robots, or servicing/deorbiting satellites, these robots will need to operate on a variety of surfaces. Traditional robotic grasping technologies grasp objects using friction or by mechanically constraining the object in the end effector. This can require large force applications for grip strength in the former case, and imposes possibly strict kinematic constraints in the latter. Gecko-inspired adhesives exploit a fundamentally different mode of grasping from internal forces and friction, allowing for a range of capabilities well suited to space applications. Useful adhesion is available on a wide range of surfaces, reducing or eliminating the need for specific grasp/docking targets, and gecko adhesive systems can attach and detach with very low forces, permitting precision positioning in microgravity. Work at Stanford has focused on the design of gecko-adhesive grippers for dynamic grasping. These grippers have been evaluated in the lab, and tested on zero-g flights in collaboration with JPL. Related technology from JPL has been evaluated in the ISS. Future research directions include tailored design of adhesive properties for specific applications, integration into free flyers, and improving performance on a wider range of surfaces.

Background: Arul Suresh earned a BSE in Mechanical and Aerospace Engineering from Princeton, and is now a PhD Candidate at Stanford University in the Biomimetics and Dexterous Manipulation Laboratory. His research focus is on making improvements in the gecko adhesive manufacturing process to enable simple manufacture of complex geometries. He is also working on developing tools and processes to tune adhesive force properties for specific applications. In his spare time, Arul launches his own rockets in *Kerbal Space Program*.

Lunch Speaker: Feb 2 (12:15 – 12:45)
"Bridging the Gap between the Aerospace and Petro-Chemical Industries:"
Demo: No
Poster: No

John Nyholt, API SCI
American Petroleum Institute
John.nyholt@sjcd.edu
978-262-8700

Abstract: Safety and environmentally responsible production, processing, storage and transportation of petrochemical products is no easy task. With the added challenges of increased demand and production of oil, gas and chemicals by the use of aging assets in a low oil price environment, petrochemical companies are turning to aerospace, defense and medical industries for collaborative solutions at an affordable price.

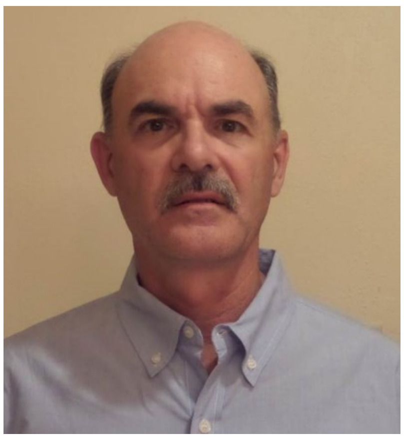
This presentation will overview a shift in the petrochemical industry culture toward outside solutions as well as some perceived barriers to success from a recent survey or petrochemical company executives. Examples of future potential aerospace and petrochemical inspection technology collaborations will also be discussed.

Background: John Nyholt is a recently retired Non-Destructive Testing and Inspection Subject Matter Expert from BP America. He has 37 years of NDE experience with major oil and aerospace companies such as BP, AMOCO and McDonnell Douglas. His roles are operating a Non-Destructive Testing applications laboratory for the petrochemical industry, teaching NDT at the San Jacinto College Central campus, serving a Vice-Chairman of the API NDT Task Force, Chairman of the API Publication 587 NDT Qualification document, Master Editor of the RP 587 NDT and Damage Mechanism document, API QUTE Qualification Exam Program Administrator, and is the Education Chairman for the Greater Houston ASNT Chapter.

Session: 11 – One-on-One ONLY
Entry, Descent & Landing(EDL) Thermal Protection System(TPS) **Stan Bouslog**

No Presentation **EDL TPS Discipline Lead**
Demo: No Poster: No
Stan.a.bouslog@nasa.gov

<u>Entry Descent and Landing TPS Needs:</u> Capability to inspect and characterize, in-space, damage to spacecraft TPS due to anomalous events such as micro-meteorite and orbital debris impacts or spacecraft system failures.



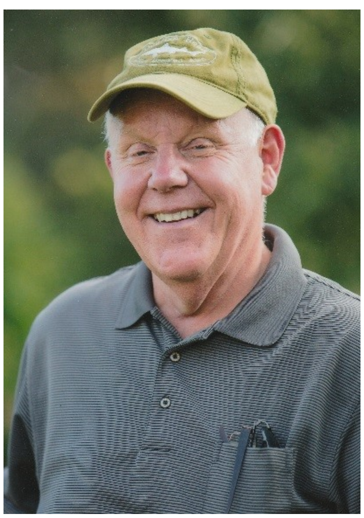
Background: Stanley A. Bouslog received B.S. and M.S. degrees in Aerospace Engineering from the University of Texas at Austin. From 1983 to 1988, he served as the lead aerodynamics/flight mechanics engineer at Tracor Aerospace developing airborne countermeasure devices for tactical aircraft and developed methods to predict the re-entry survivability of ballistic missile countermeasure devices. In 1988, Mr. Bouslog joined Lockheed and for 8 years provided aerothermodynamics support to the Aerosciences Branch at NASA Johnson Space Center on the Space Shuttle and the International Space Station Programs. In 1996, Mr. Bouslog joined Rohr Inc. (later Goodrich Aerospace) and served as the Aerothermal Manager for the X-33 thermal protection system development. After cancellation of X-33, Mr. Bouslog returned to Lockheed Martin and provided aerothermodynamics support to NASA JSC on the X-38 Project. In 2003, Mr. Bouslog supported the Columbia Accident Investigation and later that year became a Civil Servant at NASA JSC in the Thermal Design Branch. He has served as the Orbiter TPS NASA System Engineer, the Orion Heat Shield Subsystem Manager and is presently the TPS Technical Discipline Lead. Mr. Bouslog is an AIAA Associate Fellow.

Session: 11 – One on One Sessions
"Input Solicitation for ASNT Engineering Division Scope"
Demo: No
Poster: No
One-on-One Table: Yes

John Duke
ASNT NDE Engineering Division
jcduke@vt.edu
540-231-6063

Abstract: The **American Society for Nondestructive Testing** has established and NDE Engineering Division within its Technical & Education Council to support the needs of the scientific and engineering community as regards NDE engineering. At this point ASNT is soliciting input from this community regarding what it needs as well as guidance regarding establishing educational criteria for the next generation of NDE Engineers.

Is there a need for professional development short courses which supplement traditional engineering educational programs? Is there a need for an NDE Engineering Handbook? Is there a need for a validated data bank for example for Probability of Detection Data? Your opinions are welcomed. **Joint the discussion at the ASNT one-on-one table in Session 11.**



Background: John Duke is Professor Emeritus at Virginia Tech, fellow of ASNT, fellow of ASME and founding member and past chair of the ASME NDE Engineering Division. He currently is the Vice-chair of the ASNT T&E Council NDE Engineering Division. Dr. Duke is the director of the VT Damage Science & Mechanics Laboratory and editor-in-chief of Research in NDE. He is an NDE subject matter expert serving as a member of the NASA NESC TDT. His research activity, starting in the early 1970s, has focused on detecting and tracking damage, currently he is part of an STTR Phase II team developing a Prognostic Health Monitoring System.