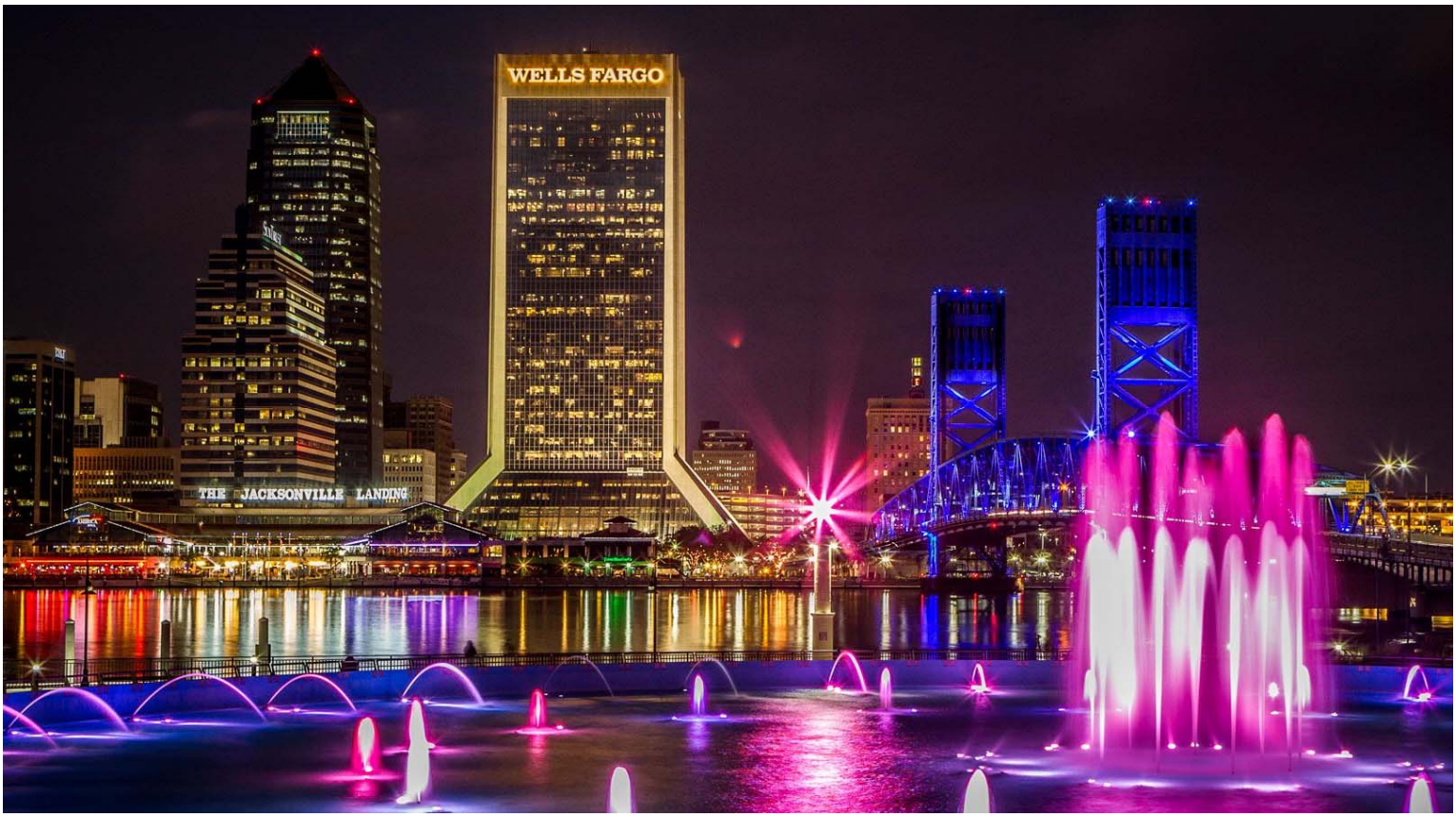
88th Shock and Vibration Symposium

Jacksonville | October 15-19, 2017



SAVE
SHOCK & VIBRATION EXCHANGE

HI-TEST
Laboratories, Inc.

SYMBOL KEY & GLOSSARY

Distribution Statements (all technical sessions have a distribution statement designation):

Unlimited Distribution A - Approved for public release: distribution unlimited.

Limited Distribution B - Distribution authorized to U.S. Government Agencies ONLY.

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DS: Dedicated Session (presentations formulated together by a session organizer/developer on a particular subject).

(p. #) Corresponding page number in Abstract Book (located at back of program).

Training: 45-minute to 2-hour training and/or educational session on a specific subject.

Tutorial: 3-hour training and/or educational session on a specific subject. Attendees receive certificate and may receive CEUs/PDHs (varies by state). Additional fees apply to attend.

Food and Beverage Events

Introduction

Welcome to Jacksonville and the 88th Shock and Vibration Symposium!

Since the first meeting in 1947, the Shock and Vibration Symposium has become the oldest continual forum dealing with the response of structures and materials to vibration and shock. The symposium was created as a mechanism for the exchange of information among government agencies concerned with design, analysis, and testing. It now provides a valuable opportunity for the technical community in government, private industry, and academia to meet and discuss research, practices, developments, and other issues of mutual interest.

The symposium is presented by HI-TEST Laboratories and The Shock and Vibration Exchange. The following section features our corporate supporters:

EVENT HOST

HI-TEST Laboratories, Inc.

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SPECTRAL DYNAMICS

GENERAL DYNAMICS Applied Physical Sciences

NTS

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SPEKTRA

88th Shock and Vibration Symposium Committee*

Dr. Edward Alexander (BAE Systems)
Dr. Joe Ambrico (NUWC Newport)
Dr. Jeff Averett (USACE ERDC)
Dr. Vesta Bateman (Consultant)
Mr. Justin Caruana (Cardinal Engineering)
Mr. Rick Coffman (Northrop Grumman)
Mr. Matthew Davis (HII—NNS)
Mr. Bill Gregory (Applied Physical Sciences)
Ms. Becky Grisso (NSWC Carderock)**
Mr. Jamil Lahham (Northrop Grumman)
Mr. Brian Lang (NSWC Carderock)**
Mr. Mark Marraccini (Spectral Dynamics)
Dr. Luke Martin (NSWC Dahlgren)
Dr. Will McMahon (USACE ERDC)
Dr. Ken Nahshon (NSWC Carderock)**
Mr. Drew Perkins (SAVE/HI-TEST)
Mr. Corbin Robeck (Thornton Tomasetti Weidlinger)
Ms. Ashley Shumaker (SAVE/HI-TEST)
Mr. Ernie Staubs (Air Force Research Laboratory)
Mr. Jon Stergiou (NSWC Carderock)**
Ms. Lauren Yancey (HI-TEST Laboratories)

**TAG members in attendance at summer meeting for 88th S&V program review (held at NSWC Carderock)*

***NSWC Carderock hosts*

DAILY OUTLINE & TABLE OF CONTENTS

INTERNET CAFÉ

Meeting Room: Boardroom 4

Sunday, Oct 15	9AM—8PM
Monday, Oct 16	9AM—8PM
Tuesday, Oct 17	7AM—8PM
Wednesday, Oct 18	7AM—8PM
Thursday, Oct 19	7AM—Noon

EXHIBIT HALL (Grand Ballroom 4/5)

(Exhibitors Listed on Pages 30-38)

Monday, Oct 16	*Setup*	*Noon—6:00PM*
	Reception	6:30PM—8:30PM
Tuesday, Oct 17	Exhibit Hall Open	7:00AM—5:00PM
	Awards Luncheon & Speaker	11:00AM—1:00PM
	Session Break—PM	3:00PM—3:40PM
Wednesday, Oct 18	Exhibit Hall Open	9:00AM—4:00PM
	Session Break—AM	9:45AM—10:15AM
	Exhibitors' Luncheon & Speaker	12:05PM—1:30PM
	Raffle / Break	3:30PM—4:00PM
	Dismantle	*4:00PM—6:00PM*

REGISTRATION

Meeting Room: Daytona

Sunday, Oct 15	8AM—5PM
Monday, Oct 16	7AM—6PM
Tuesday, Oct 17	7AM—6PM
Wednesday, Oct 18	7AM—6PM
Thursday, Oct 19	7AM—NOON

HYATT JACKSONVILLE MEETING SPACE LAYOUT ON PAGE 39

FOOD & BEVERAGE EVENTS

All Symposium Attendees Welcome at All F&B Events Listed Here
Guests Welcome at Monday Welcome Reception & Wednesday Evening Social

Monday, October 16

• Continental Breakfast	7:00am—8:30am	3rd Floor Skybridge
• Reception (w/ Beverages & Heavy Hors d'oeuvres)	6:30pm—8:30pm	Grand Ballroom 4/5 (Exhibit Hall)

Tuesday, October 17

• Continental Breakfast	7:00am—8:30am	Grand Ballroom 4/5 (Exhibit Hall)
• Awards Luncheon	11:00am—1:00pm	Grand Ballroom 4/5 (Exhibit Hall)
• Ice Cream Social	3:00pm—3:40pm	Grand Ballroom 4/5 (Exhibit Hall)

Wednesday, October 18

• Continental Breakfast	7:00am—8:30am	Grand Ballroom 4/5 (Exhibit Hall)
• Exhibitors' Luncheon	12:05pm—1:15pm	Grand Ballroom 4/5 (Exhibit Hall)
• Symposium Social/Dinner	7:00pm—10:00pm	Intuition Brewery

Thursday, October 19

• Continental Breakfast	7:00am—8:30am	3rd Floor Skybridge

Welcome Reception

Monday, Oct. 16

6:30pm—8:30pm • Grand Ballroom 4/5 (Exhibit Hall) w/ Beverages and Heavy Hors d'oeuvres

General Session 1: Symposium Awards Luncheon w/ Elias Klein Speaker

Tuesday, Oct. 17 • 11:00am—1:00pm • Grand Ballroom 4/5 (Exhibit Hall)

General Session 2: Exhibitors' Luncheon w/ Keynote Speaker

Wednesday, Oct. 18 • 12:05pm—1:15pm • Grand Ballroom 4/5 (Exhibit Hall)

Sponsored by: 88th Shock & Vibration Symposium Exhibitors

Symposium Social/Dinner at Intuition Brewery

Wednesday, Oct. 18 • 7:00pm—10:00pm • Intuition Brewery

Hosted by: National Technical Systems, PCB Piezotronics, & HI-TEST Laboratories

SUNDAY (OCTOBER 15)

SPECIAL TUTORIAL OFFERING / 9:00am-5:00pm

~ ADDITIONAL FEES APPLY TO ATTEND ~

MIL-DTL-901E Shock Training **Meeting Room: St. Johns**

Mr. Kurt Hartsough & Mr. Domenic Urzillo (NSWC Philadelphia)

MIL-DTL-901E, signed out in June of 2017, replaces MIL-S-901D (1989). The MIL-DTL-901E is the integration of MIL-S-901D-IC2 and all of the MIL-S-901D clarifications letters (2001-2012) and standardization of the Deck Simulating Shock Machine (DSSM) as an approved test platform for shock isolated deck mounted equipment. The full day training will cover, in depth, the new MIL-DTL-901E test requirements, including all of the cost reduction areas critical to a cost effective shock hardening test program. In addition, the Navy's shock qualification policy, OPNAVINST 9072.2A (2013) and NAVSEA Tech Pub T9072-AF-PRO-010 (Shock Hardening of Surface Ships) will be covered. NAVSEA Tech Pub T9072-AF-PRO-010 (Shock Hardening of Surface Ships) replaces the cancelled NAVSEAINST 9072.1A.

NO ADDITIONAL SUNDAY TUTORIALS

MONDAY AM (OCTOBER 16)

TUTORIAL SESSION 1 / 8:00am-11:00am

~ CHOOSE ONE / ADDITIONAL FEES APPLY TO ATTEND ~

MIL-DTL-901E Shock Qualification Testing **Meeting Room: St. Johns**

Mr. Kurt Hartsough & Mr. Domenic Urzillo (NSWC Philadelphia)

The Naval Surface Warfare Center Carderock Division Philadelphia (NSWCCD-SSES) Code 333 is NAVSEA 05P1's Delegated Approval Authority (DAA) for MIL-DTL-901E Surface Ship Shock. As the DAA, Code 333 engineers are responsible for review and approval of all Government Furnished Equipment (GFE) and heavyweight shock tested equipment. NSWCCD Code 333 will be presenting the requirements for shock qualification testing as detailed in MIL-DTL-901E and interpreted by NAVSEA 05P1. Shock testing theory, MIL-DTL-901E shock test devices and facilities, detailed specification requirements, cost avoidance and clarification and MIL-DTL-901E IC#2 will be covered. Attendees should include anyone involved in the acquisition, specification, review and approval of Navy shipboard equipment including PARMs and LCMs and contracting officers, contractors having to deal with the Navy and wishing to supply shock qualified equipment to the Navy, Ship Program Managers and Ship Logistic Managers responsible for the acquisition & maintenance of shock hardened Navy ships and shock qualification test facilities.

Introduction to Pyroshock Testing **Meeting Room: Clearwater**

Dr. Vesta Bateman (Mechanical Shock Consulting)

This course discusses the concepts of Near Field, Mid Field Pyroshock and Far Field Pyroshock and their criteria. Instrumentation used for measurement of pyroshock and structural response to pyroshock is described. The development of pyroshock specifications using primarily the Shock Response Spectra is discussed in detail, and various other analysis techniques are presented as well. Simulation techniques for near field, mid field and far field pyroshock are presented and include both pyrotechnic simulations and mechanical simulations. Examples of actual test specifications and the resulting laboratory test configuration and measured results are discussed. In addition, recent problems and issues in the pyroshock community are described and analyzed.

