

87th

Shock and Vibration Symposium

New Orleans | October 17-20, 2016



SEMI-FINAL CONFERENCE PROGRAM—UPDATED 10/06/16



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Introduction

Welcome to New Orleans and the 87th 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



SILVER LEVEL CORPORATE SUPPORTERS



BRONZE LEVEL CORPORATE SUPPORTERS



87th Shock and Vibration Symposium Committee*

Edward Alexander (BAE Systems)
 Vesta Bateman (Consultant)
 Jeff Cipolla (Weidlinger Associates)
 Rick Coffman (Northrop Grumman)
 Matthew Davis (HII—NNS)
 Sal Detroit (National Technical Systems)
 Bill Gregory (Applied Physical Sciences)
 Becky Grisso (NSWC Carderock)**
 Greg Harris (NSWC Indian Head)
 Kurt Hartsough (NAVSEA Philadelphia)
 Tony Keller (Spectral Dynamics)
 Alan Klembczyk (Taylor Devices)
 Jamil Lahham (Northrop Grumman)

Brian Lang (NSWC Carderock)**
 Gary Marraccini (Spectral Dynamics)
 Thomas Moyer (NSWC Carderock)**
 James O'Daniel (US Army ERDC)
 Drew Perkins (SAVE/HI-TEST)
 John Pryzbysz (IDA)
 Ashley Shumaker (SAVE/HI-TEST)
 Ernie Staubs (Air Force Research Laboratory)
 Lauren Yancey (HI-TEST Laboratories)

**TAG members in attendance at summer meeting for 87th S&V program review (held at NSWC Carderock)*

***NSWC Carderock hosts*

MONDAY, OCTOBER 17	TUTORIALS	8:00AM—7:00PM	P. 5-6
	WELCOME RECEPTION	6:30PM—8:30PM	P. 7
TUESDAY, OCTOBER 18	TUTORIALS	8:00AM—11:00AM	P. 8
	GENERAL SESSION 1 & AWARDS LUNCHEON	11:00AM—1:00PM	P. 9
	TECHNICAL PAPER SESSIONS & TRAININGS (AFTERNOON)	1:00PM—6:00PM	P. 10-13
WEDNESDAY, OCTOBER 19	TECHNICAL PAPER SESSIONS & TRAININGS (MORNING)	8:00AM—Noon	P. 14-17
	GENERAL SESSION 2 & EXHIBITORS' LUNCHEON	Noon—1:30PM	P. 17
	TECHNICAL PAPER SESSIONS & TRAININGS (AFTERNOON)	1:30PM—3:30PM	P. 18-19
	TUTORIALS	3:30PM—6:30PM	P. 22
	SYMPOSIUM SOCIAL/DINNER 100% HOSTED BY SPONSORS	7:00PM—10:00PM	P. 23
THURSDAY, OCTOBER 20	TECHNICAL PAPER SESSIONS & TRAININGS (MORNING)	8:00AM—Noon	P. 24-27
	S&V TAG COMMITTEE MEETING	1:00PM—2:30PM	P. 27
ABSTRACT BOOK	ABSTRACTS FOR ALL PAPER/PRESENTATION SESSIONS	-	COMING SOON

INTERNET CAFE	
<i>Room: Crescent</i>	
Monday, Oct 17	9AM—8PM
Tuesday, Oct 18	7AM—8PM
Wednesday, Oct 19	7AM—8PM
Thursday, Oct 20	7AM—Noon

EXHIBIT HALL SCHEDULE (Napoleon Ballroom) (Exhibitors Listed on Pages 28-35)		
Monday, Oct 17	<i>Setup</i>	<i>Noon—6:00PM</i>
	Pre-Reception	6:30PM—7:15PM
Tuesday, Oct 18	Exhibit Hall Open	7:00AM—5:00PM
	Awards Luncheon & Speaker	11:00AM—1:00PM
	Session Break—PM	3:00PM—3:40PM
Wednesday, Oct 19	Exhibit Hall Open	9:00AM—2:00PM
	Session Break—AM	9:45AM—10:15AM
	Exhibitors' Luncheon & Speaker	12:00PM—1:30PM
	Raffle & Dessert Break	1:10PM—1:30PM
	<i>Dismantle</i>	<i>2:00PM—5:00PM</i>

REGISTRATION	
<i>Room: Southdown</i>	
Monday, Oct 17	7AM—6PM
Tuesday, Oct 18	7AM—6PM
Wednesday, Oct 19	7AM—6PM
Thursday, Oct 20	7AM—NOON

FOOD & BEVERAGE EVENTS

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

Monday, October 17

- Pre-Reception (w/ Beverages & Snacks) 6:30pm—7:15pm Napoleon Ballroom (Exhibit Hall)
- Reception (w/ Beverages & Heavy Hors d'oeuvres) 7:15pm—8:30pm Waterbury Ballroom

Tuesday, October 18

- Continental Breakfast 7:00am—8:30am Napoleon Ballroom (Exhibit Hall)
- Awards Luncheon 11:00am—1:00pm Napoleon Ballroom (Exhibit Hall)
- Ice Cream Social (sponsored by HBM) 3:00pm—3:40pm Napoleon Ballroom (Exhibit Hall)

Wednesday, October 19

- Continental Breakfast 7:00am—8:30am Napoleon Ballroom (Exhibit Hall)
- Exhibitors' Luncheon 12:00pm—1:30pm Napoleon Ballroom (Exhibit Hall)
- Symposium Social/Dinner 7:00pm—10:00pm House of Blues

Thursday, October 20

- Continental Breakfast 7:00am—8:30am Fourth Floor Foyer



Welcome Reception

Monday, Oct. 17

6:30pm—7:15pm • Napoleon Ballroom (Exhibit Hall) w/ Beverages and Snack

7:15pm—8:30pm • Waterbury Ballroom w/ Beverages and Heavy Hors d'oeuvres

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

Tuesday, Oct. 18 • 11:00am—1:00pm • Napoleon Ballroom (Exhibit Hall)

General Session 2: Exhibitors' Luncheon w/ Keynote Speaker

Wednesday, Oct. 19 • 12:00pm—1:30pm • Napoleon Ballroom (Exhibit Hall)

Sponsored by: 87th Shock & Vibration Symposium Exhibitors

Symposium Social/Dinner at House of Blues

Wednesday, Oct. 19 • 7:00pm—10:00pm • House of Blues

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

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

~ CHOOSE ONE / ADDITIONAL FEES APPLY TO ATTEND ~

MIL-S-901D Shock Qualification Testing

Meeting Room: Bayside A

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

The Naval Surface Warfare Center Carderock Division Philadelphia (NSWCCD-SSES) Code 669 is NAVSEA 05P1's Delegated Approval Authority (DAA) for MIL-S-901D Surface Ship Shock. As the DAA, Code 669 engineers are responsible for review and approval of all Government Furnished Equipment (GFE) and heavyweight shock tested equipment. NSWCCD Code 669 will be presenting the requirements for shock qualification testing as detailed in MIL-S-901D and interpreted by NAVSEA 05P1. Shock testing theory, MIL-S-901D shock test devices and facilities, detailed specification requirements, cost avoidance and clarification and MIL-S-901D 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.

Principles of Acoustic Loads Origins, Effects and Simulation

Meeting Room: Gallier A/B

Mr. Zeev Sherf (Consultant)

The tutorial will cover the following topics:

- Acoustic Noise Sources
 - Rocket Motor Noise
 - Aerodynamic noise
 - Propeller Engine Noise
- Brief description of the principles of Acoustic Noise Interaction with Structures
- Effects of Acoustic Noise on:
 - Structures
 - Electronics
 - Simulation Methods of Acoustic Noise
 - *Progressive Wave Tube
 - *Reverberant Noise Chamber

Effective Solutions for Shock and Vibration Control

Meeting Room: Bayside B

Mr. Alan Klembczyk (Taylor Devices) & Mr. Herb LeKuch (Consultant)

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-S-901D 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.

9:00-
Noon

(For SAVE Staff Internal Use Only) CN Meeting Reserve

Meeting Room: Bayside C

TUTORIAL SESSION 2 / 12:00pm—3:00pm

~ CHOOSE ONE / ADDITIONAL FEES APPLY TO ATTEND ~

MIL-S-901D Shock Qualification Testing Extensions**Meeting Room: Bayside A**

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

The Naval Surface Warfare Center Carderock Division Philadelphia (NSWCCD SSES) Code 669 is NAVSEA 05P1's Delegated Approval Authority (DAA) for MIL-S-901D Surface Ship Shock. As the DAA, Code 669 engineers are responsible for review and approval of all Government Furnished Equipment (GFE) and heavyweight shock tested equipment. NSWCCD Codes 669 will be presenting the requirements for shock qualification extensions as detailed in MIL-S-901D and interpreted by NAVSEA 05P1. Shock extension specification requirements, MIL-S-901D 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.

Mechanics of Laminated Composites**Meeting Room: Bayside B**

Dr. E. Thomas Moyer (NAVSEA Carderock)

Structures constructed using Laminated Composite Materials are, today, common place in application with examples in Aerospace application (e.g. satellites, aircraft structures, etc.), Landside applications (e.g. automobiles, building structures, etc.) as well as Maritime applications (e.g. ships, boats, off shore structures, etc.). This tutorial will discuss the theoretical and practical elements of the Mechanics of Laminated Composites and application to structural design. Topics include:

- Overview Of Laminated Composite Materials
- Lamina Theory
- Laminate Theory
- Lamina and Laminate Strength & Failure Prediction
- Laminated Composite Joints + Sandwich Laminates
- Effects Of Geometric Nonlinearities

Introduction to Pyroshock Testing**Meeting Room: Gallier A/B**

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.

