24th Aerospace Testing Seminar Tutorials

The Aerospace Testing Seminar starts with a full day of tutorial sessions on Monday, April 7, 2008.

Full Day Session (8:00 a.m. – 4:30 p.m.)

Integration and Test Systems Engineering, Parts I and II

Morning Sessions (8:00 a.m. – 11:30 a.m.)

Detecting, Retaining, and Preventing Failures

Introduction to MIL-STD-1540E, *Test Requirements for Launch, Upper-stage, and Space Vehicles*

Thermal Testing and Verification

Afternoon Sessions (1:00 p.m. – 4:30 p.m.)

Applied High Frequency Structural Dynamics, Shock, and Acoustics

Satellite Structural Testing

FULL DAY SESSION

Integration and Test Systems Engineering, Parts I and II

Instructors: Bruce Arnheim, The Aerospace Corporation
Julie White, The Aerospace Corporation

Description:

Part I – Morning Session: This course presents the entire process of testing space articles. The course begins with an overview of why we test, addressing industry trends, cost, and schedule elements, and the flow of requirements to provide a foundation for building a test program. The remainder of the two-part class addresses each element of the test pyramid, to provide students with the foundation for understanding how to balance these test elements in today's environment. Test philosophies, approaches, and criteria will be presented and reinforced throughout the tutorial using an interactive approach to learning.

Part II – Afternoon Session: The second half of this course continues up the test pyramid with the higher levels of functional and environmental testing. The student will be involved in learning aspects of test problem solving techniques, anomaly handling, troubleshooting, and rework/retest. Both parts of the course will include data-driven recommended practices.

Instructor Biographies

Bruce Arnheim, The Aerospace Corporation

Mr. Bruce Arnheim is Director of Mission Assurance and System Test for the Aerospace Corporation's Space Based Surveillance Division. Mr. Arnheim has over 29 years of experience in aerospace, ranging from RF design, advanced systems design, new business development, systems engineering, and systems test. Currently, he is responsible for the program execution of SBIRS HEO and system test activities on the SBIRS High program. He holds a dual Bachelor's degree in Engineering from Harvey Mudd College and Economics from Claremont McKenna College, and an MBA from Pepperdine University. He has been a member of the Aerospace Testing Seminar's advisory board for 16 years. Among his awards, Mr. Arnheim is the recipient of two NRO Director's awards, the Otto Hamberg Best Paper award, and the 2006 SBIRS Wing Aerospace Employee of the year. In 2007, Mr. Arnheim was given the Trustee's Distinguished Achievement Award "for enhanced mission assurance leading to recovery and delivery of the SBIRS HEO payload".

Julia "Julie" White, The Aerospace Corporation

Julie White is currently a Senior Engineering Specialist in the Cross Program Systems Engineering Office for the Aerospace Corporation. Her work is now focused on establishing an industry standard process for "test like you fly" assessments and implementation for use as a Mission Assurance / Mission Success technique. Ms. White has been with The Aerospace Corporation for 34

Instructor Biographies (cont.)

years, 18 of which were spent in the Space Test Program Office helping develop six R&D spacecraft. She holds a Dual Bachelors Degree in Physics and Astronomy from the University of Maryland and a Masters in Astronomy from the University of Massachusetts.

MORNING SESSIONS

Detecting, Retaining and Preventing Failures

Instructor: Barbara "Barb" Sande**,** Lockheed Martin Space Systems Company
Description: It is inevitable that Aerospace systems, hardware, and software will experience failures during testing and operations. Successful and proven strategies that detect failures when they occur, retain failure characteristics to allow for comprehensive troubleshooting and analysis to root cause, and prevent failures from occurring by improving designs and processes, will ensure that risks to mission success are minimized. This tutorial will examine the characteristics of failures and explore the following concepts and methodologies:

- Fundamental definitions, including failure mode, mechanism, root cause
- Introduction of the failure attribute concept to initially describe failures
- Introduction to root cause cascades and the concept of unverified failures
- Standards for enhancing detection of failures
- Standards for ensuring retention of failures once they occur
- Standards for preventing failures from occurring
- Methodologies for improvement and optimization of detection, retention and prevention standards, derived from lean/six sigma tools and processes
- Introduction to Design for Six Sigma

The tutorial will use examples, exercises, and extensive graphics to enhance the learning experience for the student.