Comparison of Field-Laboratory Equivalence Evaluation Methods: Accumulated Damage Versus Energy Based Methods **Meeting Room: Orlando**

Mr. Zeev Sherf (Consultant)

This tutorial will present a comparative description of methods aimed to evaluate the equivalence between in a laboratory simulated vibration regime to a field regime. Two groups of methods are handled. Those based on accumulated damage on one hand and those based on accumulated energy on the other one. For the first group it will be shown how measured vibrations in the field, accumulated as time histories are transformed in PSDs(Power Spectral Densities) one for each mission stage, by applying parametric modeling. Following it will be shown how the PSDs are used in the load cycle counting for each mission stage and for the entire mission respectively. The counting is performed by deriving from the PSD data the load cycles' probability of occurring in a certain level interval and the number of loads of different levels per time unit. With this data and the duration of each stage the number of cycles of different levels for each mission step is evaluated. The counted loads are combined with a fatigue model in order to evaluate the accumulated damage over the entire mission. For the field data PSDs an envelope PSD is evaluated. Based on it a laboratory vibration regime is determined. It is described by a PSD with the shape of the envelope PSD, with the level and the duration of application fitted to generate in the system exposed to the simulation regime, the same damage as that accumulated under the field conditions. One of the main shortcomings of this methodology is the lack of the fatigue model of the tested system. Under these circumstances usually some universal models are used that quite often are not relevant, and appropriate to the specific system. The way to overcome this shortcoming is to evaluate the equivalence between the field and the laboratory regime in terms of accumulated energy. Under this method no knowledge about the tested system is required. The knowledge of the in field measured vibration regime in terms of acceleration time histories is enough. From the acceleration time history the velocity time history is calculated. Based on the acceleration and velocity the power per mass unit and following the energy per mass unit are evaluated for each mission stage and following for the entire mission. Using the envelope PSD mentioned above, a simulation regime that generates an energy per mass unit equal to that of the field is derived. The testing duration derived based on energy considerations as compared to that derived based on damage accumulation is significantly longer, both according to the in the literature published data and to the author experience.

MONDAY PM (OCTOBER 16)

TUTORIAL SESSION 2 / 12:00pm—3:00pm

~ CHOOSE ONE / ADDITIONAL FEES APPLY TO ATTEND ~

MIL-DTL-901E Shock Qualification Testing Extensions **Meeting Room: St. Johns**

Mr. Kurt Hartsough & Mr. Domenic Urzillo (NSWC Philadelphia)

The Naval Surface Warfare Center Carderock Division Philadelphia (NSWCCD SSES) Code 333 is NAVSEA 05P1's Delegated Approval Authority (DAA) for MIL-DTL-901E Surface Ship Shock. As the DAA, Code 333 engineers are responsible for review and approval of all Government Furnished Equipment (GFE) and heavyweight shock tested equipment. NSWCCD Codes 333 will be presenting the requirements for shock qualification extensions as detailed in MIL-DTL-901E and interpreted by NAVSEA 05P1. Shock extension specification requirements, MIL-DTL-901E design guidelines and shock design lessons learned will be covered. Attendees should include anyone involved in the acquisition, specification, review and approval of Navy shipboard equipment including PARMs and LCMs and contracting officers, contractors having to deal with the Navy and wishing to supply shock qualified equipment to the Navy, Ship Program Managers and Ship Logistic Managers responsible for the acquisition & maintenance of shock hardened Navy ships and shock qualification test facilities.

Beyond the Shock Response Spectrum **Meeting Room: Clearwater**

Mr. David Smallwood (Consultant)

In practice shocks are often quite complicated oscillatory time histories with a large random component. By far the most common method for the characterization of shocks is the shock response spectrum (SRS). The SRS was developed to reduce the complexity to a simple measure, that is, the peak response of a single-degree-of-freedom system to the shock. One of the serious limitations of the SRS is that all temporal information is lost. Several attempts have been make to reduce this limitation by specifying the duration of the shock. However the definition of the "duration" for a complicated shock has not been consistent. Temporal moments provide a consistent framework to define the duration and other moments. Fourier spectra can also be used to characterize shock, but again all temporal information is lost. The most general way to characterize a shock with a large random component is with a time varying spectral density. However, we frequently have insufficient information to estimate this spectrum. Bandlimited temporal moments can help bridge this gap.

The tutorial will introduce the temporal moments and discuss the theoretical implications. The uncertainty theorem will be discussed, and it will be shown how this theorem limits the available information about a shock. Using the product model, a connection between the uncertainty parameter and the variance in the energy estimates will be established. For a shock with a given rms duration, defined by the temporal moments, the uncertainty theorem limits the frequency resolution, as defined by the rms bandwidth. The tutorial will show how the first few bandlimited temporal moments can be used to characterize shock. This information can be used independently of the SRS, or used to supplement the SRS of a shock.

Five Good Ways to Estimate Spectral Density **Meeting Room: Orlando**

Dr. Thomas Paez (Paez Consulting)

Estimation of spectral density is critical to the practice of modern random vibration. Norbert Wiener defined the spectral density in a paper he wrote in 1930; his definition does not reflect the practical difficulties inherent in spectral density estimation. When Crandall brought random vibration to aerospace engineering practitioners in the United States, in 1958, a paper in his workshop, by Rona, provided a practical interpretation of spectral density and a hint about how to compute it. Rona's is a filtering approach, and that was used through the mid 1960s when the fast Fourier transform was rediscovered. From the mid 1960s on, the filtering inherent in spectral density estimation was carried out via discrete Fourier transform. The method commonly used by engineers to estimate the spectral density of a random source was (and is) Welch's method. Prior to the introduction of Welch's method, Parzen (and many others) developed a method for spectral density estimation that is similar, in some sense, to Welch's method. It involves frequency domain averaging of a quantity known as the periodogram. More recently, practitioners have used the auto-regressive (AR) framework to estimate spectral density. Finally, the Karhunen-Loeve (KLE) expansion is mainly used to model nonstationary random processes, but it can also be used to model stationary random processes and to estimate spectral density. All five methods will be developed in this tutorial – filtering, Welch's method, Parzen's method, AR model, and KLE. The methods will be explained with a common example. The efficiencies of the methods will be compared. MATLAB code for estimating spectral density using all the methods will be sent to all who wish to receive it.

1:30-3:30	**DTE 022 Meeting: MIMO Recommended Practice Committee**	**Meeting Room: River Terrace 2**
	Chair: Dr. Marcos Underwood (Tutuli Enterprises) Using more than one shaker to test large or unusually shaped objects is becoming an accepted part of the vibration testing industry. As interest in simultaneously testing articles in multiple axis increases, the need for guidelines to understand MIMO (multiple input multiple output) testing grows more important. Come get up to speed and contribute to our growing database on multi shaker concepts, fixturing, control, and reporting.	

MONDAY PM (OCTOBER 16)

TUTORIAL SESSION 3 / 4:00pm—7:00pm

~ CHOOSE ONE / ADDITIONAL FEES APPLY TO ATTEND ~

MIL-DTL-901E Subsidiary Component Shock Testing & Alternate Test Vehicles **Meeting Room: St. Johns**

Mr. Kurt Hartsough & Mr. Domenic Urzillo (NSWC Philadelphia)

The MIL-DTL-901E Subsidiary Component Shock Testing and Alternate Test Vehicles course will cover the following areas: NAVSEA 05P1's current policy for testing subsidiary components, description of test environment requirements, examples of recent successful test programs, alternate test vehicle descriptions, alternate test vehicle limitations, discussions on shock spectra, Multi-Variable Data Reduction (MDR) and various shock isolation systems. This course is intended to give the necessary information to equipment designers and program managers who intend to shock qualify COTS equipment that will require frequent upgrades due to obsolescence, equipment upgrades, change in mission, etc. Although not required, it is recommended that those attending this course also attend courses on Shock Policy, MIL-DTL-901E testing and particularly MIL-DTL-901E extensions offered by the same instructors (Urzillo and Kurt Hartsough).

Air Blast and Cratering: An Introduction to the ABC's of Explosion Effects in Air and on Land **Meeting Room: Clearwater**

Mr. Denis Rickman

This course introduces the effects of explosions in air and on land. Topics covered include airblast, soil/rock/pavement cratering, and ground shock phenomena produced by explosive detonations. There is a little math, but for the most part, the focus is on aspects and principles that are of practical use to those conducting (and utilizing) blast-related research. Most researchers in the blast arena have some grasp of explosion effects fundamentals, but very few have a good, broad-based understanding of how it all works. The goal is to provide the participants with enough of an understanding that they can appreciate the various explosion phenomena and those parameters that affect blast propagation and blast loading of objects in a terrestrial setting.

The Measurement & Utilization of Valid Shock and Vibration Data **Meeting Room: Orlando**

Dr. Patrick Walter (TCU / PCB Piezotronics)

Significant focus is often provided to applying sophisticated analysis techniques to data resulting from shock and vibration tests. However, inadequate focus is often provided to assuring that valid shock and vibration data are acquired in the first place. This tutorial attempts to correct this deficiency. For the instrumentation novice it will provide an introduction to shock and vibration measurements, the physics of piezoelectric and silicon based accelerometers, and motion characterization. For the experienced test technician or engineer it will provide additional insight into topics such as optimized measurement system design, accelerometer and measurement system calibration, accelerometer mounting effects, analog filtering, data validation, data utilization, and more. For the analyst or designer it will pro-vide a series of simple observations and back of the envelope calculations that he/she can make on data to validate its credibility before using it in product design.

DDAM 101 **Meeting Room: River Terrace 3**

Mr. George D. Hill (Alion Science & Technology)

The U.S. Navy Dynamic Design Analysis Method (DDAM) has been in general use since the early 1960s. It is a method of estimating peak shock response of equipment and outfitting on naval combatants using normal mode theory, originally extended from earthquake analysis methods. The DDAM requires linear-elastic model behavior and employs a statistical method of modal superposition yet has persisted to today as the U.S. Navy required method for shock qualification by analysis. This, in spite of the rapid advancement of dynamic transient simulation technology and techniques for representing nonlinearities including material plasticity and contact behavior. The tutorial will address: how the method works, how the shock spectral input values are presented in DDS-072-1, what is the role of modal weights and participation factors, why has the method persisted including what are its strengths and also what are its weaknesses. The tutorial will provide a basic understanding of the method, requirements, and procedures to those who expect to be involved in shock analysis and will demystify the procedure for many who are current users.

4:00-6:00	**DTE 044 Meeting: Transient Waveform Replication** **Meeting Room: River Terrace 2** Chair: Mr. Russ Ayres The DTE-044 Working Group (WG) committee is tasked with creating a "Recommended Practices" (RP) document which will describe best practices for running Transient Waveform Replication (TWR) vibration tests on you lab. How well has your TWR test run?? What error criteria are used to measure the acceptability of your test?? What plots and data should be reported?? These and other questions will be discussed in the DTE-044 WG committee. Please join to the DTE-044 Committee meeting and help build guidelines and recommendations that will contribute to successful performance of your TWR vibration test.

Welcome Reception

Monday, Oct. 16 • 6:30pm—8:30pm

Grand Ballroom 4/5 (Exhibit Hall)

TUESDAY AM (OCTOBER 17)

TUTORIAL SESSION 4 / 8:00am—11:00am

~ CHOOSE ONE / ADDITIONAL FEES APPLY TO ATTEND ~

Effective Solutions for Shock and Vibration Control **Meeting Room: River Terrace 3**

Mr. Alan Klembczyk (Taylor Devices) & Dr. Ed Alexander (BAE Systems)

This presentation provides an outline of various applications and methods for implementing isolation control of dynamic loads and damping within a wide array of dynamic systems and structures. Photos, videos, and graphical results are presented of solutions that have been proven effective and reliable in the past. Design examples are given and typical applications are reviewed Additionally, key definitions and useful formulae are presented that will provide the analyst or systems engineer with the methods for solving isolation problems within the commercial, military, and aerospace sectors.
A wide range of isolation mounts and systems are covered including liquid dampers, elastomer and wire rope isolators, tuned mass dampers, and engineered enclosures. Engineering guidelines are presented for the selection and evaluation of isolation control products. Protection of COTS electronic equipment and probable damage levels are reviewed for the preparation of design and test specifications. Applications involve shipboard, off-road vehicles and airborne projects. Included also are industrial equipment and seismic control of structures and secondary equipment. Field and test data such as MIL-DTL-901E barge test measurements are presented. The use of Shock Response Spectra (SRS) for equipment assessment as well as isolator analysis is discussed. Details and examples of shock and vibration analyses are presented including case studies with step by step description of engineering calculations.
The shock and vibration environment and corresponding equipment response is characterized primarily in terms of the peak response of a single degree of freedom (SDOF) system. This includes peak equipment acceleration response given by the SRS (shock response spectrum), the peak equipment velocity response given by the PVSS (pseudo-velocity shock spectrum) and the maximum total energy input to the equipment given by the energy input spectrum (EIS). An example is presented where the peak energy input to both linear and nonlinear base excited MDOF (multi-degree of freedom) systems is strongly correlated to the SDOF EIS. Absolute and relative equipment transmissibility to a vibration environment are presented. Examples of the vibration environment are discussed in terms of a power spectral density (PSD) and correlation of a PSD input and the maximum equipment RMS acceleration response, based on Miles equation. Matlab functions for SDOF equipment response based on characteristics of various shock isolators are described where example results is correlated to test data.