A Primer on Explosion Effects in the Air, Water, and Soil**Meeting Room: Edgewood A/B**

Dr. Bob Welch (Consultant)

The effects of detonations from high explosives have unfortunately become a challenge for the civilian as well as the military community. This tutorial provides basic information about explosions for the practicing engineer. Blast effects phenomena associated with explosions in air, water, and geologic media are described. Hopkinson scaling relations are discussed that dictate how explosion effects scale with charge size and distance. Simple equations are given that predict blast field parameters in water, air, and soil as a function of charge weight and range. Explosion-induced cratering phenomena in soil and rock are described and predictive graphs provided. Airblast reflection phenomena at rigid interfaces are covered and relationships that quantify the reflected waves as a function of incident pressure and incident angle are given. Airblast inside tunnels from high explosive detonations is discussed. Single-degree-of-freedom (SDOF) model for the response of equipment inside structures is presented. The tutorial material is taken from unclassified Corps of Engineers technical manuals, classical literature and papers on the subject, and the author's research experience.

1:30-3:30

DTE 022 Meeting: MIMO Recommended Practice Committee**Meeting Room: Bayside C**

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.

TUTORIAL SESSION 3 / 4:00pm—7:00pm

~ CHOOSE ONE / ADDITIONAL FEES APPLY TO ATTEND ~

MIL-S-901D Subsidiary Component Shock Testing & Alternate Test Vehicles

Meeting Room: Bayside A

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

The MIL-S-901D 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-S-901D Testing and particularly MIL-S-901D Extensions offered by the same instructors (Urzillo and Kurt Hartsough).

Beyond the Shock Response Spectrum

Meeting Room: Edgewood A/B

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 made 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.

Statistical Analysis in Random Vibration and Mechanical Shock using the Bootstrap

Meeting Room: Bayside B

Dr. Thomas Paez (Paez Consulting)

A critical element of test specification in random vibration and mechanical shock is the determination of the likelihood that the environment specified might be surpassed in nature. A second factor in test specification when the structure to be excited is known and the test time history is to be specified, is determination of an input that yields a specific probability of non-exceedance. (A simple example of when structure behavior is known occurs when the structure is approximately linear and, either it can be tested in the laboratory or a validated finite element model of the structure is available. A test can be specified with a time history when the test is transient – a nonstationary random vibration or shock – and waveform replication is used to execute the test. The probability of non-exceedance is the chance that a measure of the response will not exceed a pre-established level.)

The bootstrap is a modern, data intensive method for statistical analysis that is useful for consideration of phenomena that arise from non-Gaussian sources and/or for measures of behavior that are nonlinear and non-quadratic functions of the data. (A statistic like the sample mean is a linear function of measured data; quantities like the mean square and spectral density are quadratic measures of source behavior.) Many shock, and stationary and nonstationary random vibration sources are non-Gaussian; many of the quantities of interest to us are nonlinear and non-quadratic. For example, the modal frequencies and mode shapes of a stochastic structure are nonlinear and non-quadratic.

This course provides a brief review of the classical approach to statistical estimation and analysis. It follows with an introduction to the bootstrap that includes elementary examples. Bootstrap analysis of the spectral density of a stationary random environment and the shock response spectrum of a shock environment are analyzed. Finally, a method for selecting a transient environment with pre-established probability of non-exceedance is presented.

During the course of the presentation, the ideas of the kernel density estimator (for estimation of the probability density function of a random source) and the Karhunen-Loeve expansion (for the efficient expression of nonstationary random processes and non-homogeneous random vectors) are developed and used.

Quantitative Methods for High-G Electronics Design

Meeting Room: Gallier A/B

Dr. Jacob Dodson & Dr. Janet Wolfson (AFRL), Dr. Ryan Lowe (Applied Research Associates)

The design of high-g electronics remains more of an art than a science. Ensuring the correct operation of an electronics assembly undergoing dynamic loading can be challenging in practice. This tutorial will introduce quantitative methods useful for the design and evaluation of high-g electronics. This tutorial will focus on the design of electronics with loadings that result from a sudden change in velocity (velocity shock). In general the presented methods were developed for applications with accelerations greater than 10,000 g. Emphasis will be placed on the mechanical and thermal aspects of the design process.

The tutorial presentation will be **Distribution D**. Specifics about electrical components and their survivability in laboratory scale testing will be discussed. Weapon systems, their electrical components, and their high-g performance will not be discussed at the tutorial. A list of attendees will be collected during the presentation. Co-authors can choose to share none, some, or all of their presentation materials with attendees.



Welcome Reception

Monday, Oct. 17 • 6:30pm—8:30pm

6:30pm-7:15pm in Napoleon Ballroom (Exhibit Hall) / 7:15pm-8:30pm in Waterbury Ballroom

TUTORIAL SESSION 4 / 8:00am—11:00am

~ CHOOSE ONE / ADDITIONAL FEES APPLY TO ATTEND ~

The Measurement & Utilization of Valid Shock and Vibration Data

Meeting Room: Borgne

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 provide 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.

MIL-S-901D Cost Avoidance and Clarification Letters-Explained

Meeting Room: Bayside A

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

In November of 2012, NAVSEA 05P1, the Shock Technical Warrant, issued three MIL-S-901D Cost Avoidance and Clarification letters. The intent of these letters was to clarify areas of MIL-S-901D, reduce the occurrence of repeat testing and normalize the amount of testing required for Lightweight, Medium Weight and Floating Shock Platform testing. 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-S-901D Engineering Topics

Meeting Room: Gallery

Mr. Domenic Urzillo (NAVSEA Philadelphia)

MIL-S-901D Engineering topics is a follow-on course to the MIL-S-901D 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-S-901D testing, digital data filtering, shock response frequency, shock test fixture design fundamentals and FSP deck simulation fixtures.

Understanding Aliasing, FFT, Filtering, SRS/PVSS for FEA/ Test Engineers

Meeting Room: Maurepas

Dr. Ted Diehl (Bodie Technology)

This three hour seminar covers, in the language of Mechanical Engineering, Digital Signal Processing (DSP) theory and its application to analyzing challenging transient problems (shock, impact, and other nonlinear, noisy problems). A key focus of the course is obtaining credible correlation and improved interpretation between physical test data and transient simulation data derived from FEA software or similar programs (LS-Dyna, Abaqus/Explicit, Radioss, DOE & DOD codes, ...). The presentation explains best practices for working with noisy data and offers many tips to avoid mistakes in data collection and analysis that result in distorted data and incorrect conclusions. One aspect that is often underappreciated is the importance of properly using (DSP) in the collection and processing of BOTH the test and simulation data. Users of explicit dynamics codes compute transient solutions with constantly varying time increments that typically contain significant "solution noise" in addition to the expected "frequency-rich" content created by severe impacts, shocks, failure, etc. This complexity along with other undesirable effects such as aliasing (an often unseen mistake made by the simulation community), numerical stability of DSP algorithms, and filter-induced distortions, can make it very difficult to obtain accurate correlation between simulations and tests. The best approach to achieve success is for both the simulation analyst and the test engineer to understand key concepts of DSP and how to apply them to mechanical engineering problems.

The seminar covers time-domain and frequency domain analysis (DFS, FFT, PSD); data collection (sampling, aliasing, up-sampling, decimation); filtering (lowpass, highpass, IIR, FIR, cascaded vs non-cascaded, numerical stability, and filter-induced distortions), calculating Shock Response Spectrum (SRS and PVSS) from transient data, and numerous unique aspects related to explicit dynamics FEA data (non-constant time increments, massively over-sampled data, short transient signals with non-zero end conditions, ...). Along with a review of the underlying theory, the seminar presents practical applications that demonstrate concepts and also shows how different DSP software products process this class of challenging data.

Application of Engineering Fundamentals in Solving Shock and Vibration Problems

Meeting Room: Bayside C

Mr. Fred Costanzo (Engineering Consultant, LLC & NAVSEA Carderock/UERD, ret.)

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 in the form of a Python script is developed and presented. Next, a solution is generated and the results are illustrated and discussed.

General Session 1 incl. Elias Klein Lecture & Awards Luncheon

11:00am—1:00pm / Napoleon Ballroom (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. Alan Klembczyk (Taylor Devices)
11:10am—11:50am	Elias Klein Lecture - “How Shock and Vibration Technology Saves Lives from Earthquake Disaster” by: Dr. Kit Miyamoto
11:50am—12:20pm	Buffet Lunch
12:20pm—12:30pm	Lifetime Achievement Award - Mr. W. Scott Walton presented by: Dr. Vesta Bateman
12:30pm—12:40pm	Lifetime Achievement Award (TBD)
12:40pm—12:50pm	Henry Pusey Best Paper Award Winner - “6 Degree of Freedom Shock and Vibration: Testing and Analysis” presented to: Dr. Brian Owens, Dr. Gregory Tipton, and Mr. Matthew McDowell (Sandia National Labs)

Elias Klein Lecturer—Dr. Kit Miyamoto

H. Kit Miyamoto, Ph.D., S.E., leads Miyamoto International, a global earthquake structural engineering company, Miyamoto Global Disaster Relief, a non-profit technical organization, and is a California Seismic Safety Commissioner. Dr. Miyamoto was the recipient of the National Council of Structural Engineers Association's Excellence in Structural Engineering Award, ENR Best Global Projects Award and ASCE Humanitarian Award. He is a Fellow of American Society of Civil Engineers. He specializes in high-performance earthquake engineering, disaster mitigation, response and reconstruction.