Instructor Biography
Barbara "Barb" Sande, Lockheed Martin Space Systems Company
Barbara ("Barb") Sande holds a senior engineer staff position at Lockheed Martin Space Systems Company (LMSSC) in the Mission Success Integration organization; she transitioned to this staff position in 2005 after 25 years in various technical and lead positions on the Titan launch vehicle program. For Mission Success Integration, Barb performs special technical studies, is creating a library of mission failure forums and is working to establish improved

Instructor Biography (cont.)

operational and test anomaly analysis and trending processes. Barb is a recognized expert in non-conformance systems, data analysis and trending, lean/six sigma tools, problem resolution, systems engineering, risk management, technical writing and presenting, and launch vehicle processes. She is a Lean/Six Sigma certified Black Belt and co-chaired the Titan program Black Belt Board, approving certification of 202 Green Belts and 11 Black Belts at three different sites and currently serves as the Lean/Six Sigma Point of Contact for LMSSC Mission Success. Barb has facilitated several Development Kaizen events on Project Orion at the request of the program due to her expertise in the use of Quality Functional Deployments for requirements analysis. She has presented many papers and tutorials to a variety of organizations, conferences and symposiums, including Aerospace Testing Seminars, AIAA conferences, Lean Aerospace Initiative Plenary session, University of Colorado Aerospace Engineering Seminar, Mission Critical Enterprise Symposium, American Society for Quality and International Council on Systems Engineering. Barb helped develop a new risk/opportunity management process and tool that was submitted for patent consideration. She was also a contributor to the Titan History Project, helping to document the detailed history of this 50-year program. Barb is a two-term member of the LMSSC Diversity Council, a Council Member of the AIAA Rocky Mountain section and has been a Solar System Ambassador (Community Outreach and Education program) for JPL and NASA for three years. She has received numerous LMSSC individual and team awards, a Diversity Champions Award and received the Otto Hamberg Award in 2000 for best paper at the 19th Aerospace Testing Seminar.

Education

B.S., Electrical Engineering, University of Colorado at Boulder, 1977.
MBA, Information Systems, University of Colorado at Denver, 1983.
Certified Lean/Six Sigma Black Belt and Lean/Six Sigma Green Belt
Registered Professional Engineer, State of Colorado

Introduction to MIL-STD-1540E, *Test Requirements for Launch, Upper-stage and Space Vehicles*

Instructor: James Snyder, The Aerospace Corporation

Description: Most military space programs rely on MIL-STD-1540 to define test requirements that will maximize reliability in space systems. Gaining an understanding of the various optional approaches within MIL-STD-1540 will facilitate and enhance tailoring opportunities. The evolution of MIL-STD-1540 test requirements from its first release in the early 1970's to the latest 1540E version is discussed, along with the advantages to space system development programs that these requirements offer. The course includes an overview of why we test and the criteria leading to the specified requirements that provide a

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foundation for building a thorough test program. It brings out the importance of a rigorous and perceptive test program, and how a space system's reliability is enhanced as a result. Test philosophy, criteria, and approaches will be presented and reinforced using historical data and lessons learned.

Instructor Biography
James "Jim" Snyder, The Aerospace Corporation
Jim Snyder is a Senior Engineering Specialist in The Aerospace Corporation's Environments, Test and Assessment Dept. He joined Douglas Aircraft Co. in Long Beach, CA after receiving his BSME from Cal Poly Pomona in 1967. He started his career as a Structural Test Engineer, conducting tests on nearly every jet powered aircraft built at the Long Beach plant, including the A3, A4, YC-15, DC-8, DC-9, MD-80/90, DC-10, MD-11 and T45, to name a few. Jim became a manager in 1980 and led the Test Engineering Team for several years. He transferred to the Space and Defense Component of McDonnell Douglas (now Boeing) at Huntington Beach, CA in 1991, assuming the responsibilities of Senior Manager of the Engineering Labs, where he led a team of Test Engineers and Technicians. This team has successfully conducted testing for numerous test programs including the Delta III/IV, International Space Station, X-37 ALTV, and Delta Clipper. In April of 2004, Mr. Snyder retired from Boeing, and assumed his current position at The Aerospace Corporation, where he has been involved in various projects including updating MIL-STD-1540, authoring sections of two new Aerospace handbooks, and has consulted on several military satellite test programs.