Changes from MIL-S-901D to MIL-DTL-901E Explained **Meeting Room: St. Johns**

Mr. Kurt Hartsough & Mr. Domenic Urzillo (NSWC Philadelphia) ~ Mr. Hartsough Presenting

The intent of this tutorial is to cover the changes between MIL-S-901D and MIL-DTL-901E. This tutorial will provide an opportunity to discuss specific situations related to shock qualification testing with NAVSEA 05P1's Delegated Approval Authorities for Surface Ships and Submarines. Areas covered include: updated and new definitions, reduce shock test schedules, shock isolation, use of standard and non-standard fixtures, reduced hammer blows, reduced multiple operating mode requirements, reduced retesting, Shock Response Frequency (SRF) and more.

MIL-DTL-901E Engineering Topics **Meeting Room: Clearwater**

Mr. Domenic Urzillo (NSWC Philadelphia)

MIL-DTL-901E Engineering topics is a follow-on course to the MIL-DTL-901E Test and Extension training courses and is aimed at providing the NAVSEA acquisition and engineering communities with a more in-depth review of engineering mathematics routinely used in equipment shock qualification. Topics covered include shock spectrum as it relates to MIL-DTL-901E testing, digital data filtering, shock response frequency, shock test fixture design fundamentals and FSP deck simulation fixtures.

Application of Engineering Fundamentals in Solving Shock and Vibration Problems **Meeting Room: Orlando**

Mr. Fred Costanzo (Consultant)

This tutorial first presents a brief primer in underwater explosion (UNDEX) fundamentals and shock physics. Included in this discussion are the features of explosive charge detonation, the formation and characterization of the associated shock wave, bulk cavitation effects, gas bubble formation and dynamics, surface effects and shock wave refraction characteristics. In addition, analyses of associated measured loading and dynamic response data, as well as descriptions of supporting numerical simulations of these events are presented. Next, simple tools are introduced to assist engineers in benchmarking solutions obtained for more complex UNDEX problems. Presented will be the generation of "bounding" estimates for the global dynamic response of surface ship and submarine structures subjected to underwater shock. Three well documented methodologies are presented, including the Taylor flat plate analogy for both air- and water-backed plates, the peak translational velocity (PTV) method, and the application of the conservation of momentum principle to estimating the vertical kickoff velocity of floating structures (spar buoy approach). Derivations of the governing equations associated with each of these solution strategies are presented, along with a description of the appropriate ranges of applicability.

Finally, special case studies involving numerical methods applications in shock and vibration problems will be presented. Specific areas that are discussed include finite difference approximations, root finding techniques and other numerical solution strategies. For each area covered, the basic theory is briefly described, a shock and vibration application is set up and a solution algorithm is developed and implemented in the form of a Python script. Next, a solution is generated and the results are illustrated and discussed.

TUESDAY AM (OCTOBER 17)

General Session 1 incl. Elias Klein Lecture & Awards Luncheon

11:00am—1:00pm / Grand Ballroom 4/5 (Exhibit Hall)

11:00am—11:05am	Call to Order by: Mr. Drew Perkins (SAVE / HI-TEST Laboratories)
11:05am—11:10am	Elias Klein Lecturer Introduction presented by: Mr. Domenic Urzillo (NSWC Philadelphia)
11:10am—11:50am	***Elias Klein Lecture - "Space Shuttle Docking"*** by: Mr. Siamak Ghofranian, Technical Fellow (Boeing Company)
11:50am—12:20pm	Buffet Lunch
12:20pm—12:40pm	**Lifetime Achievement Award Presentation** presented to Dr. Michael Hale by Dr. Luke Martin
12:40pm—12:50pm	**Henry Pusey Best Paper Award Presentation** "On the Nature of Spectral Density Matrices used to Characterize Vibration Environments" presented to: Dr. Luke Martin & Mr. Shawn Schneider

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Elias Klein Lecturer

Mr. Siamak Ghofranian, Technical Fellow
(Structures, Dynamics, Multi-Disciplinary Simulations & Test / Boeing Company / Huntington Beach, CA)

Siamak Ghofranian entered the Aerospace Industry in 1981. He has a BS and an MS degree in Aerospace Engineering. In 1987 he founded an advanced simulation team in response to the need for performing multi-body nonlinear dynamic simulations for designing NASA's next generation spacecraft docking system. In 1993 he was requested by NASA Johnson's Space Center to evaluate the Russian-designed spacecraft docking system for use in the US Space Shuttle for docking to the Russian Mir Space Station. He also developed simulations, conducted tests, and modified the Russian docking system for use on NASA's International Space Station, and received the 1997 American Institute of Aeronautics & Astronautics' Design Engineering Award for this effort. Models developed were used for docking operation predictions and real-time performance evaluation until the last Shuttle mission. He later led a team of experts simulating many of the International Space Station on-orbit assembly operation scenarios. Siamak also supported Delta IV, Sea-Launch, Hy-Fly hypersonic missile, Shroud and Payload separation systems, Rocket transportation systems, Arrow-3 flight simulator, Orbital Express autonomous satellite capture and servicing, Navy's P-8 Poseidon, and X-37. In 2012 NASA selected his patented SIMAC spacecraft docking system to replace NASA's in-house docking system concept as the new standard for the International Space Station and the Orion Crew Vehicle. Siamak is a member of the NASA Engineering Safety Center's Loads & Dynamics Discipline. He is currently consulting different space programs for the Army and Air Force, as well as supporting navigation system upgrade of Ohio class submarines for the Navy.

Lifetime Achievement Award Winner

Dr. Michael T. Hale has been a pioneer in the field of Multiple Degree of Freedom (MDOF) testing, and his contributions to the field of Multiple Exciter Testing/Multiple Degree of Freedom pushed the state of the art. Dr. Hale led the effort to include a new method in MIL-STD-810G entitled Multiple Exciter Testing, marking the first time the standard recognized MDOF testing for Shock and Vibration. In addition to his work in MDOF, Dr. Hale has been a leader in the S&V symposium by offering dozens of technical papers, chairing multiple sessions, and serving as a strong voice on the Technical Advisory Group.

Henry Pusey Best Paper Award Winner (*presented for best paper at previous symposium*)

"On the Nature of Spectral Density Matrices used to Characterize Vibration Environments" by Dr. Luke Martin & Mr. Shawn Schneider

In recent years, new technologies in vibration laboratory test equipment have allowed for successful recreation of real world multiple degree of freedom (MDOF) vibration environments. However, a knowledge vacuum currently exists between MDOF laboratory capabilities and common laboratory test specifications often defined in MIL-STDs, product specifications, or other requirement documents. This knowledge vacuum is due to the fact that MDOF tests require more information about the vibration environment than single degree of freedom (SDOF) test specifications traditionally provided. The new information required is best explained by examining the spectral density matrix (SDM) and understanding how the SDM applies for SDOF and MDOF. The SDM is the complete test definition for an environmental vibration test. The size of the SDM determines the maximum number of spatial degrees-of-freedom (DOF) that can be defined. Typically, the size of the SDM available and the easily collapsed to define tests of lesser DOF. For SDOF tests, the SDM collapses to a single power spectral density (PSD). The nature of SDMs used to characterize vibration environments are discussed along with insight into cross spectral density (CSD) definitions and a

TUESDAY PM (OCTOBER 17)

	SESSION 1	*SESSION 2*	*SESSION 3*
	Mechanical Shock I / Isolation I 1:00pm-3:00pm / Unlimited Dist. A Chair(s): Mr. Justin Caruana (Cardinal Engineering) Dr. J. Edward Alexander (BAE Systems)	**Instrumentation** 1:25pm-3:00pm / Unlimited Dist. A Chair(s): Dr. Vesta Bateman (Mechanical Shock Consulting)	**Blast** 1:00pm-1:20pm / Limited Dist. B 1:25pm-2:10pm / Limited Dist. D 2:15pm-3:00pm / Limited Dist. C Chair(s): Mr. Denis Rickman (USACE—ERDC)
	All Presenters and Chairs (for Oct 17) are Required to Meet at 7:00AM in Grand Ballroom 6 for Presentation Loading		
	Meeting Room: Grand Ballroom 6	***Meeting Room: Grand Ballroom 7***	***Meeting Room: River Terrace 3***
1:00	**Submarine Component Design Tool to Assess Relative Resistance to Shock Loading (p. 1)** Mr. Justin Caruana & Mr. Connor Way (Cardinal Engineering), Dr. Jeff Cipolla, Dr. Abilash Nair, Dr. Heather Reed (Thornton Tomasetti)		**Blast Effects within Embankments (p. 5)** Ms. Alyson Armstrong, Mr. Denis Rickman, & Dr. Ramon Moral (USACE—ERDC)
1:25	**Influence and Enhancement of the Damping of Wire Rope Isolators for Naval Applications (p. 1)** Mr. Claude Prost & Mr. Bruno Abdelnour (Vibro/Dynamics SOCITEC)	**Dynamic Calibration of Pressure Transducers (p. 3)** Mr. Thomas Platte, Mr. Martin Iwanczik, & Mr. Michael Mende (SPEKTRA)	**Experiments to Study Secondary Debris from Buried Explosions under Brick Patios (p. 5)** Dr. Wije Wathugala & Dr. George Lloyd (ACTA Inc.)
1:50	**Managing Excursions for a Lightweight Payload Subjected to MIL-S-901D (p. 2)** Mr. Neil Donovan & Mr. Gary Melone (Shock Tech)	**Testing of the Endevco 7274 and 7284 Triaxial High-G Shock Accelerometers to the MIL-STD-810G, CN1 Cross-Axis Requirements (p. 4)** Mr. James Nelson (Meggitt Sensing Systems), Dr. Vesta Bateman (Mechanical Shock Consulting)	**Predicting Secondary Debris from Buried Explosions under Brick Patios using Numerical Simulations (p. 6)** Dr. Wije Wathugala & Dr. Wenshui Gan (ACTA Inc.)
2:15	**Nonlinear Single Degree-of-Freedom (SDOF) Fluidic Shock Isolator Model (p. 2)** Dr. J. Edward Alexander (BAE Systems)	**Innovation in Ultra Miniature Piezoelectric Accelerometer Design (p. 4)** Mr. David Change (Dytran Instruments)	**Fast-Running Tools for Blast Prediction and Load Mapping to Finite Element Models (p. 6)** Dr. Gregory Bessette, Mr. Michael Edwards, & Mr. Gustavo Emmanuelli (USACE - ERDC)
2:40	**Shock Failure Analysis and Isolation of Electronic Components used on Antenna Structures in Military Applications (p. 2)** Mr. Mehmet Emre Demir (Aselsan A.S.), Dr. Mehmet Caliskan (Middle East Technical University)	**Characterization of Debris Fields Using Drone Photogrammetry (p. 5)** Dr. Wije Wathugala, Mr. Jacob Maarek, & Mr. Timothy Wang (ACTA Inc)	**Tunnel Configuration Effects on Air Blast and Impulse for Cased Charge Detonations (p. 7)** Maj. Matthew Gettings , Dr. Joshua D. Kittle, & Dr. Eric Rinehart (DTRA)

ICE CREAM SOCIAL
3:00PM - 3:40PM
GRAND BALLROOM 4/5 (EXHIBIT HALL)

TUESDAY PM (OCTOBER 17)

	SESSION 4	*VENDOR SESSION A*	*TRAINING*
	Structural Response I / Material Properties 1:00pm-2:35pm / Unlimited Dist. A Chair(s): Dr. Peter Vo (Raytheon)	**Exhibitor Presentations including: Product and/or Service Overviews, Product Demos, & New Developments & Technologies** 1:00pm-3:00pm / Unlimited Dist. A Chair(s): Mr. Darren Fraser (Crystal Instruments) Mr. Bluejay Robinson (Correlated Solution)	**Structural Dynamics with Octave (an Open-Source Alternative to MatLab)** 1:00pm-2:30pm / Unlimited Dist. A
	All Presenters and Chairs (for Oct 17) are Required to Meet at 7:00AM in Grand Ballroom 6 for Presentation Loading		
	Meeting Room: Clearwater	***Meeting Room: Grand Ballroom 3***	***Meeting Room: St. Johns***
1:00	**Determination of Johnson-Cook Material Properties from Taylor Impact Testing (p. 7)** Mr. Mehmet Emre Demir (Aselsan A.S.)	1:00 "HBM Measurement Solutions using Sensors, DAQ, and Analysis"	**Structural Dynamics with Octave (an Open-Source Alternative to MatLab)** 1:00pm—2:30pm Mr. Robert Browning & Mr. Gustavo Emmanuelli (USACE—ERDC) Commercial software has a strong legacy within virtually every field of engineering. In structural dynamics, programs like MatLab have filled many gaps for both simulation and data processing. However, if the software is only used sparingly throughout the year, this could make it difficult to justify the rising costs of software licenses. One alternative to this is to resort to a programming language such as Fortran and simply write programs on a case-by-case basis. But while this may be a reasonable solution computationally speaking, it brings on new challenges in areas such as visualization. Languages like Fortran can also be difficult to set aside for months at a time and then be expected to effectively leverage them when the need arises. Thus, what is needed, is a low-cost alternative to programs like Mathematica and MatLab. Octave could be that alternative. Octave provides a graphical user interface that is similar to MatLab and uses a high-level programming language that is mostly compatible with MatLab, thus enabling many MatLab scripts to be run with minimal to no editing. All of this makes the program and the language very user-friendly. In addition, Octave is freely redistributable under the terms of the GNU General Public License (GPL) as published by the Free Software Foundation, so there is no cost to use it. This session is intended to introduce engineers and scientists to Octave with the aim of establishing a strong user-group in the field of structural dynamics. To that end, examples will be provided that cover typical problems encountered in structural dynamics. These will be used to introduce the basics of the language and demonstrate various techniques for visualizing data. Time will be allowed for questions and based on the interests of the audience more examples may be shown or more time given to discussion.
1:25	**Structural Health Monitoring of Composite Structures in an UNDEX Environment (p. 7)** Mr. Bill Gregory & Mr. Chris Key (Applied Physical Sciences), Dr. Mike Yeager (vScenario), Dr. Michael Todd (University of California, San Diego)	1:15 "Solutions for High Value Vibration Testing"	
1:50	**Simplified Finite Element Model Generation for Exodus II and Sierra SD/SM (p. 8)** Mr. Joshua Pennington (Altair)	1:30 "Measuring ODS's with DIC"	
2:15	**Margin Assessment using Energy Quantities (p. 9)** Dr. Vit Babuska, Mr. Troy Skousen, Mr. Matthew Raymer, & Mr. Carl Sisemore (Sandia National Laboratories)	1:45 "Polytec Overview"	
2:40		2:00 "A Brief History of Vibration Controllers"	
		2:15 "Case Study of Vibration Testing"	
		2:30 "Dewesoft Overview"	
		2:45 "LDS V8900 – New Product Introduction"	