Dr. Miyamoto is an expert consultant to the World Bank projects globally, including a seismic risk mitigation project for 2,000 schools in Istanbul. In the 2010 Haiti earthquake, he worked with the government of Haiti, UN, USAID and various NGOs to conduct damage assessments of more than 430,000 earthquake-damaged structures and rebuild more than 12,000 buildings. He is currently involved with earthquake reconstruction in Nepal, where his team has completed over 1,000 assessments and is retrofitting severely damaged schools, monasteries and high-rise buildings using high-performance engineering.

Dr. Miyamoto holds graduate degrees from the Tokyo Institute of Technology and California State University, where he has been recognized as a Distinguished Alumni. Dr. Miyamoto has published more than 100 technical papers. He has been featured by CNN, NBC, ABC, CBS, PBS, the Discovery Channel, the New York Times and Rolling Stone.

Lifetime Achievement Award Winner(s)

This Lifetime Achievement Award is presented to **W. Scott Walton** in recognition of his fundamental, pioneering contributions to the ballistic shock and air blast knowledge base. His innovative ballistic measurements define the ballistic shock environment and are the basis for numerous standards including MIL-STD-810, Method 522 for Ballistic Shock, adopted worldwide.

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

Abstract of “6 Degree of Freedom Shock and Vibration: Testing and Analysis”...

Six degree of freedom (DOF) shock and vibration testing provides an avenue for improved mechanical qualification of a system or component. Six DOF testing allows for application of a test input that is more representative of actual operational environments. Thus, 6 DOF testing allows for a more meaningful stress state to be excited in a test article. Furthermore, 6 DOF analysis should be considered as a critical companion to 6 DOF testing. 6 DOF analysis is an invaluable tool to improve 6 DOF testing methodologies and recover unmeasured quantities (i.e. stress) from associated test inputs. This paper presents a combined experimental and analytical study of 6 DOF shock and vibration. The theory of 6 DOF analysis is presented, important considerations are discussed, and key differences between traditional single-axis and 6 DOF testing and analysis approaches are highlighted.

TUESDAY PM (OCTOBER 18)

	SESSION 1 UNDEX I 1:00pm-3:00pm / Unlimited Dist. A Chair(s): Dr. Thomas Moyer (NSWC Carderock) Mr. Brian Lang (NSWC Carderock)	SESSION 2 Instrumentation 1:00pm-3:00pm / Unlimited Dist. A Chair(s): Mr. Robert Sill (PCB Piezotronics) Dr. Jon Yagla (NSWC Dahlgren)	SESSION 3 Blast Testing 1:20pm-2:50pm / Unlimited Dist. A Chair(s): Mr. Ernie Staubs (Air Force Research Lab) Mr. Vince Chiarito (US Army ERDC)
<i>All Presenters and Chairs (for Oct 18) are Required to Meet at 7:00AM in Borgne for Presentation Loading</i>			
	<i>Meeting Room: Bayside A</i>	<i>Meeting Room: Bayside B</i>	<i>Meeting Room: Maurepas</i>
1:00	Underwater Shock Wave Propagation in a Littoral Environment Dr. Giovanni Fusina, Dr. Craig Burrell, & Dr. Julian Lee (Defence R&D Canada)	Embedded Surface Mount Triaxial Accelerometer Mr. Robert Sill (PCB Piezotronics)	
1:20	Bubble-Induced Whipping Motion in a Floating Structure Dr. Julian Lee, M.J. Smith, & D. Roseveare (Defence R&D Canada), E. Van Daelen (TNO)	An Automated Method to Identify Outlier Sensor Response Ms. Angela Montoya, Mr. Vit Babuska, Ms Melissa C' de Baca, & Mr. Jason Booher (Sandia National Laboratories)	Soil Effects on Blast Intensity Dr. James Eridon (General Dynamics Land Systems)
1:40	Comparative Study on Shock Response Analysis with UNDEX Experimental Data using Down Scale Ship Model (II) Dr. Jeong-Il Kwon, Dr. Jung-Hoon Chung, Dr. Seok-Jun Moon, & Mr. Jin-Woo Park (Korea Institute of Machinery & Materials), Dr. Jong-ahn Jeong (Super Century Co., Ltd.)	Cross Axis Correction of Acceleration Data Dr. Jon Yagla (NSWC Dahlgren)	Blast Effects on Concrete Perimeter Barriers Cpt. Geoff Dinneen, C. S. Stephens, O. G. Flores, & W. Vanadit-Ellis (US Army ERDC)
2:00	Interaction Tools for Underwater Shock Analysis in Naval Platform Design Mr. Johannes E. van Aanhold, Dr. Johan T. Tuitman, & Mr. Willem Trouwborst (TNO, the Netherlands), Mr. Johannes A.A. Vaders (Ministry of Defence, Defence Material Organisation, the Netherlands)	Six Degree of Freedom Shockwave Monitoring Dr. Laura Jacobs & Dr. Avery Cashion (Sandia National Laboratories)	Blast-Resistant Response of Nail-Laminated Timber Mr. Mark Weaver (Karagozian & Case, Inc)
2:20	MIL-S-901 Land Based Shock Testing Machine Simulation for Elastically Supported Equipment Mr. Claude Prost (Vibro Dynamics)	Equipment Qualifications for Dynamic Materials Testing to Blast Testing Mr. Mike Hoyer (HBM Test and Measurement)	High Speed Fiber Optic FBG Strain Sensor for Acquiring High Shock Strain Response Mr. Vince Chiarito (US Army ERDC)
2:40	Submarine Component Design Tool to Assess Relative Resistance to Shock Loading Mr. Justin Caruana & Mr. David Batol (Cardinal Engineering), Dr. Jeffrey Cipolla (Thornton Thomasetti—Weidlinger Assoc.)	Ultra Miniature Shock and Vibration Product Development Testing Mr. Kevin Westhara (Dytran)	*Multiple Degree of Freedom Blast Effects Simulator (MDOF-BES) Mr. Robert Kargus & Mr. Justin Pritchett (Army Research Laboratory)



ICE CREAM SOCIAL
3:00PM - 3:40PM

	<p>SESSION 4</p> <p>Structural Dynamics Testing & Analysis 1:00pm-3:00pm / Limited Dist. D</p> <p>Chair(s): Mr. Jeffrey Averett (US Army ERDC)</p>	<p>VENDOR SESSION A</p> <p>Exhibitor Presentations including: Product and/or Service Overviews, Product Demos, & New Developments & Technologies 1:00pm-3:00pm / Unlimited Dist. A</p> <p>Chair(s): Mr. Sean Murphy (Huntington Ingalls Industries) Mr. Sal Detruit (National Technical Systems)</p>	<p>TRAINING</p> <p>Tips for Successful MIL-S-901D Shock Qualification 1:00pm-1:45pm / Unlimited Dist. A</p> <p>DDAM-Coupled Optimization Methods 2:00pm-3:00pm / Unlimited Dist. A</p>
<p><i>All Presenters and Chairs (for Oct 18) are Required to Meet at 7:00AM in Borgne for Presentation Loading</i></p>			
	<p><i>Meeting Room: Borgne</i></p>	<p><i>Meeting Room: Bayside C</i></p>	<p><i>Meeting Room: Gallery</i></p>
<p>1:00</p>	<p>Simulating Penetration and Perforation of Different Concrete Targets Dr. Jennifer Cordes, Mr. David W. Geissler, & Mr. Pavol Stofko (US Army Picatinny Arsenal)</p>	<p>1:00 "Introduction to Laser Doppler Vibrometry—A Non-Contact Vibration Measurement Technique" <i>presented by: John Foley</i></p> 	<p>Tips for Successful MIL-S-901D Shock Qualification 1:00pm-1:45pm Mr. Calvin Milam (NTS—Rustburg)</p>
<p>1:20</p>	<p>Dynamic Fatigue Testing of Breech Assemblies with Low Plasticity Burnishing Mr. David Alfano, Jr. (Benet Labs - ARDEC)</p>	<p>1:15 "Analyzing ODS's with DIC" <i>presented by: Bluejay Robinson</i></p> 	<p>This training will highlight the importance of selecting the appropriate test type (lightweight shock, medium weight shock, DSSM, heavy-weight shock, DDAM or qualify by extension). Next, the importance of procedure development and approval will be discussed including topics such as selecting the appropriate deck frequency, the importance of the SRF for class II equipment and the need for appropriate operational pass/fail criteria. The final topic for discussion will cover common failure modes and pitfalls to avoid.</p>
<p>1:40</p>	<p>Simulation of High-Velocity Penetrator into Ultra-High-Performance Concrete Using the Lagrangian Finite Element Code ParaDyn Mr. Robert Browning, Dr. Jesse Sherburn, Dr. Jason Roth, & Dr. Michael Hammons (US Army ERDC)</p>	<p>1:30 "HBM Sensors, Testing, Analysis, & Simulation Solutions" <i>presented by: Mike Hoyer</i></p> 	
<p>2:00</p>	<p>M&S of Probable Effects Modeling of Infrastructure Components Dr. George Lloyd & Mr. Ryan Schnalzer, (ACTA Inc.), Mr. Randy Anderson & Ms. Diane Verner (Applied Research Associates)</p>	<p>1:45 "Vibro/Dynamics Overview" <i>presented by: Claude Prost</i></p>  <p>2:00 "Huntington Ingalls Industries Overview" <i>presented by: Sean Murphy</i></p> 	<p>DDAM-coupled Optimization Methods 2:00pm-3:00pm Mr. Leo Jeng (Altair Engineering)</p>
<p>2:20</p>	<p>Finding and Defining Mechanical Environment Requirements for Ground Penetrating Weapons Mr. Alma Oliphant, Mr. John Perry, Mr. Justin Bruno, Mr. Craig Doolittle, Mr. Drew Malecuk, Ms. Ericka Amborn (Applied Research Associates), Mr. Russ Klug (AFLCMC/EBD)</p>	<p>2:15 "National Technical Systems Overview" <i>presented by: Sal Detruit</i></p>  <p>2:30 "Dayton T. Brown Inc. Overview" <i>presented by: Haim Gurewich</i></p> 	<p>In this workshop, the focus will be on optimizing DDAM simulations. The solver-neutral DDAM utility in HyperMesh will be used to illustrate how you can prepare your finite element models more effectively regardless of your choice of solver. In addition, an analysis will be run using OptiStruct to provide both the initial DDAM analysis and topology, size, and shape optimization as well to improve the performance of the model under DDAM shock simulation conditions. Post-processing of the analysis and optimization will be completed using HyperView and HyperGraph.</p>
<p>2:40</p>	<p>Characterization of Fragment Impacts from Propelled Munitions Dr. Kyle Crosby, Mr. Cameron Thomas, Dr. Jay Ehr Gott, & Mr. Denis Rickman (US Army ERDC)</p>	<p>2:45 "Spectral Dynamics Inc. Overview" <i>presented by: TBD</i></p> 	