Thermal Testing and Verification

Instructor: John Welch, The Aerospace Corporation
Description: This course provides the background and specific information toward understanding the purposes and critical parameters in thermal tests. The course is intended for entry-level thermal engineers without extensive testing experience, engineers in other related disciplines, system managers, and government professionals in the space industry. It provides information needed by individuals who must make program-level decisions involving thermal testing or desire the background in why specific tests are performed. The course addresses thermal testing with practical examples from industry-based experiences. The scope covers thermal cycling, thermal vacuum, thermal balance, burn-in, model correlation, and test facilities. Only a basic understanding of conductive, radiative, and convective heat transfer principles is needed.

Instructor Biography
John Welch, The Aerospace Corporation
John Welch is a Senior Engineering Specialist in the Spacecraft Thermal

Instructor Biography (cont.)

Department at The Aerospace Corporation. His expertise includes thermal testing, interface thermal conductance, and unit thermal design techniques. He is the author of the Thermal Testing chapter in the "Satellite Thermal Control Handbook" and the "Spacecraft Thermal Control Handbook". He has authored papers on thermal testing and taught courses on the subject through The Aerospace Institute, AIAA and UCLA. Mr. Welch holds B.S. and M.S. degrees in Mechanical Engineering from the University of Washington.

AFTERNOON SESSIONS

Applied High Frequency Structural Dynamics, Shock and Acoustics

Instructor: Dick Foss, Lockheed Martin Space Systems Company
Description: The tutorial covers basics associated with the high frequency structural excitation sources of shock and acoustics. Characterization of energy sources associated with these phenomena, the nuances of structural coupling, and how the sources and responses are measured and analyzed will be a central theme of this discourse. Statistically based environments derivation and the basis for N-th octave acoustic analyses commonly used will be presented with typical curves for source shock, attenuation relations for common aerospace structures, and the basis of the Shock Response Spectra will be dissected. Acoustic field characterization and empirical methods for predicting acoustic environments will be touched upon with emphasis on how structures couple with acoustic energy and the benefits and limitations of reverberant chamber testing. Statistical methods for characterizing acoustic fields and peak responses will be included along with basic data reduction guidelines and beneficial test methods.

Instructor Biography
Richard "Dick" Foss, Lockheed Martin Space Systems Company
Dick Foss began his engineering career at Lockheed Martin Astronautics in Denver in 1983 where he specialized in vibration, acoustics, mechanical design and test. His experience in the space industry spans several tiger-team recovery efforts, POGO assessments, Solid Rocket Motor integration, Liquid Engine health assessments to science acquisition mechanism design for space discovery missions, and sample return capsule development. He currently supports the Test Department at Lockheed Martin Space Systems Company.

Satellite Structural Testing

Instructor: Paul A. Larkin, Sandia National Laboratories
Description: This course will present material and concepts necessary for the

Tutorials (cont.)

successful development and verification of spacecraft structural systems. Material covered will include requirements flow down, structural environments, test definitions, test flow, verification, and tests including static, modal, sine, random, force limited vibration, acoustics, shock and workmanship.

Instructor Biography

Paul Larkin, Sandia National Laboratories

Paul Larkin has over 30 years of experience in structural design, analysis and test and brings a true practitioner's perspective to this unique course. He has contributed to the design, analysis, fabrication and test of major NASA programs such as LANDSAT, Solar Max Repair, Space Telescope Maintenance and Repair, UARS, GRO, TOPEX/POSEIDON, ACRIM, QuikTOMS, VCL and GALEX. He has also participated in the SGS Block I, GEOSAT/OIS, and MightySat programs for the Air Force. He was employed as a structural dynamics engineer by Fairchild Space Systems Division from 1979 until 1995. From 1995 until 1998, Mr. Larkin was president of his own consulting company where he contributed to such recent projects as the Indostar DBS Satellite, Earthwatch, TSX-5 and the NASDA RMS transportation and storage container. Since then, Mr. Larkin was employed by Orbital Sciences Corporation's Space Systems Group where he was responsible for the mechanical integrity of their space systems products and contributed to several commercial satellite programs such as OrbView, NSTARc and PanAmSat. Currently, Mr. Larkin is employed by Sandia National Laboratories where he participates in the dynamic analysis and test of structural systems.