TUESDAY PM (OCTOBER 17)

	SESSION 5	*SESSION 6*	*SESSION 7*
	Vibration I 3:45pm-5:20pm / Unlimited Dist. A Chair(s): Dr. Luke Martin (NSWC Dahlgren)	**UNDEX I** 3:45pm-4:55pm / Limited Dist. D 5:00pm-5:20pm / Limited Dist. C Chair(s): Dr. Jeffrey Cipolla (Thornton Tomasetti Weidlinger) Mr. Corbin Robeck (Thornton Tomasetti Weidlinger)	**DS: Ground Shock & Buried Blast** 3:45pm-5:20pm / Limited Dist. C Chair(s): Dr. Neil Williams (USACE—ERDC) Mr. Jeff Averett (USACE—ERDC)
	All Presenters and Chairs (for Oct 17) are Required to Meet at 7:00AM in Grand Ballroom 6 for Presentation Loading		
	Meeting Room: Grand Ballroom 6	***Meeting Room: Grand Ballroom 7***	***Meeting Room: River Terrace 3***
3:45	**Virtual Platform for Vibration Test in Shaker (p. 9)** Mr. Eric Dodgen, Mr. Washington J. DeLima, & Mr. Richard Jones (Honeywell Federal Manufacturing & Technologies)	**DDAMX: Extension of DDAM Methods to External Items (p. 11)** Dr. Jeffrey Cipolla, Mr. Alex McVey, Mr. Mahesh Bailakanavar, & Mr. Corbin Robeck (Thornton Tomasetti Weidlinger)	**The Effect of Dispersion on the Measurement of Pressure from Buried Blast (p. 13)** Dr. David Fox (Army Research Lab)
4:10	**Predicting Shaker Displacement during Random Vibration (p. 9)** Dr. Benjamin Shank (Thermotron Industries)	**MODCHK—Finite Element Preprocessor for Shock Applications (p. 11)** Mr. Corbin Robeck & Mr. Abilash Nair (Thornton Tomasetti Weidlinger)	**Full-scale Underbody Blast Experiments that Quantify Effects of Homemade-Explosive Types on aboveground Impulse (p. 13)** Mr. Garrett Doles, Dr. Neil Williams, & Dr. Jay Ehrgott (USACE—ERDC)
4:35	**Control of Multi-Shaker, Stationary Random Vibration via Mean Square (p. 10)** Dr. Thomas Paez (Thomas Paez Consulting), Dr. Norman F. Hunter (Sandia Laboratories Consultant)	**Simulation of UNDEX-Induced Implosion for Low-Ductility Metallic and Composite Unstiffened Cylinders (p. 12)** Mr. Adam Dick, Mr. Ryan Anderson, Mr. Alex McVey, Dr. Pawel Woelke, & Mr. Adam Hapij (Thornton Tomasetti Weidlinger)	**Modeling Homemade Explosive's Effect on Underbody Blast Impulse and Soil Motion (p. 13)** Dr. Neil Williams, Mr. Garrett Doles, & Dr. Stephen Akers (USACE—ERDC)
5:00	**Fiber Optic Ultra High Temperature (1000°C) Accelerometer (p. 10)** Mr. Nicholas Burgwin (FIBOS)	**Vulnerability and Mitigation of Radial Spillway Gates to Blast (UNDEX) Effects (p. 12)** Mr. Matthew Murray & Mr. Stephen Rowell (USACE—ERDC)	**Hybrid Laminated Metal Composite Structures for Underbody Blast (p. 14)** Dr. Ken Nahshon, Dr. Jessica Dibelka, & Dr. Nicholas Reynolds (NSWC Carderock)

TUESDAY PM (OCTOBER 17)

	SESSION 8	*VENDOR SESSION B*	*TRAINING*
	Mechanical Shock II 3:45pm-5:20pm / Unlimited Dist. A Chair(s): Mr. Jerome Cap (Sandia National Labs) Mr. Carl Sisemore (Sandia National Labs)	**Exhibitor Presentations including: Product and/or Service Overviews, Product Demos, & New Developments & Technologies** 3:45pm-5:15pm / Unlimited Dist. A Chair(s): Mr. Alan Klembczyk (Taylor Devices) Mr. Sean Murphy (Huntington Ingalls Industries)	**UNDEX Phenomena and Underwater Bulk Charge Weapon Effects** 3:45pm-5:00pm / Limited Dist. D
	All Presenters and Chairs (for Oct 17) are Required to Meet at 7:00AM in Grand Ballroom 6 for Presentation Loading		
	Meeting Room: Clearwater	***Meeting Room: Grand Ballroom 3***	***Meeting Room: River Terrace 2***
3:45	**Monte Carlo Optimization of a Hybrid Spectral / Temporal Single Input Multiple Output (SIMO) Input Derivation for an Oscillatory Decaying Shock (p. 14)** Mr. Jerome Cap, Mr. Chad Heitman, & Mr. Matthew Raymer (Sandia National Laboratories), Mr. Trevor Hunt (ATA Engineering)	3:45 "Vibro/Dynamics Overview" VIBRODYNAMICS a Socitec company 4:00 "The Advantage of Damped Sensors in Velocity Measurement" MEGGiTT 4:15 "Overview of the NVT Group: Data Physics, Lansmont, & Team dp Data Physics Lansmont Team Members of the NVT GROUP 4:30 "Taylor Devices Company and Product Overview" taylor devices inc. 4:45 "Huntington Ingalls Industries Overview" Huntington Ingalls Industries Hard Stuff Done Right 5:00 "iX Cameras Overview" iX Cameras	**UNDEX Phenomena and Underwater Bulk Charge Weapon Effects (DISTRO D)** 3:45pm—5:00pm Mr. Greg Harris (NSWC Indian Head) This training will provide an overview of underwater explosion (UNDEX) shock wave and bubble phenomena, including the effects of nearby boundaries such as the water surface and solid surfaces. This talk provides special emphasis on UNDEX bubble dynamics, bubble pulse loading, and bubble jetting phenomena. The procedures used to characterize the UNDEX shock and bubble output of explosives will be discussed. An overview of UNDEX effects on naval structures and submerged infrastructure will be given.
4:10	**Displacement Predictions of Oscillatory Decaying Shocks (p. 14)** Mr. Chad Heitman, Mr. Jerome Cap, Dr. Garrett Nelson, & Mr. Randy A. Hielo (Sandia National Laboratories)		
4:35	**Using Temporal Moments to Detect Interactions During Simultaneous Shock Testing of Multiple Components (p. 15)** Dr. Carl Sisemore, Dr. Vit Babuška, & Mr. Jason Booher (Sandia National Laboratories)		
5:00	**Shock Attenuation with Distance: A Comparison of Test Data with NASA Curves (p. 15)** Mr. Alexander Hardt (Orbital ATK)		

WEDNESDAY AM (OCTOBER 18)

	SESSION 9	*SESSION 10*	*SESSION 11*
	Structural Response II 8:00am-10:00am / Unlimited Dist. A Chair(s): Ms. Rebecca Grisso (NSWC Carderock) Dr. Emily Guzas (NUWC Newport)	**SRS and Piezoelectric Zero Shift** 8:00am-9:35am / Unlimited Dist. A Chair(s): Dr. Patrick Walter (PCB Piezotronics)	**DS: Vehicle Borne IED Research & Testing I** 8:00am-10:00am / Limited Dist. C Chair(s): Dr. Jay Ehrgott (USACE—ERDC) Dr. Kyle Crosby (USACE—ERDC)
	All Presenters and Chairs (for Oct 18) are Required to Meet at 7:00AM in Grand Ballroom 6 for Presentation Loading		
	Meeting Room: Grand Ballroom 6	***Meeting Room: Grand Ballroom 7***	***Meeting Room: River Terrace 2***
8:00	**Axial Impact of a Fluid-Filled Deformable Pipe (p. 15)** Dr. Catherine Florio, Mr. Adam L. Foltz, & Mr. Lyonel Reinhardt (US Army ARDEC)	**Comparison of Input Levels on the Shapes of SRS Functions (p. 17)** Mr. William Larsen, Dr. Jason R. Blough, Dr. James DeClerck, & Mr. Charles VanKarsen (Michigan Technological University), Mr. David Soine & Mr. Richard Jones (Honeywell)	**Experimental Testing of Potassium Chlorate-Diesel in Vehicle-Borne Improvised Explosive Devices (p. 19)** Mr. Daniel Vaughn, Mr. Joshua Payne, Dr. Kyle Crosby, Dr. Jay Ehrgott, & Mr. Denis Rickman (USACE - ERDC)
8:25	**Structural Response of Reinforced Concrete Slabs to Blast Loading: The Role of Material Strength (p. 16)** Dr. Tarek Kewaisy (Louis Berger)	**Velocity and Other Low Frequency SRS Shape Modifiers (p. 18)** Dr. Jason Blough, Mr. William Larsen, Dr. James DeClerck, Mr. Charles VanKarsen (Michigan Technological University), Mr. David Soine & Mr. Richard Jones (Honeywell)	**VIPER Tool - Vehicle Borne IED Post-Blast Forensic Data Collection and Analysis Tools (p. 19)** Mr. Joshua Payne, Dr. Kyle Crosby, Mr. Daniel Vaughan, Mr. Ernesto Cruz, Mr. Jasiel Ramos Delgado, Dr. Jay Ehrgott, & Mr. Denis Rickman (USACE ERDC)
8:50	**A Methodology for Scaling Shock Response Spectra (p. 16)** Dr. Arup Maji & Mr. Matthew Raymer (Sandia National Laboratories)	**Recommended Practices to Minimize Accelerometer Zero Shift Under Severe Shock; Part 1 (p. 18)** Dr. Patrick Walter (Texas Christian University), Mr. Anthony Agnello, Mr. Jeff Dosch, & Mr. Robert Sill (PCB Piezotronics), Mr. Strether Smith (Independent Consultant)	**Vehicle-Borne Improvised Explosive Device Crater Test Data and Analysis Techniques (p. 20)** Mr. Ernesto Cruz, Mr. Joshua Payne, Mr. Jasiel Ramos Delgado, Dr. Kyle Crosby, Dr. Jay Ehrgott, & Mr. Denis Rickman (USACE—ERDC)
9:15	**Survey of the Nuclear Weapon Effects Experimental Database (p. 17)** Dr. Eugene Sevin (ESCS) *Presented By: Mr. Fred Costanzo (Consultant)*	**Recommended Practices to Minimize Accelerometer Zero Shift Under Severe Shock; Part 2 (p. 18)** Dr. Patrick Walter (Texas Christian University), Mr. Anthony Agnello, Mr. Jeff Dosch, & Mr. Robert Sill (PCB Piezotronics), Mr. Strether Smith (Independent Consultant)	**Civilian Vehicle Damage Analysis from Vehicle Borne IED Detonations (p. 20)** Mr. Jasiel Ramos Delgado, Mr. Joshua Payne, Dr. Kyle Crosby, Mr. Ernesto Cruz, Dr. Jay Ehrgott, & Mr. Denis Rickman (USACE—ERDC)
9:40	**SHANFO Cylinder Tests (p. 17)** Maj. Matthew Gettings & Mr. D. Rand (Defense Threat Reduction Agency), Dr. Eric Rinehart (Applied Research Associates)		**An Introduction to the Super Heavy Improvised Explosive Loading Demonstration (SHIELD) Test Program (p. 21)** Mr. Denis Rickman (USACE-ERDC), Mr. Anders Persson (Swedish Fortifications Agency), Mr. Markus Jaun (Federal Department of Defence/Civil Protection and Sport DDPS), Mr. Tor Knutsen (Norwegian Defence Estate Agency), Mr. Hans Dirlewanger (Bundeswehr Technical Center for Protective and Special Technologies)

Coffee Break in the Exhibit Hall
10:00am—10:30am (Grand Ballroom 4/5)

WEDNESDAY AM (OCTOBER 18)