TUESDAY PM (OCTOBER 18)

	SESSION 5	SESSION 6	SESSION 7
	Structural Response, to Mechanical Shock or Vibration, with Special Applications 4:00pm-5:00pm / Unlimited Dist. A Chair(s): Dr. Bryan Joyce (University of Dayton)	Vibration Analysis & Solutions 3:40pm-5:20pm / Unlimited Dist. A Chair(s): Mr. Alan Klembczyk (Taylor Devices)	UNDEX Analysis: Modeling 3:40pm-5:20pm / Limited Dist. C 5:20pm-5:40pm / Unlimited Dist. A Chair(s): Mr. Rick Griffen (HII - Newport News Shipbuilding)
<i>All Presenters and Chairs (for Oct 18) are Required to Meet at 7:00AM in Borgne for Presentation Loading</i>			
	<i>Meeting Room: Bayside A</i>	<i>Meeting Room: Bayside B</i>	<i>Meeting Room: Maurepas</i>
3:40		Performance Characteristics of a Vibration Integrated Shock Isolation System Mr. Mark Downing, Mr Eric Peiffer, & Mr. John Paner (ITT Enidine)	The Response of Composite Cylinders Subjected to Near Field Underwater Explosions Dr. Erin M. B. Gauch (NUWC Newport)
4:00	Modeling and Simulation of an Electronics Assembly Responding to Drop Test Mr. Miroslav Tesla & Dr. Jennifer Cordes (ARDEC US Army), Dr. Janet Wolfson (Air Force Research Laboratory)	Ten Year Case Study on the Long-Term Performance of Hermetically Sealed Fluid Viscous Dampers under Nearly Continuous Forced Vibration in an Unprotected Marine Environment Mr. Alan Klembczyk (Taylor Devices)	FSP Deck Simulator Fixture Mode-1 Design Spectra Mr. Rick Griffen & Dr. Michael Talley (HII-Newport News Shipbuilding)
4:20	Complexities of Performing Coordinate Transforms on Dynamic Structures Mr. Prenn Tran (NSWC Dahlgren)	Adjustment of Vibration Response to Account for Fixture-Test Article Dynamic Coupling Effects Mr. Jesus Reyes & Dr. Peter Avitabile (University of Massachusetts Lowell)	FSP Deck Simulator Fixture Mode-3 Design Spectra Mr. Rick Griffen (HII-Newport News Shipbuilding)
4:40	Ship Foundation Optimized for DDAM Shock Conditions Mr. Leo Jeng (Altair Engineering)	Use of Wire Rope Isolators for Tuned Mass Dampers on Chimneys Mr. Claude Prost (Vibro Dynamics)	Analysis of Discretization Error on Shock Loading in Eulerian UNDEX Analyses Using DYSMAS/FD Mr. Nicholas Reynolds, Dr. John Gilbert, & Dr. Erwin T. Moyer (NSWC Carderock)
5:00		Simulation of High Frequency Random Vibration Test Mr. Richard Jones (Honeywell FM&T)	Progress on Verification and Acceptance of the Residual Mass DDAM Mr. Rick Griffen (HII-Newport News Shipbuilding)
5:20			Simplified Exodus II/ Sierra SD Model Generation with Altair HyperMesh v14 Mr. Joshua Pennington (Altair Engineering)

SESSION 8	VENDOR SESSION B	TRAINING
<p>Explosive Detonations: Tunnel & Crater Applications 3:40pm-4:30pm / Limited Dist. D 4:40pm-5:20pm / Limited Dist. C</p> <p>Chair(s): Dr. Catie Stephens (US Army ERDC)</p>	<p>Exhibitor Presentations including: Product and/or Service Overviews, Product Demos, & New Developments & Technologies 3:45pm-5:30pm / Unlimited Dist. A</p> <p>Chair(s): Mr. Neil Donovan (Shock Tech) Ms. Jennifer MacDonell (Meggitt)</p>	<p>Introduction to Medium Weight & Lightweight Shock Testing 3:40pm-5:40pm / Unlimited Dist. A</p>
<p><i>All Presenters and Chairs (for Oct 18) are Required to Meet at 7:00AM in Borgne for Presentation Loading</i></p>		
<p><i>Meeting Room: Borgne</i></p>	<p><i>Meeting Room: Bayside C</i></p>	<p><i>Meeting Room: Gallery</i></p>
<p>3:40 Inserting ERDC Geomaterial Models into SIERRA/SM: Applications in Impact Simulations with Zapotec 3 Dr. Ramon Moral, Dr. Laura Walizer, Dr. Stephen Akers, Dr. Jesse Sherburn, Dr. Mark Adley, & Dr. Andreas Frank (US Army ERDC), Dr. Arne Gullerud & Mr. Timothy R. Shelton (Sandia National Labs)</p>	<p>3:45 "Video Capture & Motion Analysis Solutions"  <i>presented by: Patrick Hope</i></p> <p>4:00 "Multi-Measurement Capabilities of the Abacus 901 Vibration Controller"  <i>presented by: Tom Reilly</i></p> <p>4:15 "Shock Tech Overview"  <i>presented by: Neil Donovan</i></p> <p>4:30 "Dytran Instruments Overview"  <i>presented by: Kevin Westhora</i></p> <p>4:45 "Meggitt Product Overview"  <i>presented by: Jennifer MacDonell</i></p> <p>5:00 "When You Need Data Fast...and You Won't Compromise on Accuracy"  <i>presented by: Stephen Hanly</i></p> <p>5:15 "ITT Overview"  <i>presented by: TBD</i></p>	<p style="text-align: center;">Introduction to Medium Weight & Lightweight Shock Testing</p> <p style="text-align: center;">3:40pm – 5:40pm Mr. Braden O'Meara (HI-TEST Laboratories)</p> <p>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. MIL-S-901D test requirements applicable to medium weight shock testing will be discussed.</p>

WEDNESDAY AM (OCTOBER 19)

	SESSION 9 Vibration: Transportation & Flight 8:20am-9:40am / Unlimited Dist. A Chair(s): Mr. Jerome Cap (Sandia National Labs)	SESSION 10 Structural Response & Testing 8:00am-9:30am / Unlimited Dist. A Chair(s): Mr. David Hogg (Air Force Research Laboratory)	SESSION 11 Blast: Near-field 8:00am-8:30am / Limited Dist. D 8:40am-9:00am / Limited Dist. C Explosive Countermeasures 9:00am-9:30am / Limited Dist. C Chair(s): Mr. Robert Browning (US Army ERDC)
<i>All Presenters and Chairs (for Oct 19) are Required to Meet at 7:00AM in Borgne for Presentation Loading</i>			
	<i>Meeting Room: Gallery</i>	<i>Meeting Room: Bayside A</i>	<i>Meeting Room: Maurepas</i>
8:00	<i>Open Presentation Slot</i>	Developing, Verifying, and Validating Variable Axial Loading in Thick Walled Pressure Vessels Mr. Lucas Smith (Benet Laboratories)	Near-Field Airblast Characterization of Homemade Explosives Dr. Andreas Frank, Mr. Garrett Doles, & Dr. Jay Ehrgott (US Army ERDC)
8:20	Creating a More Realistic Transport Handling Profile Mr. Andy Cogbill & Mr. Jade Vande Kamp (Vibration Research)	High-Strain Rate Testing of Ultra-High Performance Concrete with Flow-Induced Fiber Orientation Mr. Andrew Groeneveld & Dr. Tess Ahlborn (Michigan Technological University), Dr. C. Kennan Crane (US Army ERDC)	*Validation of the MINEX3D Code for Predicting Loads from Underbody Blast Mr. Micael Edwards, Mr. Greg Bessette, & Mr. Gustavo Emmanuelli (US Army ERDC)
8:40	Environmental Engineering Application in the Development of an Airborne System Mr. Uria Heller (RAFAEL)	The Dynamic Tensile Behavior and Dynamic Residual Strength after Fatigue of 321 Austenitic Stainless Steel at Intermediate Strain Rate Dr. Yilei Liu (Nuclear Power Institute of China)	Full-Scale Underbody Blast Experiments for Component Testing and Computational Simulation Validation Mr. Garrett Doles & Dr. Neil Williams (US Army ERDC)
9:00	Helicopter Vibration Measurement Analysis and Generation of Laboratory Vibration Simulation Programs Based on Energy Considerations Mr. Zeev Sherf, Y.Cohen, P. Hopstone, I. Sofer, & A. Elka (RAFAEL)	Bolt Behavior under Combined Tension and Shear: Tests Dr. Emily Guzas (NUWC Newport), Dr. Wes Trim (US Army ERDC)	Analysis of Cable Stayed Bridge Cable Protective Countermeasures Mr. Christopher Rabalais, Dr. C. Kennan Crane, & Mr. David Miller (US Army ERDC)
9:20	Aspects of Stationary and Non-stationary Flight Vibration Analysis, with Application to the Formulation of Vibration Simulation Programs Mr. Zeev Sherf, Y.Cohen, P. Hopstone, I. Sofer, & A. Elka (RAFAEL)	*Measurement of Dynamic Stiffness and Damping of Electric Cables for Shipboard Use Mr. Joseph Donovan (Northrop Grumman)	*Internal Retrofit Explosive Threat for Landmark Bridges Mr. Richard Bennett, Dr. Charles K. Crane, & Mr. Bob E. Walker (US Army ERDC)