	SESSION 12	*VENDOR SESSION C*	*TRAINING*
	DS: Experimental Testing Methods & Instrumentation in High-G Environments 8:00am-10:00am/ Limited Dist. D Chair(s): Dr. Alain Beliveau (Applied Research Associates) Ms. Hayley Chow (UDRI)	**Exhibitor Presentations including: Product and/or Service Overviews, Product Demos, & New Developments & Technologies** 8:00am-10:00am / Unlimited Dist. A Chair(s): Mr. Gary Marraccini (Spectral Dynamics) Mr. Greg Hoshal (Instrumented Sensor Technology)	**Introduction to Heavyweight Shock Testing** 8:00am-10:00am / Unlimited Dist. A
	All Presenters and Chairs (for Oct 18) are Required to Meet at 7:00AM in Grand Ballroom 6 for Presentation Loading		
	Meeting Room: River Terrace 3	***Meeting Room: Grand Ballroom 3***	***Meeting Room: St. Johns***
8:00	**Bullets with Brains: Evaluating Integrated Circuit Memory in Ultra High-G Environments (p. 21)** Mr. Shane Curtis & Mr. Rus Payne (Sandia National Labs)	8:00 "Xcitex Overview"	**Introduction to Heavyweight Shock Testing** 8:00am—10:00am Mr. Travis Kerr (HI-TEST Laboratories) This training will cover the necessary background information relative to heavyweight shock testing. This session is intended for engineers and product developers who are unfamiliar with the heavyweight shock testing process. Subjects covered include pre-test planning, procedure preparation, fixture design, test set-up, test operations, instrumentation interpretation, and reporting. Construction and use of the floating shock platforms (FSP, IFSP, and LFSP) will be covered. Shock test requirements applicable to heavyweight shock testing will be discussed.
8:25	**Pressure Transducer Dynamic Response to Extreme Pressure and Mechanical Shock (p. 22)** Mr. Curtis McKinion & Dr. Jacob Dodson (Air Force Research Laboratory), Dr. Alain Beliveau (Applied Research Associates)	8:15 "Kistler Overview" KISTLER measure. analyze. innovate.	
8:50	**Displacement Measurement of the Fill Material in Sub-Scale Penetrator (p. 22)** Dr. Alain Beliveau (Applied Research Associates)	8:30 "Spectral Dynamics Overview" SPECTRAL DYNAMICS	
9:15	**Forward Assembly Test Protocol for Functional Validation (FATP-FV) (p. 22)** Ms. Hayley Chow (UDRI), Dr. Jacob C. Dodson & Dr. Janet C. Wolfson (AFRL/RWMF), Dr. Alain Beliveau (ARA)	8:45 "Shock Tech Overview" Shock Tech	
9:40	**Characterization of Explosive Fill Dynamics for Hard Target Munitions (p. 23)** Mr. Phil Marquardt, Mr. Justin Bruno, Mr. Dan Chitty, Mr. Drew Malechuk, Mr. Craig Doolittle, Mr. Dave Truncellito, Mr. Alma Oliphant, & Mr. John Perry (Applied Research Associates), Mr. Edwardo Freeman & Mr. Jamie Conley (Air Force Lifecycle Management Center - Eglin AFB, FL)	9:00 "Dytran's Innovation in Action: New Products" DYTRAN INSTRUMENTS, INC.	
		9:15 "High G Vibration & Shock Testing" experior laboratories	
		9:30 "Motion Analysis and Phantom High-Speed Cameras" VISION RESEARCH	
		9:45 "IST Overview" IST instrumented sensor technology	

Coffee Break in the Exhibit Hall

10:00am—10:30am (Grand Ballroom 4/5)

WEDNESDAY AM (OCTOBER 18)

	SESSION 13 **Structural Response III** 10:55am-12:05pm / Unlimited Dist. A Chair(s): Mr. Scott Yamada (PEO Subs) Mr. Thomas Brodrick (PEO Subs)	*SESSION 14* **UNDEX II** 10:30am-12:05pm / Limited Dist. D Chair(s): Mr. Kevin Behan (NUWC Newport) Mr. Brian Lang (NSWC Carderock)	*SESSION 15* **Isolation II** 10:30am-11:15am / Unlimited Dist. A **Numerical Methods / Modeling** 11:20am-12:05pm / Unlimited Dist. A Chair(s): Mr. Neil Donovan (Shock Tech) Mr. Claude Prost (Vibro/Dynamics SOCITEC)
	All Presenters and Chairs (for Oct 18) are Required to Meet at 7:00AM in Grand Ballroom 6 for Presentation Loading		
	Meeting Room: Grand Ballroom 6	***Meeting Room: River Terrace 2***	***Meeting Room: Grand Ballroom 7***
	Mid-Morning Break Continues in Exhibit Hall (10:00am-10:30am)		
10:30		**Comparison of the Nonlinear Shock Response of Stressed-Skin Modules (p. 25)** Mr. Matthew Tilley & Mr. Matt Davis (Newport News Shipbuilding)	**Evaluation of Elastomeric Isolators' Properties in Broad Temperature Range Avionics Applications (p. 26)** Mr. Neil Donovan & Mr. Kevork Kayayan (Shock Tech)
10:55	**Evaluating the use of Energy Response Spectra for Determining the Relative Severity of Machining Operations (p. 23)** Dr. Carl Sisemore & Dr. Vit Babuška (Sandia National Laboratories)	**On the Torpedo Tube-Loaded Shock Assessment of Navy Payloads (p. 25)** Dr. Emily Guzas & Mr. Kevin Behan (NUWC Newport)	**A Use of Wire Rope Isolators for Seismic Applications (p. 26)** Mr. Claude Prost & Mr. Bruno Abdelnour (Vibro/Dynamics SOCITEC)
11:20	**DDAM-coupled Optimization Methods for Ship Structures (p. 24)** Mr. Leo Jeng (Altair)	**UNDEX Initiated Implosion in Shallow Water of Cylinders in a Confined Environment (p. 25)** Dr. Joseph Ambrico & Dr. Ryan Chamberlin (NUWC Newport)	**Improving Model Quality and Accuracy through Automated Links to Design Information (p. 26)** Mr. Michael Boddie (General Dynamics—Bath Iron Works)
11:45	**2D FE and 2DOF Simulations of Ground Shock Experiments – Reflection Pressure Time History Dependency due to the Charge´s and Structure´s Properties (p. 24)** Prof. Leo Laine (LL Engineering), Prof. Morgan Johansson (Chalmers University), Mr. Ola-Pramm Larsen (ANKER—ZEMER Engineering AS)	**Finite Element Modeling of Isolation Mounts (p. 25)** Ms. Janet Bivens & Dr. Emily Guzas (NUWC Newport)	**Damage Based Analysis: Theory, Derivation and Practical Application using both an Acceleration and Pseudo-Velocity Approach (p. 27)** Mr. Vince Grillo (AI Solutions/NASA)

WEDNESDAY AM (OCTOBER 18)

	VENDOR SESSION D	*TRAINING*
	Exhibitor Presentations including: Product and/or Service Overviews, Product Demos, & New Developments & Technologies 10:30am-Noon / Unlimited Dist. A Chair(s): Mr. Ray Deldin (Altair Engineering) Ms. Lauren Yancey (HI-TEST Laboratories)	**Sensor and Signal Conditioning Considerations for Pyroshock Measurements** 10:30am-11:30am / Unlimited Dist. A
	All Presenters and Chairs (for Oct 18) are Required to Meet at 7:00AM in Grand Ballroom 6 for Presentation Loading	
	Meeting Room: Grand Ballroom 3	***Meeting Room: St. Johns***
10:00	***Mid-Morning Break Continues in Exhibit Hall (10:00am-10:30am)***	
10:30	10:30 "Testing & Services of HI-TEST Laboratories" 10:45 "Latest Kulite Semiconductor Products, Inc. Product Developments" 11:00 "Vibration by Thermotron" 11:15 "Altair Overview" 11:30 "New Shock Accelerometers and Blast Pressure Sensors " 11:45 "Fibos Company and Product Overview "	**Sensor and Signal Conditioning Considerations for Pyroshock Measurements** 10:30am-11:30am Mr. Alan Szary (Precision Filters) & Dr. Patrick Walter (PCB Piezotronics/TCU) This is a synergistic two part training session on sensor selection and signal conditioning considerations for shock measurements. After a brief discussion of challenges associated with pyroshock measurements, Part 1 will explore three different accelerometer types used for shock measurements and compare salient characteristics of each. Part 2 will expand on the signal conditioning aspects of the measurement system, The discussion will focus on the proper selection of filter characteristics which will provide faithful reproduction of in-band shock data while reducing sensor resonance and preventing aliasing artifacts in the digital record. We will also discuss key amplifier stage characteristics crucial for use with energy rich, transient pyroshock data. Results of experimentation will be provided to validate the presentation.
10:55		
11:20		
11:45		

General Session 2 incl. Keynote Lecture & Exhibitors' Luncheon

12:05pm—1:15pm / Grand Ballroom 4/5 (Exhibit Hall)

12:05pm—12:30pm	Buffet Lunch
12:30pm—12:35pm	Keynote Lecturer Introduction by: NSWC Carderock
12:35pm—1:15pm	*Keynote Lecture* by: Mr. Fred Costanzo (Consultant)

Mr. Costanzo is a recognized expert in the field of underwater explosion shock, structural analysis and in the application of numerical methods to the solution of complex engineering problems. He has made significant contributions both domestically and worldwide for 40-plus years. He served as Head of the Applied Mechanics Branch of the Survivability and Weapons Effects Division in the Survivability, Structures, and Materials Directorate, Carderock Division, NSWC. The scope of his Branch's tasks included projects involving the application of complex computational tools to large problems, the planning and execution of detailed survivability testing series, the interpretation of dynamic response measurement data, and the transformation of dynamic ship and submarine response data into design and test criteria for survivability. Mr. Costanzo has worked in the area of submarine and surface ship shock and survivability since 1975. His work focused on the development and application of shock analysis techniques for the assessment of the effects of underwater explosions on Navy ships and submarines. He also worked extensively in developing shock qualification design and test criteria for shipboard equipment. Mr. Costanzo has extensive experience in the NATO Survivability Subgroup on Ship Combat Survivability, which covers a very broad range of disciplines (including shock, blast, and fragmentation). This experience has fostered an understanding of the intricate interrelationships of these varied disciplines, and the strategies one must apply to achieve a reasonable balance in the area of protection against these damaging effects.

Mr. Costanzo led or participated in numerous weapons effects trials that involve both shock and blast effects. He also led major Navy R&D efforts for the integration of advanced isolation systems for shock and whipping into emerging surface ship designs. He has been active in applying advanced modeling and simulation (M&S) strategies to solving underwater explosion shock problems and recently led extensive efforts to develop technically feasible alternatives to explosive testing for conducting first of class shock trials (FSST) across the Navy enterprise. He also has developed competency in the application of several computational tools and finite element programs. Additionally, his experience involves a heavy concentration of efforts related to structures, structural response to shock loadings and vibration excitation, including both allowable stress and allowable loads design. He specializes in numerical solutions of mechanical systems subjected to shock and vibration loadings in support of design verification and survivability assessment efforts. He is also proficient in numerous computational tools that are special purpose research codes, hull girder analysis codes, and internally (NSWCCD) developed simple shock and survivability weapons effects codes.

Since his retirement after 38 years of federal government service, Mr. Costanzo has formed an engineering consultant LLC for which he is the sole proprietor. His post-federal government work has included serving as a consultant to Brüel & Kjær North America for support in the area of structural dynamics, and to Thornton-Tomasetti (Weidlinger Applied Science) for collaboration on a variety of STTR/SBIR efforts. Additionally, he has directly supported NSWC Carderock in a number of tasks, including the development and presentation of a comprehensive shock training course in underwater explosions fundamentals and the shock response of naval ships to the Finnish Navy and Finnish defense contractors in Helsinki, Finland, as part of a bilateral data exchange agreement between the two countries. He has also been active in mentoring recently hired engineers at NSWC Carderock in the area of underwater explosion phenomena and shock data analysis, and was recently hired by M&J Engineering, currently serving as principal investigator on a Navy sponsored SBIR.

Mr. Costanzo actively participates in the annual Shock and Vibration Symposium, chairing technical sessions, presenting three-hour training tutorials and technical papers. He also serves on the forum's Technical Advisory Group and was presented with the 2014 SAVE Lifetime Achievement Award.

Exhibitor Passport Program

- Each symposium attendee is given a "passport" with a listing of participating companies (exhibitors).
- Participating exhibitors are provided a customized stamp or sticker.
- As the attendees visit the participating exhibitors in the Passport Program, exhibitors "stamp" the passport of the attendee.
- Attendees who collected the stamp of all participating vendors are entered into the drawing* of multiple prizes.