(AB #) Abstract Book Page Number / * Short Presentation (10 min.)

Coffee Break in the Exhibit Hall
9:45am – 10:15am (Napoleon Ballroom)



SESSION 12	SESSION 13	VENDOR SESSION C
Vibration and Mechanical Shock Testing incl. Fixture Design 8:00am-9:00am/ Limited Dist. D 9:00am-10:00am / Limited Dist. C Chair(s): Mr. Troy Skousen (Sandia National Labs)	Evaluation of Accelerometers for Pyroshock Performance in a Harsh Field Environment 8:00am-10:00am / Unlimited Dist. A Chair(s): Dr. Patrick Walter (Texas Christian Univ. / PCB)	Exhibitor Presentations including: Product and/or Service Overviews, Product Demos, & New Developments & Technologies 8:00am-9:45am / Unlimited Dist. A Chair(s): Mr. Ray Deldin (Altair Engineering) Mr. Andy Cogbill (Vibration Research)
<i>All Presenters and Chairs (for Oct 19) are Required to Meet at 7:00AM in Borgne for Presentation Loading</i>		
<i>Meeting Room: Borgne</i>	<i>Meeting Room: Bayside B</i>	<i>Meeting Room: Bayside C</i>
8:00 Payload Integration MWSM Shock Testing: Fixture Design Dr. Emily Guzas, Ms. Monica Black, & Mr. Kevin Behan (NUWC Newport)	Technologies, Manufacturers, and Models Evaluated With Mounting Details Mr. Anthony Agnello (PCB Piezotronics, Inc.)	8:00 "TBD" " presented by: TBD 8:15 "Data Acquisition with DEWESoft"  presented by: Jake Rosenthal 8:30 "IMV Corporation Overview"  presented by: Shinichi Hirokawa 8:45 "Motion Analysis & Phantom High-Speed Cameras"  presented by: Dan Hafen
8:20 Payload Integration MWSM Shock Testing: Test Conduct Ms. Monica Black & Mr. Kevin Behan (NUWC Newport)	Test Configuration, Stimuli, and Observations Mr. Robert Sill (PCB Piezotronics)	9:00 "Altair Engineering Overview"  presented by: Ray Deldin
8:40 Refurbishment, Improvement, and Calibration of the WOX-7B Shock Machine with the Dahlgren Shipboard Shock Simulator Fixture Mr. Sloan Burns (NSWC Dahlgren)	Signal Conditioning and Digital Recording Considerations Dr. Patrick Walter (Texas Christian University/PCB Consultant)	9:15 "Innovator in Vibration Control"  presented by: Kevin Van Popering
9:00 Equipment on Deck Fixture Response Prediction With a 2-DOF Model Mr. Rick Griffen & Mr. Matt Davis (HII-Newport News Shipbuilding)	General Overview of Signal Conditioning Considerations for Pyroshock Measurements Mr. Alan Szary (Precision Filters)	9:30 "B&K Overview & New Product Introduction"  presented by: Dominic Acquarulo
9:20 Fixture Design for Improved Mechanical Shock and Vibration Testing Mr. Troy Skousen, Mr. Ronald N. Hopkins, & Dr. Brian C. Owens (Sandia National Laboratories)	Data Analysis Technique and Compilation Mr. Strether Smith (Independent Consultant), Dr. Patrick Walter (Texas Christian University / PCB Consultant)	
9:40 Torquing Strategies for Fixture Design Including Unit Placement and Temperature Affect Mr. Matthew Raymer & Mr. Thomas R. Bosiljevac (Sandia National Labs)	Conclusions of the Testing Mr. Anthony Agnello & Mr. Robert Sill (PCB Piezotronics), Mr. Strether Smith (Independent Consultant), Dr. Patrick Walter (Texas Christian University / PCB Consultant)	

(AB #) Abstract Book Page Number / * Short Presentation (10 min.)

Coffee Break in the Exhibit Hall

9:45am – 10:15am (Napoleon Ballroom)



WEDNESDAY AM (OCTOBER 19)

	SESSION 14 MIMO/SIMO Testing 10:20am-Noon / Unlimited Dist. A Chair(s): Mr. Tony Keller (Spectral Dynamics)	SESSION 15 Pyroshock & Ballistic Shock 10:20am-Noon / Unlimited Dist. A Chair(s): Dr. Vesta Bateman (Mechanical Shock Consulting)	SESSION 16 UNDEX & Implosion Analysis: Applications 10:20am-10:40am / Limited Dist. D 10:40am-Noon / Limited Dist. C Chair(s): Dr. Ken Nahshon (NSWC Carderock)
<i>All Presenters and Chairs (for Oct 19) are Required to Meet at 7:00AM in Borgne for Presentation Loading</i>			
	<i>Meeting Room: Bayside A</i>	<i>Meeting Room: Bayside B</i>	<i>Meeting Room: Maurepas</i>
10:00	<i>Mid-Morning Break Continues in Exhibit Hall (9:45am-10:15am)</i>		
10:20	Advances in MIMO Testing over the Past 2 Decades; From MIL-STD-810G to a Recommended Practice, RP Dr. Marcos Underwood, Mr. Russ Ayres, & Mr. Tony Keller (Spectral Dynamics, Inc.)	Understanding Sensor Limitations, Time Data Quality Checks, and Test Boundary Conditions During Pyroshock Testing Applications Mr. Giann Cornejo & Dr. Erik J. Wolf (Harris Corporation)	DYSMAS Simulations of the Response of Dam Structures to Blast Loading Mr. Roger Ilamni & Mr. James Warner (NSWC Indian Head)
10:40	On the Nature of Spectral Density Matrices used to Characterize Vibration Environments Dr. Luke Martin (NSWC Dahlgren)	Cylindrical Structure Pyroshock Test Data Mr. Alex Hardt (Orbital ATK)	Dynamic Response of Marine Mammal Lungs to UNDEX Loading Dr. Stephen Turner (NUWC Newport)
11:00	Defining the Error of Single and Multi-Axis Vibration Tests: A Move from Qualitative to Quantitative Metrics Dr. Garrett Nelson, Mr. Norman Hunter, & Mr. Kevin Cross (Sandia National Laboratories)	Reusable Rapid Prototyped Blunt Impact Simulator Mr. Douglas Petrick (US Army Research Laboratory)	Characterization of Black Powder Underwater Explosion Output Mr. Gregory Harris & Dr. Thomas McGrath (NSWC Indian Head), Mr. Kent Rye, Mr. William Lewis, & Dr. Kenneth Nahshon (NSWC Carderock)
11:20	Development of a Single Input Multiple Output (SIMO) Input Derivation Algorithm for Oscillatory Decaying Shocks Mr. Chad Heitman, Mr. Dylan Murphy, & Mr. Jerome Cap (Sandia National Laboratories)	Instrumentation for Local Accelerative Loading Mr. Christopher Monahan & Mr. Brandon Hepner (US Army Aberdeen Test Center), Mr. Jake Hawkins (CORVID Technologies), Mr. Robert Spink (U.S. Army Research Lab), Ms. Anne Purtell (MCSC SIAT)	Underwater Explosion Analysis of the HL Hunley Submarine Dr. Ken Nahshon (NSWC Carderock)
11:40	Derivation of Testing Conditions for Multi-Axis, Multi-Shaker Laboratory Vibration Simulation Mr. Zeev Sherf, Y.Cohen, P. Hopstone, I. Sofer, & A. Elka (RAFAEL)	Frequency Response Correction of MEMS Pressure Transducers & Accelerometers Dr. Adam Hurst, Mr. Andrew Bemis, & Mr. Steve Carter (Kulite Semiconductor Products, Inc.)	In-Tube Implosion: Experiments and Simulations Dr. Joseph M. Ambrico & Mr. Ryan E. Chamberlin (NUWC Newport)