**Drawing will be held between 3:15pm-4:00pm on Wednesday , October 18th*

Thank You to the Organizations Participating in the Passport Program:

Program Continues with More Technical Sessions, Tutorials, and Events →

WEDNESDAY PM (OCTOBER 18)

	SESSION 16	*SESSION 17*	*SESSION 18*
	Design & Modeling of Tests 1:40pm-3:15pm / Unlimited Dist. A Chair(s): Mr. Robert Sharp (Hutchinson)	**Navy Enhanced Sierra Mechanics (NESM) I** 1:15pm-2:50pm / Limited Dist. D Chair(s): Mr. Jonathan Stergiou (NSWC Carderock) Mr. Corbin Robeck (Thornton Tomasetti Weidlinger)	**DS: Vehicle Borne IED Research & Testing II** 1:15pm-3:15pm / Limited Dist. C Chair(s): Mr. Denis Rickman (USACE—ERDC) Mr. Joshua Payne (USACE—ERDC)
	All Presenters and Chairs (for Oct 18) are Required to Meet at 7:00AM in Grand Ballroom 6 for Presentation Loading		
	Meeting Room: Grand Ballroom 6	***Meeting Room: River Terrace 2***	***Meeting Room: River Terrace 3***
1:15		**Navy Enhanced Sierra Mechanics (NESM) Version 5.0 (p. 28)** Mr. Jonathan Stergiou, Mr. Raymond DeFrese, Dr. John Gilbert, Mr. Michael Miraglia, Dr. E. Thomas Moyer, & Dr. Nicholas Reynolds (NSWC Carderock), Dr. Najib Abboud, Mr. Paul Hassig, & Dr. Badri Hiriyur (Thornton Tomasetti Weidlinger), Dr. Garth Reese & Dr. Jesse Thomas (Sandia National Labs)	**Vehicle Borne IED HME Airblast Equivalency Testing and Analysis (p. 30)** Dr. Jay Ehrgott, Mr. Joshua Payne, Dr. Kyle Crosby, Mr. Daniel Vaughan, Mr. Denis Rickman, & Dr. Jon Windham (USACE—ERDC)
1:40	**Designing Hardware for the Boundary Condition Round Robin Challenge (p. 27)** Mr. David Soine & Mr. Richard Jones (Honeywell), Ms. Julie Harvie & Mr. Tyler Schoenherr (Sandia National Laboratories)	**Acoustic Shock Capabilities for Deep Submergence (p. 29)** Dr. Nicholas Reynolds & Mr. Jonathan Stergiou (NSWC Carderock), Dr. Scott Miller & Dr. Garth Reese (Sandia National Labs)	**Near-Field Airblast Characterization of Unconfined Homemade Explosives (p. 30)** Dr. Andreas Frank, Mr. Stephen Turner, Mr. Donny Guynes, Mr. Sonny Johnson, Mr. Neill Stephens, Mr. Jim Hall III, Mr. Billy Bullock, Mr. Tom Carriveau, & Dr. Jay Ehrgott (USACE—ERDC)
2:05	**Fatigue Based Technique to Compensate for Imperfect Test Fixtures (p. 27)** Mr. William Barber (US Army Redstone Test Center)	**Performance Engineering in Navy Enhanced Sierra Mechanics (p. 29)** Dr. John Wohlbier (DoD High Performance Computing Modernization Program), Dr. John Gilbert, Mr. Michael Miraglia, & Mr. Jonathan Stergiou (NSWC Carderock), Mr. Paul Hassig & Dr. Badri Hiriyur (Thornton Tomasetti Weidlinger), Dr. John Linford (ParaTools, Inc.)	**Spherical Equivalency of Ellipsoidal Charges in Free Air (p. 31)** Dr. Kyle Crosby, Dr Andreas Frank, Mr. Denis Rickman, Mr. Joshua Payne, Mr. Daniel Vaughan, & Dr. Jay Ehrgott (USACE—ERDC)
2:30	**Experimental Optimization of a Structural Element's Vibro-acoustic Robustness—Pt I (p. 28)** Mr. Zeev Sherf & Mr. Philip Hopstone (RAFAEL)	**Verification and Validation of Coupled Fluid Structure Analyses using EPSA-NEMO (p. 29)** Dr. Abilash Nair, Dr. Najib Abboud, Mr. Adam Hapij, Dr. Badri Hiriyur, & Mr. Corbin Robeck (Thornton Tomasetti Weidlinger)	**Numerical Analysis of the Effects of Barrier Wall Shielding on Dynamic Pressure and Impulse from a Detonation (p. 31)** Dr. Kyle Crosby, Dr. Andreas Frank, Mr. Denis Rickman, Mr. Joshua Payne, Mr. Daniel Vaughan, & Dr. Jay Ehrgott (USACE—ERDC)
2:55	**Experimental Optimization of a Structural Element's Vibro-acoustic Robustness—Pt II (p. 28)** Mr. Zeev Sherf & Mr. Philip Hopstone (RAFAEL)		**FERRET Data Collection Methodologies for Forensic Analysis of Small Arms and Propelled Munitions (p. 32)** Mr. Cameron Thomas, Dr. Jay Ehrgott, Dr. Kyle Crosby, & Mr. Denis Rickman (USACE—ERDC)

BALLPARK BREAK & PASSPORT PRIZE WINNER ANNOUNCEMENT

3:15PM - 4:00PM

WEDNESDAY PM (OCTOBER 18)

	SESSION 19 **Vibration II** 1:15pm-1:35pm / Limited Dist. C 1:40pm-2:25pm / Unlimited Dist. A **Revised Navy Shock Test Requirements** 2:30pm-3:15pm / Unlimited Dist. A Chair(s): Dr. Luke Martin (NSWC Dahlgren)	*TRAINING* **DDAM-coupled Optimization Methods** 1:15pm-2:00pm / Unlimited Dist. A *DISCUSSION GROUP* **Boundary Conditions Discussion Group** 2:15pm-3:15pm / Unlimited Dist. A
	All Presenters and Chairs (for Oct 18) are Required to Meet at 7:00AM in Grand Ballroom 6 for Presentation Loading	
	Meeting Room: Orlando	***Meeting Room: Clearwater***
1:15	**Statistical Compilation of Sounding Rocket Flight Vibration Environments (p. 32)** Dr. Ricky Stanfield (Northrop Grumman Technology Services)	**DDAM-coupled Optimization Methods** 1:15pm-2:00pm Mr. Leo Jeng (Altair) In this workshop, the focus will be on optimizing components for DDAM simulations. This workshop will demonstrate setting up the model in a FEA pre-processor. The model will then be run in a solver and optimized using the same solver engine to generate DDAM-optimized results. Optimization techniques covered in this workshop include topology, gauge, and shape optimization to improve the performance of the model under DDAM shock simulation conditions. Additional post-processing of the analysis will be done to evaluate and compare the optimized and baseline designs.
1:40	**A New Method of PSD Estimation (p. 33)** Mr. Philip Van Baren, Mr. Joel Minderhoud, & Mr. Jacob Maatman (Vibration Research) *Mr. Aaron Offringa (Vibration Research) presenting*	
2:05	**Vibration Specifications of a Supersonic Missile (p. 33)** Mr. Matan Mendelovich (Rafael)	**Boundary Conditions in Environmental Testing Round Robin Discussion Group** 2:15pm-3:15pm Mr. Troy Skousen The current practices for component-level shock & vibration testing may result in over- or under-stressing the component as compared to the stress experienced in the next level assembly. While the success of the component test is dependent on several factors, a significant contributor is the boundary condition in the component test. Common test practices cause the component to have notably different dynamic boundary conditions between the component test and system configuration. This may be causing false failures in the component tests that are not indicative of the true system environments and/or leading us to miss failures in the component tests that would have occurred in the system. A test bed, the Box Assembly with Removable Component (BARC), has been designed for interested parties to study this problem in a common framework. This round robin will include an overview of the hardware and problem statement followed by a discussion among current and prospective participants regarding approaches for improving the issues associated with differing boundary conditions. Current efforts are primarily focused on improved test specifications and fixture design optimization. Please join us!
2:30	**Basic Structure and Features of MIL-DTL-901E for Use on Surface Ships, Carriers, and Submarines (p. 34)** Dr. Christopher Merrill (NAVSEA 05P1)	
2:55	**Basic Structure and Features of T9072-AF-PRO-010 for Use on Surface Ships and Carriers (p. 34)** Dr. Christopher Merrill (NAVSEA 05P1)	

BALLPARK BREAK & PASSPORT PRIZE WINNER ANNOUNCEMENT

3:15PM - 4:00PM

WEDNESDAY PM (OCTOBER 18)

TUTORIAL SESSION 5 / 3:30pm—6:30pm

~ CHOOSE ONE / ADDITIONAL FEES APPLY TO ATTEND ~

Shock Test Failure Modes **Meeting Room: St. Johns**

Mr. Kurt Hartsough & Mr. Domenic Urzillo (NSWC Philadelphia)

This tutorial will cover examples of shock test failures typically experienced by equipment exposed to MIL-DTL-901E shock levels. MIL-DTL-901E provides guidance for designers responsible for meeting the requirements of MIL-DTL-901E. This tutorial will show how and why equipment failures occur and show how minor design changes can prevent shock failures. Hands on demonstrations, real time high speed video and analysis will be used to demonstrate both failures and corrective actions.

Analysis for Medium Weight Shock **Meeting Room: Orlando**

Mr. Josh Gorfain (Applied Physical Sciences) & Mr. Jeff Morris (HI-TEST Laboratories)

While a shock test is essentially the bottom line for a shock qualification, a lot of analysis often goes into the mix before the test. The reasons for this are many: The equipment manufacturer wants his equipment to pass and will often commission some kind of pre-test prediction to maximize the likelihood of success or to high-light design problems. Since the weight and frequency of the tested equipment can affect the response of the test significantly, the system may need to be examined to assure that the tested environment is correct. This tutorial will first review the Medium Weight Shock Machine (MWSM) and its use in shock qualification testing, followed by presentation of the test environment. Next, the types of analysis that can be performed to estimate the test environment experienced by a given piece of equipment will be described. The intention of these analyses is to provide an assessment of equipment response subject to a MWSM test in an effort to assure a successful test. Additionally, the merits and limits of these methods are discussed so the most appropriate method may be rationally selected for a given application. Examples will be presented that illustrate the different types of analyses and how they may be applied.

Single and Sequences of Shocks, Analysis and Laboratory Simulation Conditions Generations **Meeting Room: Clearwater**

Mr. Zeev Sherf (Consultant)

In many cases of systems' real life, they are excited by bursts of mechanical energy that last for milliseconds and originate from different sources; pyrotechnic events, firing and launching events, earthquakes, transportation events, etc . As a result, mechanical shocks operate on the systems and can damage them. The design of shock resistant structures requires an appropriate description of the exciting source. The shocks that are usually measured as time histories. This is the basic mode of a shock description. With the modern data recording and storage tools this is the most realistic and efficient method both for laboratory and numerical simulation of shocks. The fact that must be taken care of is the statistical character of the shock time history (both in level and in duration-each measurement of the same event results in a shock time history that is a member of shock population). This shock statistics must be identified, for a complete description of the shocks population. The characterization of a shock sequence requires also an identification of the statistical features of the shocks in the sequence in order to build a data base for the shock sequence simulation. When the issue of accelerating the application of a shock sequence arises it is required to identify the damage or the energy carried by the sequence and to find a way to apply this damage or energy in a shorter time. Usually shocks of higher damage potential or higher energy must be identified and applied. Methods of shocks ' sequences statistical feature identification are presented. Techniques of shocks modeling on their two parts (the deterministic and the random) are described. Methods of shock and shock sequences induced damage evaluation are presented. Also techniques of single shock and shock sequences energy calculation are discussed. Use of these techniques in the generation of laboratory simulation programs is exemplified.

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Wednesday, October 18th

7:00pm—10:00pm

Food, Drinks, & Entertainment

THURSDAY AM (OCTOBER 19)

	SESSION 20	*SESSION 21*	*SESSION 22*
	Mechanical Shock III 8:00am-8:45am / Limited Dist. D 8:50am-10:00am / Limited Dist. C Chair(s): Mr. Matthew Davis (Newport News Shipbuilding) Mr. Mike Poslusny (Huntington Ingalls Industries)	**Navy Enhanced Sierra Mechanics (NESM) II** 8:00am-9:35am / Limited Dist. D Chair(s): Mr. Jon Stergiou (NSWC Carderock) Dr. John Gilbert (NSWC Carderock)	**Structural Response of Ground and Mechanical Structures** 8:00am-10:00am / Limited Dist. D Chair(s): Mr. Roosevelt Davis (Air Force Research Laboratory)
	All Presenters and Chairs (for Oct 19) are Required to Meet at 7:00AM in Grand Ballroom 6 for Presentation Loading		
	Meeting Room: Clearwater	***Meeting Room: River Terrace 3***	***Meeting Room: St. Johns***
8:00	**Subsidiary Shock Testing of a Circuit Card Assembly Utilizing an Electrodynamic Shaker (p. 34)** Mr. Sloan C. Burns (NSWC Dahlgren)	**Navy Enhanced Modeling Oracle (NEMO) Improvements (p. 37)** Dr. John Gilbert, Mr. Michael Miraglia, & Mr. Jonathan Stergiou (NSWC Carderock), Mr. Paul Hassig & Dr. Badri Hiriyur (Thornton Tomasetti Weidlinger)	**Modeling Nonlinear Roller-Spring Kinematics with a Hyperelastic Material (p. 38)** Dr. Emily Guzas (NUWC Newport)
8:25	**NSRP Shock and Vibration Qualification Testing of Flexible Infrastructure Bulkhead Track (p. 35)** Mr. Mike Poslusny (Huntington Ingalls Industries)	**Navy Enhanced Sierra Mechanics (NESM) Automated Remeshing Tool (p. 37)** Mr. Michael Miraglia, Mr. Raymond DeFrese, Dr. John Gilbert, Dr. E. Thomas Moyer, Dr. Nicholas Reynolds, & Mr. Jonathan Stergiou (NSWC Carderock), Dr. Garth Reese & Dr. Jesse Thomas (Sandia National Labs)	**Response of Adobe Structures Subjected to Internal Blast Loads (p. 38)** Dr. Bryan Bewick, Mr. Brandon Taylor, & Mr. Ernie Staubs (AFRL/RWML)
8:50	**Medium Weight Shock Test of a Superbolt Expansion Bolt: Modeling & Design (p. 35)** Mr. Matthew Davis, Dr. Michael Talley, Mr. Jeremy Tucker, & Mr. Kevin Lafountain (Newport News Shipbuilding)	**Framework for a Streamlined Workflow and the Future Role of the Analyst (p. 37)** Dr. Nicholas Reynolds, Mr. Michael Miraglia, & Mr. Jonathan Stergiou (NSWC Carderock)	**Multi-Strike Breach and Spall Prediction in Reinforced Concrete Walls (p. 39)** Dr. George M. Lloyd , Dr. Wije Wathugala, & Ryan Schnalzer (ACTA Inc.), Mr. Casey Meakin, Mr. Joe Magallanes, & Mr. Joseph Abraham (Karagozian & Case Inc.) *presented by: Dr. Wije Wathugala (ACTA Inc.)*
9:15	**Medium Weight Shock Test of a Superbolt Expansion Bolt: Findings & Recommendations (p. 36)** Mr. Matthew Davis, Dr. Michael Talley, Mr. Jeremy Tucker, Mr. Kevin Lafountain, & Mr. Steve Arturo (Newport News Shipbuilding)	**Multiple Program Multiple Data FSI Coupling of Structural Dynamics (Sierra-SD) and UNDEX (NEMO) (p. 38)** Dr. Lynn Munday, Dr. Gregory Bunting, Dr. Scott Miller, & Mr. Jonathan Stergiou (NSWC Carderock)	**Experimental Door Response Results from Multiple Charges (p. 39)** Mr. Roosevelt Davis & Capt. Brian Lagrange (Air Force Research Laboratory)
9:40	**High Impact Shock Testing of Lithium Ion Batteries (p. 36)** Ms. Janet Bivens & Ms. Monica Black (NUWC Newport)		**Explosive Removal of Upheaval Using Shaped Charges (p. 40)** Mr. Stephen Turner, Dr. Jay Ehrgott, & Mr. Denis Rickman (USACE—ERDC)