	<p>SESSION 17</p> <p>DS: Electronic Components in Extreme Environments</p> <p>10:00am-11:00am / Limited Dist. D 11:00am-Noon / Limited Dist. C</p> <p>Chair(s): Capt. Haley Chow (Air Force Research Laboratory)</p>	<p>VENDOR SESSION D</p> <p>Exhibitor Presentations including: Product and/or Service Overviews, Product Demos, & New Developments & Technologies</p> <p>10:15am-Noon / Unlimited Dist. A</p> <p>Chair(s): Mr. Alan Klembczyk (Taylor Devices)</p>	<p>DISCUSSION GROUP</p> <p>Bolted Joint Design for Navy Shock</p> <p>10:20am-Noon / Unlimited Dist. A</p>
<p><i>All Presenters and Chairs (for Oct 19) are Required to Meet at 7:00AM in Borgne for Presentation Loading</i></p>			
	<p><i>Meeting Room: Borgne</i></p>	<p><i>Meeting Room: Bayside C</i></p>	<p><i>Meeting Room: Gallery</i></p>
10:00	<p>Finite Element Modeling and Experimental Evaluation of Electronics Packaging Strategies</p> <p>Mr. Matthew Neidigk, Dr. Jamie Kropka, & Mr. Shane Curtis (Sandia National Laboratories)</p>	<p>10:15 "TBD" " presented by: TBD</p> <p>10:30 "Bodie Technologies Overview" presented by: Ted Diehl</p> <p>10:45 "Taylor Devices Overview" presented by: Alan Klembczyk</p>	
10:20	<p>Recorder Technology and Instrumentation for Hard-Target Penetrations</p> <p>Mr. Curtis McKinion, Dr. Janet Wolfson, & Dr. Jacob Dodson (Air Force Research Laboratory), Dr. Alain Beliveau (ARA)</p>	<p>11:00 "Introduction of CODA To Reduce Overtesting" presented by: Dale Schick</p> <p>11:15 "Introduction of Model 350A43 Shock Accelerometer" presented by: Patrick Walter</p> <p>11:30 "The World's Highest Speed, High-speed Video Camera: iSPEED7 Series" presented by: Jonathan Hatton</p> <p>11:45 "HI-TEST Laboratories Overview" presented by: Mr. Jackson Snarr</p>	<p>Bolted Joint Design for Navy Shock: Issues & Concerns</p> <p>10:20am-Noon Host: Mr. James Jennings (NSWC Philadelphia)</p> <p>The Navy's design criteria for bolted joints under shock are known to be highly conservative, and have not been adequately or consistently converted into finite element analysis (FEA) criteria and models. Due to this, NSWCPCD is funded in FY2017 to identify issues and problems with Navy fastener and bolted joint shock design and to develop a roadmap for resolving these issues.</p> <p>NSWCPCD is kicking-off this effort with a discussion session at the 2016 Shock and Vibration Symposium. We want to open a dialog with the shock and vibration community about issues with bolted joint design for Navy shock applications, as well as make contact with people in the shock and vibration field outside of the Navy community.</p>
10:40	<p>Measuring the Dynamic Pressure Environment of an Embedded System in Extreme Environments</p> <p>Dr. Jacob Dodson, Mr. Curtis McKinion, Dr. Janet C. Wolfson (Air Force Research Laboratory), Dr. Alain Beliveau (ARA)</p>	<p>11:00 "Introduction of CODA To Reduce Overtesting" presented by: Dale Schick</p> <p>11:15 "Introduction of Model 350A43 Shock Accelerometer" presented by: Patrick Walter</p> <p>11:30 "The World's Highest Speed, High-speed Video Camera: iSPEED7 Series" presented by: Jonathan Hatton</p> <p>11:45 "HI-TEST Laboratories Overview" presented by: Mr. Jackson Snarr</p>	
11:00	<p>Understanding the Preloaded Threaded Interface: Transmission of Impulsive Dynamic Tensile Waves</p> <p>Mr. Marc Sanborn, Aine Mangan, & Dr. Lauren Stewart (Georgia Institute of Technology), Dr. Jacob Dodson & Dr. Janet Wolfson (AFRL)</p>	<p>11:00 "Introduction of CODA To Reduce Overtesting" presented by: Dale Schick</p> <p>11:15 "Introduction of Model 350A43 Shock Accelerometer" presented by: Patrick Walter</p> <p>11:30 "The World's Highest Speed, High-speed Video Camera: iSPEED7 Series" presented by: Jonathan Hatton</p> <p>11:45 "HI-TEST Laboratories Overview" presented by: Mr. Jackson Snarr</p>	
11:20	<p>Energy Dissipation through a Threaded Joint Subjected to Impact Loading</p> <p>Dr. Bo Song & Mr. Brett Sanborn (Sandia National Laboratories)</p>	<p>11:00 "Introduction of CODA To Reduce Overtesting" presented by: Dale Schick</p> <p>11:15 "Introduction of Model 350A43 Shock Accelerometer" presented by: Patrick Walter</p> <p>11:30 "The World's Highest Speed, High-speed Video Camera: iSPEED7 Series" presented by: Jonathan Hatton</p> <p>11:45 "HI-TEST Laboratories Overview" presented by: Mr. Jackson Snarr</p>	
11:40	<p>Frequency-based Impact Energy Dissipation in Silicone Foam and Rubber</p> <p>Mr. Brett Sanborn & Dr. Bo Song (Sandia National Laboratories)</p>	<p>11:00 "Introduction of CODA To Reduce Overtesting" presented by: Dale Schick</p> <p>11:15 "Introduction of Model 350A43 Shock Accelerometer" presented by: Patrick Walter</p> <p>11:30 "The World's Highest Speed, High-speed Video Camera: iSPEED7 Series" presented by: Jonathan Hatton</p> <p>11:45 "HI-TEST Laboratories Overview" presented by: Mr. Jackson Snarr</p>	

General Session 2 incl. Keynote Lecture & Exhibitors' Luncheon

Noon—1:30pm / Napoleon Ballroom (Exhibit Hall)

12:00pm—12:25pm	Buffet Lunch
12:25pm—12:30pm	Keynote Lecturer Introduction by: Dr. Charles R. “Bob” Welch (Consultant)
12:30pm—1:10pm	Keynote Lecture - “TBD” by: Dr. Reed Mosher, SES (Director, Information Technology Laboratory, US Army ERDC)
1:10pm—1:30pm	Exhibit Hall Passport Program Recognition and Contestant Winner Announcements

Keynote Lecturer—Dr. Reed Mosher

Dr. Reed L. Mosher is director of the Information Technology Laboratory (ITL) at the U.S. Army Engineer Research and Development Center in Vicksburg, Miss. ERDC research and development supports the Department of Defense and other agencies in military and civilian projects. Principal mission areas include civil engineering, environment, water resources engineering and physical sciences. Research projects include facilities, airfields and pavements, protective structures, sustainment engineering, environmental quality, installation restoration (cleanup), compliance and conservation, regulatory functions, flood control, navigation, recreation, hydropower, topography, mapping, geospatial data, winter climatic conditions, oceanography, environmental impacts, and information technology. The ERDC has been named the Army's R&D Organization of the Year five of the last eight years, and for the past three consecutive years.

ITL executes a broad R&D and operational program on behalf of the Corps, Army and DOD. Functions include high-performance computing, high-bandwidth communications, computer-aided engineering, computer-aided design and drafting (CADD), geographic information systems (GIS), software engineering and scientific visualization. The laboratory manages one of six DOD supercomputing centers.

Mosher began his career at ERDC in 1989 as a senior research civil engineer in ITL, a position he held for five years before transferring to the Geotechnical and Structures Laboratory (GSL). While at GSL, he served as chief of the Structural Mechanics Division, as technical director for Survivability and Protective Structures, and as lead technical director for Military Engineering. He returned to ITL as director in January 2008.

He earned a bachelor's in civil engineering with specialization in geotechnical engineering from Worcester Polytechnic Institute in 1977. He received a master's in civil engineering with specialization in geotechnical engineering and engineering mechanics from Mississippi State University in 1982, and a doctorate in the same from Virginia Polytechnic Institute and State University in 1992.

Mosher is a past recipient of the DOD Distinguished Civilian Service Award, the Meritorious Civilian Service Award and the Society of American Military Engineers' National Technology Advancement Award. He is a member of the American Society of Civil Engineers, the International Society of Soil Mechanics and Foundation Engineers, the Society of American Military Engineers and the U.S. Army Engineer Association. He has authored more than 75 publications, including a report for the Secretary of Defense.

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

WEDNESDAY PM (OCTOBER 19)

	SESSION 18	SESSION 19	SESSION 20
	<p>Test Measurement Methods 1:30pm-3:30pm / Unlimited Dist. A</p> <p>Chair(s): Dr. Luke Martin (NSWC Dahlgren)</p>	<p>Shock Isolation Analysis & Performance Studies 1:50pm-3:10pm / Unlimited Dist. A</p> <p>Chair(s): Mr. Robert Sharp (Hutchinson)</p>	<p>Structural Response & Blast 1:30pm-3:00pm / Limited Dist. D</p> <p>Chair(s): Dr. Wije Wathugala (ACTA)</p>
	<p><i>All Presenters and Chairs (for Oct 19) are Required to Meet at 7:00AM in Borgne for Presentation Loading</i></p>		
	<i>Meeting Room: Bayside A</i>	<i>Meeting Room: Bayside B</i>	<i>Meeting Room: Maurepas</i>
1:30	<p>Improvements in Accelerometer Calibration at NIST Using Digital Vibrometry</p> <p>Mr. Beverly Payne, Mr. Richard A. Allen, & Ms. Colleen E. Hood (NIST)</p>		<p>Breach of Urban Walls due to Small Munitions Detonating on Impact or After Partial Penetration: Part 1: HFPB Simulations</p> <p>Mr. Joseph Abraham, Mr. Jason Yang, & Mr. Pietro Gheorghiu (Karagozian and Case), Dr. Wije Wathugala & Dr. George Lloyd (ACTA)</p>
1:50	<p>Testing Compliance of High-G Shock Accelerometers to MIL-STD-810G</p> <p>Mr. James Nelson (Meggitt Sensing Systems), Dr. Vesta Bateman (Mechanical Shock Consulting)</p>	<p>Using Analyses and Models to Evaluate the Shock Response and Mechanical Stresses of an Isolated Enclosure</p> <p>Mr. Fred Sainclivier & Mr. Mahmoud Zreik (901 LLC)</p>	<p>Breach of Urban Walls due to Small Munitions Detonating on Impact or After Partial Penetration: Part 2: FRM Development</p> <p>Dr. Wije Wathugala & Dr. George Lloyd (ACTA), Mr. Joseph Abraham (Karagozian and Case)</p>
2:10	<p>Traceable High-Frequency Vibration Calibration of Accelerometers in the Temperature Range of -60C to 90C</p> <p>Mr. Randy Mendoza (Sandia National Laboratories), Mr. Michael Mende (SPEKTRA)</p>	<p>Designing Shock and Vibration Isolation Systems and Components</p> <p>Mr. Robert Sharp (Hutchinson)</p>	<p>Peridynamic Solution of an Elasto-Plastic Plate with Failure</p> <p>Mr. Michael Miraglia & Dr. E Thomas Moyer (NSWC Carderock)</p>
2:30	<p>Rugged Piezoresistive Bridge Shock Accelerometer with Internal Signal Conditioning</p> <p>Mr. Randall Martin & Mr. Alan Stillwell (Meggitt Sensing Systems)</p>	<p>UK Royal Navy Mount Shock Characterisation Programme - Mount Characterisation Programme Overview</p> <p>Mr. Matthew Brownlow & Mr. Thomas Fairchild (BAE Systems Maritime-Submarines)</p>	<p>Predicting Secondary Debris for Vehicles Subjected to Close-In or Internal Detonations</p> <p>Mr. Joseph Abraham, Mr. Mark Weaver, & Mr. Joe Magallanes (Karagozian and Case, Inc.), Mr. Ernest Staubs & Mr. Brandon Taylor (Air Force Research Laboratory), Mr. Brandon Whitworth (A-P-T Research, Inc.)</p>
2:50	<p>Development of Digital Filter Methodology for Hopkinson Bar Dispersion Correction</p> <p>Mr. Craig Doolittle (Applied Research Associates), Dr. Julius Smith, III (CCRMA), Dr. Weining Chen (Purdue University)</p>	<p>UK Royal Navy Mount Shock Characterisation Programme - Comparative Study of Shock Performance between Pre-Service and Post-Service Resilient Machinery Mounts</p> <p>Mr. Thomas Fairchild & Mr. Matthew Brownlow (BAE Systems Maritime-Submarines)</p>	<p>*A Component-Based Fast-Running Model (FRMs) Suite for Estimating Weapons Effects on Structures</p> <p>Mr. Joseph Magallanes (Karagozian and Case), Dr. George Lloyd (ACTA), Mr. Randy Anderson (ARA)</p>
3:10	<p>European Service Module Structural Test Article (E-STA) "Building Block Approach" Modal Test Results</p> <p>Mr. Vicente Suarez, Mr. Lucas Staab, Dr. James Akers, Ms. Samantha Bittinger, Mr. Trevor Jones, & Mr. James Winkel (NASA Glenn Research Center)</p>		

	SESSION 21	SESSION 22	SESSION 23
	<p>Blast Effects on Structures 1:50pm-2:50pm / Limited Distribution D 2:50pm-3:10pm / Limited Distribution C</p> <p>Chair(s): Dr. Catie Stephens (US Army ERDC) Mr. Omar Esquilin-Mangual (US Army ERDC)</p>	<p>Shock and Vibration Projects Sponsored by the National Shipbuilding Research Program (NSRP) 1:30pm-3:10pm / Limited Distribution C</p> <p>Chair(s): Mr. Mike Poslusny (HII—Ingalls) Mr. Sean Murphy (HII—Ingalls)</p>	<p>Validation of Methods for Shock Wave Propagation and Post-Shock Operability 1:30pm-2:30pm / Limited Distribution C</p> <p>Chair(s): Mr. Chris Abate (General Dynamics Electric Boat)</p> <hr/> <p>DISCUSSION GROUP Boundary Conditions for Component Qualification 2:30pm-3:30pm / Unlimited Distribution A</p>
<p><i>All Presenters and Chairs (for Oct 19) are Required to Meet at 7:00AM in Borgne for Presentation Loading</i></p>			
	<i>Meeting Room: Borgne</i>	<i>Meeting Room: Bayside C</i>	<i>Meeting Room: Gallery</i>
1:30		<p>What is NSRP? Mr. Sean Murphy (HII—Ingalls)</p>	<p>Validation of Methods to Model Shockwave Propagation Through Enclosed Fluid Volumes: Part I - Ballast Box Test Series Mr. Chris Abate & Mr. Dashiell Parsons (General Dynamics Electric Boat), Mr. Steve Rutgeron (NSWC Carderock)</p>
1:50	<p>Evaluating Effects of Common Pre-Detonation Materials on Protective Structure Blast Loads Mr. Omar Esquilin-Mangual, Mr. Donald H. Nelson, & Mr. Omar G. Flores (US Army ERDC)</p>	<p>Door Standardization through Shock Extensions Ms. Jennifer Schilling (HII—Ingalls)</p>	<p>Validation of Methods to Model Shockwave Propagation Through Enclosed Fluid Volumes: Part II - Numerical Methods and Analysis-to-Test Correlation Mr. Dashiell Parsons, Mr. Tom Harrigan, & Mr. Chris Abate (General Dynamics Electric Boat)</p>
2:10	<p>Blast Effects on Modular Relocatable Buildings Mr. David Roman-Catro, Dr. C. S. Stephens, Mr. O. G. Flores, Mr. R. E. Walker, & Dr. T. R. Slawson (US Army ERDC), Dr. L. E. Suárez (UPRM)</p>	<p>Shock Testing of Flexible Infrastructure Arrangements for Surface Combatants Mr. Sean Murphy (HII—Ingalls)</p>	<p>Validation of a Finite Element Methodology for Evaluating Post Shock Operability of Complex Mechanical Systems Mr. Dashiell Parsons (General Dynamics Electric Boat)</p>
2:30	<p>Blast Effects on Elevated Expeditionary Tower Mr. Aaron Sullivan, Mr. Benjamin Jones, Mr. Omar Esquilin -Mangual, Dr. Catherine Stephens, Mr. Omar G Flores, & Mr. James Davis (US Army ERDC)</p>	<p>Vibration Testing of Flexible Infrastructure Mr. Mike Poslusny (HII—Ingalls)</p>	<p>Boundary Conditions for Component Qualification Disc. Group 2:30pm-3:30pm Host: Mr. Troy Skousen (Sandia Natl. Labs)</p> <p>The current practices for shock & vibration testing of components may result in damage exposure that is different from what the component would experience in the full assembly. While the potential differences in exposure may be attributed to countless items, the difference in boundary conditions has been identified as a major contributor. To study and hopefully overcome these differences, a test bed is being developed by the Kansas City National Security Campus (KCNSC) in conjunction with Sandia National Laboratories (SNL). The test bed consists of a simple assembly with a component that can be removed, allowing users to optimize the component qualification setup. This may entail test specification alterations, fixture optimization, etc. This discussion group will consist of: introduction to the test bed design, any preliminary results, discussion of methods for approaching the problem, and soliciting collaboration outside of KCNSC and SNL.</p>
2:50	<p>Further Study of the Effect of Barrier Wall Shielding on the Relationship between Overpressure Mr. Denis Rickman, Mr. Joshua E. Payne, Dr. Z. Kyle Crosby, & Dr. Jay Q. Ehr Gott (US Army ERDC)</p>	<p>Shock and Vibration Testing of Adhesive Attachment Methods Mr. Mike Poslusny (HII—Ingalls)</p>	
3:10			

TUTORIAL SESSION 5 / 3:30pm—6:30pm*~ CHOOSE ONE / ADDITIONAL FEES APPLY TO ATTEND ~***Shock Test Failure Modes****Meeting Room: Bayside C**

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

This tutorial will cover examples of shock test failures typically experienced by equipment exposed to MIL-S-901D shock levels. MIL-S-901D provides guidance for designers responsible for meeting the requirements of MIL-S-901D. 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: Maurepas**

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.

Shock Response Spectra & Time History Synthesis**Meeting Room: Bayside A**

Mr. Tom Irvine (Vibrationdata)

This session covers classical, seismic and pyrotechnic shock. Students will receive basic instruction in calculating shock response spectra for time histories and for synthesizing time histories to meet shock response spectra specifications. The synthesis is performed using wavelets and damped sine functions. Students will receive software programs in both C/C++, Matlab & Python for making these calculations, as well as accompanying pdf files with formulas.