THURSDAY AM (OCTOBER 19)

	SESSION 23	*TRAINING*
	DS: Mechanical Shock—Instrumentation, Modeling, & Simulation I 9:15am-10:00am / Limited Dist. D Chair(s): Mr. Curtis McKinion (Air Force Research Laboratory) Dr. Bryan Joyce (UDRI)	**Introduction to Medium Weight & Lightweight Shock Testing** 8:00am-10:00am / Unlimited Dist. A
	All Presenters and Chairs (for Oct 19) are Required to Meet at 7:00AM in Grand Ballroom 6 for Presentation Loading	
	Meeting Room: River Terrace 2	***Meeting Room: Orlando***
8:00		**Introduction to Medium Weight & Lightweight Shock Testing** 8:00am—10:00am Mr. Jeff Morris (HI-TEST Laboratories) This training will cover the necessary background information relative to medium weight shock testing. This session is intended for engineers and product developers who are unfamiliar with the medium weight shock testing process. Subjects covered include pre-test planning, fixture selection, test set-up, test operations, and reporting. Some aspects of medium weight shock machine operation will be covered. Shock test requirements applicable to medium weight shock testing will be discussed.
8:25		
8:50		
9:15	**The Effect of Potting Material on the Mechanical Response of the Electronic Components of the PINE Fireset to an Impact Load (p. 40)** Dr. Catherine Florio & Dr. Jennifer Cordes (US Army ARDEC)	
9:40	**COTS Recorder Adapted for Use in High-G Embedded Environment (p. 41)** Mr. James Scheppegrell (AFRL Fuzes Branch)	

THURSDAY AM (OCTOBER 19)

	SESSION 24	*SESSION 25*	*SESSION 26*
	UNDEX III 10:00am-Noon / Unlimited Dist. A Chair(s): Mr. Tony Keller (Spectral Dynamics)	**DS: DYSMAS & UNDEX Loading** 10:00am-11:35am / Limited Dist. D 11:40am-Noon / Unlimited Dist. A Chair(s): Mr. Adam Goldberg (NSWC Indian Head) Mr. Bradley Klenow (NSWC Carderock)	**DS: Mechanical Shock—Instrumentation, Modeling, & Simulation II** 10:00am-Noon / Limited Dist. D Chair(s): Mr. Curtis McKinion (Air Force Research Laboratory) Dr. Bryan Joyce (UDRI)
	All Presenters and Chairs (for Oct 19) are Required to Meet at 7:00AM in Grand Ballroom 6 for Presentation Loading		
	Meeting Room: Clearwater	***Meeting Room: St. Johns***	***Meeting Room: River Terrace 2***
10:00	**Comparative Study on Shock Response Analysis with UNDEX Experimental Data using Down-Scaled Submerged Ship Model (p. 41)** Dr. Jeong-Il Kwon, Dr.Seok-Jun, Moon, Dr.Jung-Hoon, Chung, & Mr.Jin-Woo Park (Korea Institute of Machinery & Materials)	**Verification and Validation Studies Using Abaqus/Gemini (p. 43)** Mr. Chris Abate (General Dynamics Electric Boat)	**Repackaging Fuze Electronic Components for Enhanced Reliability and Survivability (p. 44)** Mr. Curtis McKinion (Air Force Research Laboratory)
10:25	**The Characteristics of Loading of the Contact UNDEX of TNT (p. 41)** Prof. Jianhu Liu (China Ship Scientific Research Center)	**DYSMAS Status, Recent Accomplishments, and Plans (p. 43)** Mr. Greg Harris (NSWC Indian Head)	**Mapping Legacy Penetrator Fuzing System Limits with Modeling and Simulation (p. 44)** Mr. Alma Oliphant, Mr. Justin Bruno, Ms. Ericka Amborn, & Mr. Daniel Fajardo (Applied Research Associates), Mr. Russ Klug (AFLCMC/EBD) *presented by: Mr. Nick Jarrett (Applied Research Assoc.)*
10:50	**Fluid-Structure Interaction on an Air-Backed plate Subjected to Strong Shock Wave by Close-In Underwater Explosion (p. 42)** Mr. Zhangtao Zhou (China Ship Scientific Research Center)	**DYSMAS Modeling of Buried Blast and Structural Response (p. 43)** Dr. Thomas McGrath, Mr. Roger Ilamni, Dr. Alan Luton, Mr. James Warner, Mr. Jeff St. Clair, & Mr. Cameron Stewart (NSWC Indian Head)	**Defining Structural Dynamic Environments for Penetrator Fuzes (p. 45)** Mr. Alma Oliphant, Mr. Justin Bruno, Ms. Ericka Amborn, Mr. Craig Doolittle, & Mr. Drew Malechuk (Applied Research Associates), Mr. Russ Klug (AFLCMC/EBD) *presented by: Ms. Ericka Amborn (Applied Research Assoc.)*
11:15	**Research on the Coupling Damage of Surface ship Structures to Underwater Explosions (p. 42)** Dr. Hai Kun Wang (China Ship Scientific Research Center)	**Pre-Test Predictions of Near-Field Bubble Loads on Stiffened Plate Structures (p. 43)** ***(Lim D + AUS-UK-CAN-NZ-USA as invited)*** Dr. Kenneth Nahshon & Mr. Nicholas Reynolds (NSWC Carderock), Mr. Gregory Harris & Mr. Roger Ilamni (NSWC Indian Head), Dr. G. Chahine & Mr. C.T. Hsiao (Dynaflow Inc)	**Wave Propagation in Polymer Composites under High-g Loading with Embedded Instrumentation (p. 45)** Dr. Bryan Joyce, Ms. Hayley Chow (University of Dayton Research Institute), Dr. Jacob Dodson & Dr. Janet Wolfson (AFRL/RWMF), Ms. Aine Mangan (Georgia Tech)
11:40	**The Coupling Damage Effect of Yield and Buckling of a Ring-Stiffened Cylinder to Underwater Explosions (p. 42)** Dr. Jun Wang (China Ship Scientific Research Center)	**Dynamic Response of Marine Mammal Lungs to UNDEX Loading (p. 44)** Dr. Stephen Turner, Dr. Emily Guzas, Tom Fetherston, & Glenn Mitchell (NUWC Newport)	**Simulation of a Reinforced Concrete Wall Subjected to Blast Effects Using MARS and LDPM (p. 46)** Mr. Micael Edwards, Dr. James Baylot, & Dr. James O'Daniel (US Army - ERDC)

THURSDAY AM/PM (OCTOBER 19)

	SESSION 27 **Blast Modeling and Testing** 10:00am-10:45am / Limited Dist. D 10:50am-Noon / Unlimited Dist. A Chair(s): Mr. Andrew Barnes (USACE—ERDC) Mr. Robert Browning (USACE—ERDC)	*TRAINING* **Developing Exodus II and Sierra SD/ SM Format Models** 10:30am-11:15am / Unlimited Dist. A
	All Presenters and Chairs (for Oct 19) are Required to Meet at 7:00AM in Grand Ballroom 6 for Presentation Loading	
	Meeting Room: Grand Ballroom 3	***Meeting Room: Orlando***
10:00	**Modeling and Simulation of Combined Blast and Fragment Munitions Benchmarked against Experimental Data (p. 46)** Mr. Andrew Barnes, Mr. Robert Browning, and Dr. James O'Daniel (USACE—ERDC)	
10:25	**Preliminary Assessment of Finite Element Codes for Simulating Concrete Subjected to Blast Effects (p. 47)** Dr. William Lawrimore, Dr. James Baylot, Mr. Robert Browning, & Dr. James O'Daniel (USACE—ERDC)	**Developing Exodus II and Sierra SD/ SM Format Models** 10:30am-11:15am Mr. Joshua Pennington (Altair) The training session will be a presentation of the process involved to develop an Exodus II model using Altair's preprocessor - HyperMesh. The session will be based on the Technical Presentation introducing the Exodus/ Sierra SD interface. Within the interface CAD import, geometry modification/creation, model meshing, and potential for model optimization will be demonstrated. Editing of existing Exodus II/Sierra formatted models to incorporate design changes will also be illustrated.
10:50	**Application of the AFRL Blastpad to Low Height of Burst Configurations (p. 47)** Ms. Michelle Barreto & Dr. Alan Ohrt (AFRL/ RWML), Dr. Catherine Stephens (USACE—ERDC)	
11:15	**Generating a BlastX Explosive Source Model (p. 48)** Mr. Gustavo Emmanuelli (USACE—ERDC)	
11:40	**Ballistic Performance of Cross-Laminated Timber (p. 48)** CDT Zade Koch & CDT Andrew Valkenberg (United States Military Academy)	

1:00-2:30	**S&V Technical Advisory Group Meeting**	**Meeting Room: Grand Ballroom 6/7**
	The annual meeting of the members of the SAVE Technical Advisory Group (TAG) will convene to review the 88th S&V Symposium and discuss plans for 2018.	

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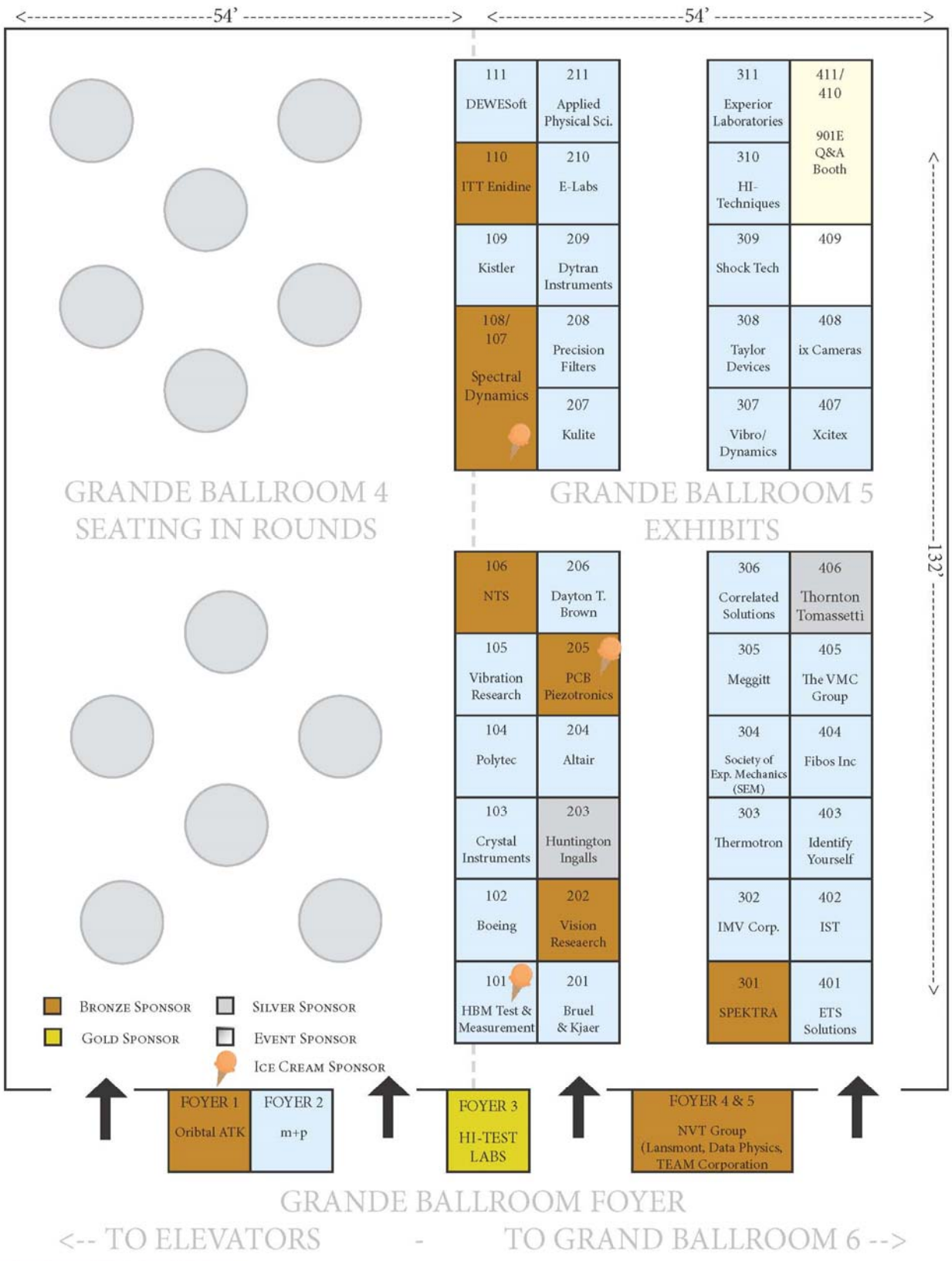

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At **Identify Yourself**, we're all about taking the big ideas you have for your business and finding ways to get them off the ground. As a family owned and operated company, we understand the challenges you face getting your brand to stand out from the competition and the importance of partnering with the right people. When you mix great ideas with great people, your branding goals can really take flight.

Since it was founded in 1957, **IMV Corporation** is a world's leading supplier of high reliability vibration test systems in Japan offering single-axis, sequential and simultaneous (up to 6 degree of freedom) multi-axis vibration test systems, vibration diagnostic instruments and engineering consultancy services with physical location in Anaheim, CA, USA.

IST offers a full line of instruments from low cost shock detectors and shock & vibration loggers to full-featured shock & vibration waveform recorders and high speed/large memory units for demanding airborne measurements. We offer systems for applications ranging from low level seismic (milli-g range) to high g shock applications up to several thousand (2,000+ gs). We also offer specialized instruments for 6-axis measurement including roll, pitch and yaw as well as high speed atmospheric pressure recorders for specialized air drop & rate of descent testing. We even offer a miniaturized unit for in-situ helmet testing during sporting events or military or industrial training.

ITT Enidine Defense designs and manufactures energy absorption, vibration isolation and shock systems for defense applications. These engineered products support applications in weapon systems, naval, transportation, and aviation. Products include elastomeric, hydraulic, mechanical shock isolation, as well as standard off the shelf products such as HERMS and Wire Rope Products.

EXHIBITOR INFORMATION

iX Cameras designs and manufactures a wide range of high-end, high-speed digital cameras. The revolutionary i-SPEED 726 features a 3 megapixel sensor capable of recording 8,500 full frames/second, 1080p HD images at 12,500 frames/second, 720p HD images at 23,000 frames/second, and top speeds in excess of one million frames/second.

The Kistler Group is the global market leader in dynamic measurement technology. Our technology measures pressure, force, acceleration and torque. Our instruments are used to measure and analyze physical processes, control industrial processes and optimize products. Our product offering is used in engine development and monitoring, vehicle technology, plastics processing and metal machining, as well as assembly and testing technology. We develop and supply sensors, electronics, and software, backed up by a full range of services. In short: everything from one single source.

Kulite is globally recognized as the leading name in transducer technology by maintaining its edge with vigilant research, ingenious designs and forward-thinking minds. With over 340 patents, Kulite has developed high-performance, state-of-the-art custom and stock products, including transducers for extreme and harsh environmental conditions. Highlighted products will include miniature g-insensitive transducers for measuring blast and shock pressure, pyroshock accelerometers and advanced signal conditioning.

m+p international is a worldwide provider of high-quality test and measurement solutions for vibration control, noise & vibration analysis and general data acquisition. By working closely with our customers, we understand their applications from an engineer's point of view and this is apparent in our products. A policy of continuous research and development, which has led to many pioneering solutions, ensures that our products demonstrate superior performance and quality.

Meggitt Sensing Systems is a leading supplier of high-performance sensing and monitoring systems for physical parameter measurements in extreme environments. Meggitt's Endevco® range of piezoelectric, piezoresistive, Isotron® and variable capacitance accelerometers, piezoresistive pressure transducers and acoustic sensors ensures critical accuracy and reliability for shock, pressure and vibration measurements.

For over a half-century, **NTS** has helped manage your toughest environmental test requirements. Leveraging our national network of laboratories, we are uniquely qualified to guide clients through the Navy shipboard MIL-Standard requirements. Our engineers are experts in shock and vibration, possessing extensive knowledge of ship design and dynamic structural analysis.

NVT Group (Data Physics, Lansmont, and Team) have proven expertise in measuring, simulating, and analyzing the effects of vibration, noise, shock, and other environmental variables for our industry customers. Our combined capabilities make us a leading global provider of test and measurement solutions.

EXHIBITOR INFORMATION

Orbital ATK is a global leader in aerospace and defense technologies. The company designs, builds and delivers space, defense and aviation systems for customers around the world, both as a prime contractor and merchant supplier. Its main products include launch vehicles and related propulsion systems; missile products, subsystems and defense electronics; precision weapons, armament systems and ammunition; satellites and associated space components and services; and advanced aerospace structures. Headquartered in Dulles, Virginia, Orbital ATK employs approximately 13,000 people across the U.S. and in several international locations. For more information, visit www.orbitalatk.com.

PCB® manufactures precision sensors and sensor accessory products. Our product lines include sensors for the measurement of acceleration, acoustics, force, load, pressure, shock, strain, torque, and vibration. Our products are the first choice of engineers and scientists at leading businesses, research institutions, and independent laboratories around the world. We offer unmatched customer service, a global distribution network, 24-hour SensorlineSM, and a Lifetime Warranty to deliver Total Customer Satisfaction.

Polytec is the market leader for non-contact, laser based vibration and velocity measurement instrumentation. Our innovative solutions allow customers to maintain their own technical leadership across many fields. Polytec has recently celebrated its 50th anniversary, earning an unrivalled reputation for technical support and offering an unmatched range of laser vibrometer solutions.

Since 1975, **Precision Filters, Inc. (PFI)** has been a global provider of instrumentation for test measurements. You can rely on a single source for signal conditioning and switching—a complete range of instrumentation—products optimized to work together to provide high performance at reasonable cost.

Shock Tech designs, manufactures and tests shock attenuation and vibration isolation mounting systems for the most demanding environments. We provide solutions for your equipment's dynamic protection problems and are experts at quick-turn, affordable results.

The Society for Experimental Mechanics is composed of international members from academia, government, and industry who are committed to interdisciplinary application, research and development, education, and active promotion of experimental methods to: (a) increase the knowledge of physical phenomena; (b) further the understanding of the behavior of materials, structures and systems; and (c) provide the necessary physical basis and verification for analytical and computational approaches to the development of engineering solutions.

Spectral Dynamics (SD) is a technically innovative company that has served the Shock and Vibration community continuously for 56 years. Whether it's Sine control of challenging tests, innovative MIMO control of multiple shakers, Shock data capture at 5 Msample/s/channel or accurate Phase-locked acquisition of hundreds of channels of data, Spectral Dynamics uses mathematics effectively to reduce the total costs of dynamic testing. Call Spectral Dynamics for a customized solution to your needs in Vibration, Shock or Acoustic Test Control; Multi-Channel Data Acquisition; Modal Analysis or PIND Testing. Ask about our Electrodynamic and Hydraulic Shaker Systems and our Shock Tables.

EXHIBITOR INFORMATION

SPEKTRA is the leading provider of Calibration and Test systems for the measurement of Shock, Vibration and Acoustics. The company develops, manufactures, sells and supports a broad range of test and calibration systems, from very low frequency to very high frequency systems, low g to high g shock, and both Primary (i.e. laser vibrometer) and Secondary measurement systems. These are fully automated systems for the test and recalibration of shock, vibration and motion transducers used in aerospace applications, in automotive crash testing, for seismic measurements, etc. SPEKTRA also offers calibration and test services as well as engineering services for the development of customized test solutions.

Taylor Devices has provided innovative solutions for shock and vibration control since 1955. Our customers include all branches of the US Military and NASA Space Programs. Products include precise positioning shock isolators, fluid, elastomer and hydropneumatic spring-dampers, high capacity fluid dampers, and modular machined springs. Made 100% in the USA.

For over 10 decades, **The VMC Group** has been recognized as a world leader in the design and manufacture of vibration isolation, seismic control and shock protection products. Our comprehensive product and engineering solutions cover a variety of industries – commercial construction, industrial/vehicular, OEM and military/aerospace. Our full range of spring, elastomeric architectural mounts, wire rope isolators, curbs and bases are proven to meet and exceed specifications for any seismic, non-seismic, shock, or even bomb blast application.

For more than 55 years, **Thermotron** has provided quality environmental test equipment. We've worked to establish a trusted reputation among our peers, and when people hear the name Thermotron, they have confidence in the testing of their own product. We've been building our name since 1962; now it's your turn. Quality. Trust. Confidence. Build yours with a Thermotron.

Thornton Tomasetti provides engineering design, investigation and analysis services to clients worldwide on projects of every size and complexity. We have more than 60 years of experience in research, testing and software development for the U.S. Navy and Department of Defense in the fields of blast, underwater shock, impact and vibration effects.

Vibration Research offers testing products, software and support with unrivaled value. Our VR9500 Controller and ObserVR1000 DAQ/Analyzer, along with VibrationVIEW and ObserVIEW software, include patented innovations used by world-wide testing labs and engineers. iDOF™, FDS, FDR, and Kurtosion® are some of VR's applications that ensure accurate, fast vibration testing.

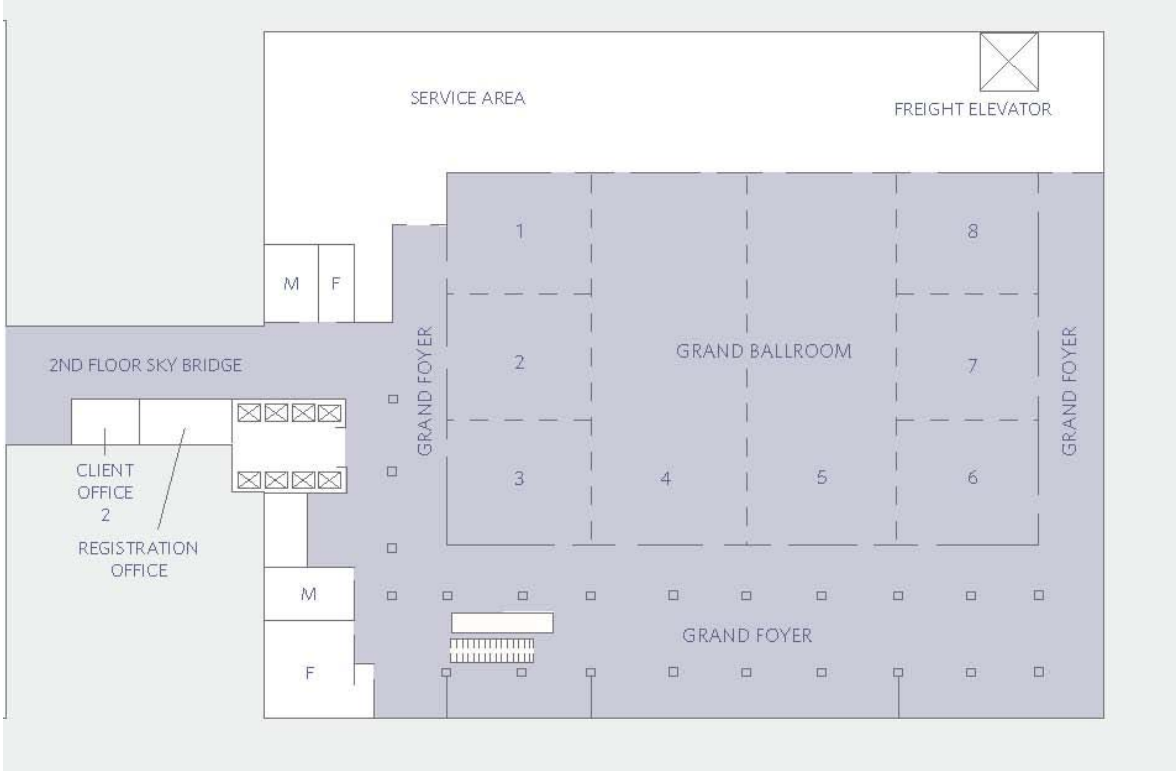
Since 1964, **Vibro/Dynamics** has been the leader and pioneer in the design and manufacture of vibration isolation and shock control systems. Our Products and Services are designed to effectively reduce transmitted shock and vibration and to provide an adjustment means to precisely level, align, and properly support industrial machinery. We also provide systems that protect machinery and building structures from incoming vibration caused by machinery, railroads, earthquakes, etc. In 2014, Vibro/Dynamics became a member of the Socitec Group, worldwide leader and specialist of wire rope isolators and elastomeric solutions.

EXHIBITOR INFORMATION

Vision Research designs and manufactures high-speed digital imaging systems that are used in all military, industry, academic and entertainment sectors. Marketed under the Phantom® brand, our cameras allow you to analyze physical phenomena when it's too fast to see, and too important not to™. Please visit www.phantomhighspeed.com for additional information.

Xcitex is an innovator in the industries of motion analysis and video-based motion capture. ProAnalyst® is the world's leading software for extracting ("tracking"), analyzing, and presenting motion from pre-recorded video. MiDAS DA software combines and synchronizes data from a variety of sensors with your high-speed video.

HYATT REGENCY JACKSONVILLE - 2ND FLOOR



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