Some Engineering Applications of Statistics**Meeting Room: Borgne**

Dr. E. Thomas Moyer (NAVSEA Carderock)

As engineers, we're required to work in a world with large uncertainty. The discipline of Mathematical Statistics provides the framework for modeling uncertainty and assessing the impact on engineering performance. This tutorial will review a subset of the theory of Mathematical Statistics which is important for select engineering applications. It will also discuss specific statistical modeling approaches which are in practical engineering practice today. Topically, the tutorial will discuss:

- Overview Of Probability & Statistics
 - o Statistical Metrics
 - o Probability Distribution Functions (PDFs) Of Practical Interest
 - o Elements Of Decision Theory & Confidence Estimates
 - o Elements Of Correlation Theory & Practical Metrics
- Overview Of Modeling & Uncertainty Quantification
- Simulation Based Methods – Monte Carlo Based Approaches
 - o Practical Application Of Simulation Based Methods
- Expansion Methods
- Overview Of Inverse Methods
- Design Of Experiments



*ALL 87TH S&V SYMPOSIUM ATTENDEES, AND THEIR GUESTS,
ARE INVITED TO:*



Wednesday, October 19th

7:00pm—10:00pm

Food, Drinks, & Entertainment



- * *Located at 225 Decatur Street (1/5 mile walk). When leaving hotel (facing away from hotel), turn right on Canal St. Then take the next left onto Decatur St. The House of Blues is a block-and-a-half from here on Decatur St.*
- ** *This dinner social is 100% commercially hosted. No funds from registration fees, tutorial fees, or other symposium*

THURSDAY AM (OCTOBER 20)

	SESSION 24 Blast Investigations & Modeling 8:20am-9:40am / Unlimited Dist. A Chair(s): Dr. Peter Vo (Raytheon)	SESSION 25 Energy Based Shock Methods 8:20am-9:40am / Unlimited Dist. A Chair(s): Dr. J. Edward Alexander (BAE Systems)	SESSION 26 DS: Advancement of Navy Enhanced Sierra Mechanics (NESM) 8:00am-10:00am / Limited Dist. C Chair(s): Dr. Thomas Moyer (NSWC Carderock) Dr. John Gilbert (NSWC Carderock)
<i>All Presenters and Chairs (for Oct 20) are Required to Meet at 7:00AM in Borgne for Presentation Loading</i>			
	<i>Meeting Room: Gallier A/B</i>	<i>Meeting Room: Bayside B</i>	<i>Meeting Room: Maurepas</i>
8:00			Navy Enhanced Sierra Mechanics (NESM) Version 4.1 Dr. E. Thomas Moyer & Mr. Jonathan Stergiou (NSWC Carderock), Dr. Najib Abboud (Thornton Tomasetti Weidlinger Applied Science), Dr. Garth Reese (Sandia National Laboratories)
8:20	A Layered Metamaterial for Blast Protection Dr. Hossein Sadeghi, Mr. John Crawford, Mr. Zach Smith, & Mr. Joe Magallanes (Karagozian and Case)	6-DOF Mechanical Shock Failure Predictions of a Cantilever Structure Using Energy Response Spectra Methods Dr. Carl Sisemore, Dr. Vit Babuska, & Mr. Jason Booher (Sandia National Laboratories)	Navy Energetic Modeling Oracle (NEMO) Updates Dr. John Gilbert, Mr. Michael Miraglia, & Mr. Jonathan Stergiou (NSWC Carderock), Mr. Paul Hassig & Dr. Badri Hiriyur (Thornton Tomasetti Weidlinger Applied Science)
8:40	Modeling the Blast Load Simulator: Effects of the Obliquity Angle of a Structure on Overpressure Mr. Gustavo Emmanuelli, Mr. Andrew Barnes, Dr. Gregory Bessette, Dr. Carol Johnson, & Dr. James O'Daniel (US Army ERDC), Mr. Mark Hunt (Mississippi State University)	Generation of Equivalent Half Sine Shocks to Measured Shocks during Free Flight of a Missile Mr. Zeev Sherf, P. Hopstone, I. Sofer, & A. Elka (RAFAEL)	Verification & Validation of NESM Mr. Raymond DeFrese, Mr. Michael Miraglia, Dr. E. Thomas Moyer, Dr. Nicholas Reynolds, & Mr. Jonathan Stergiou (NAVSEA Carderock), Dr. Garth Reese & Dr. Jesse Thomas (Sandia National Laboratories)
9:00	A Computational Study on the Effects of Cas-ing Properties on Close-in Airblast Mr. Joseph Abraham & Mr. Pietro Gheorghiu (Karagozian and Case, Inc.)	A New Method to Synthesize an SRS Compatible Base Acceleration with Energy and Temporal Moments to Improve MDOF System Response, Part I Dr. J. Edward Alexander (BAE Systems)	Navy Enhanced Sierra Mechanics (NESM) Roadmap Dr. E. Thomas Moyer & Mr. Jonathan Stergiou (NSWC Carderock), Dr. Garth Reese & Dr. Jesse Thomas (Sandia National Laboratories)
9:20	*Effects of Charge Shape on Overpressure Distribution Mr. Christopher Price, Mr. Sean R. Wade, Dr. Catherine S. Stephens, Dr. Jesse A. Sherburn, & Dr. Robert E. Walker (US Army ERDC)	A New Method to Synthesize an SRS Compatible Base Acceleration with Energy and Temporal Moments to Improve MDOF System Response, Part II Dr. J. Edward Alexander (BAE Systems)	Verification and Validation of the User-Defined Mount Capability in NESM Dr. Heather Reed & Mr. Ryan Anderson (Thornton Tomasetti Weidlinger Applied Science)
9:40			Fluid Structure Interactions in Massively Parallel Navy Applications Dr. Garth Reese (Sandia National Laboratories)

	<p>SESSION 27</p> <p>Internal Blast Research & Penetration Test Measurements 8:00am-9:40am / Limited Distribution D 9:40am-10:00am / Limited Distribution C</p> <p>Chair(s): Dr. Al Ohrt (Air Force Research Laboratory)</p>	<p>WORKING GROUP</p> <p>IEST-RD-DTE012 Handbook Working Group 8:20am-10:00am / Unlimited Dist. A</p>	<p>TRAINING</p> <p>Developing Exodus II and Sierra Format Models 8:00am-9:00am / Unlimited Dist. A</p>
<p><i>All Presenters and Chairs (for Oct 20) are Required to Meet at 7:00AM in Borgne for Presentation Loading</i></p>			
	<p><i>Meeting Room: Borgne</i></p>	<p><i>Meeting Room: Bayside A</i></p>	<p><i>Meeting Room: Bayside C</i></p>
8:00	<p>Overview of AFRL Joint Weapon Effects Research Mr. Ernest Staubs (Air Force Research Laboratory)</p>		<p>Developing Exodus II and Sierra Format Models 8:00am-9:00am Mr. Joshua Pennington (Altair Engineering)</p>
8:20	<p>An Introductory Scalability Investigation of Explosive Charge Detonations Inside a Sub-scale Structure Mr. Roosevelt Davis, Dr. Alan Ohrt, & Dr. John Rogers (Air Force Research Laboratory)</p>	<p style="text-align: center;">IEST-RD-DTE012 Handbook Working Group 8:20am – 10:00am Host: Mr. Neil Loychik (Los Alamos Natl. Labs)</p> <p>This handbook provides guidelines for acquiring and analyzing dynamic data in order to ensure accuracy while reducing the error and variability associated with the measurement process. The handbook covers a broad range of topics including Measurement Planning, Data Acquisition, Data Validation and Editing, and Data Analysis. For 20 years, the document has been a cornerstone of modern mechanical shock and vibration, and acoustic measurements.</p> <p style="text-align: center;">Come join us as we modernize the document for its 3rd revision. Commentary and expertise are welcome!</p>	<p>The training session will be a presentation of the process involved to develop an Exodus II model using Altair’s pre-processor - 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.</p>
8:40	<p>An Evaluation of Confined Airblast Environments from a Single and Multiple Distributed Charges Mr. Roosevelt Davis & Dr. Alan Ohrt (Air Force Research Laboratory)</p>		
9:00	<p>Research into Secondary Debris and its Potentially Damaging Effects on Personnel, Infrastructure, and Equipment Mr. Ernest Staubs (Air Force Research Laboratory)</p>		
9:20	<p>Explosive Fill Response Measurements in Penetrating Weapons Mr. Justin Bruno, Mr. John Perry, Mr. Drew Malechuk, Mr. James Wertz, Mr. Craig Doolittle, Mr. David Truncellito, & Mr. Nicolas Jarrett (Applied Research Associates), Mr. Edwardo Freeman, Mr. Tyler Underwood (AFLCMC/EBDP)</p>		
9:40	<p>Recent Improvements to the BlastX Engineering Level Code Dr. Gregory Bessette & Mr. Gustavo Emmanuell (US Army ERDC), Mr. Van Le (Integrated Solutions for Systems), Dr. Alan Ohrt (Air Force Research Laboratory)</p>		

THURSDAY AM (OCTOBER 20)

	SESSION 28 Mechanical Shock Test Design & Analysis 10:00am-11:40am / Unlimited Dist. A Chair(s): Capt. Hayley Chow (Air Force Research Laboratory) Dr. Jacob Dodson (Air Force Research Laboratory)	SESSION 29 Structural Response & Numerical Methods 10:20am-11:40am / Unlimited Dist. A Chair(s): Dr. Brian Bewick (Air Force Research Laboratory)	SESSION 30 UNDEX II 10:00am-Noon / Unlimited Dist. A Chair(s): Ms. Rebecca Grisso (NSWC Carderock) Dr. Bradley Klenow ((NSWC Carderock)
<i>All Presenters and Chairs (for Oct 20) are Required to Meet at 7:00AM in Borgne for Presentation Loading</i>			
	<i>Meeting Room: Bayside A</i>	<i>Meeting Room: Bayside B</i>	<i>Meeting Room: Gallier A/B</i>
10:00	Shock Response Spectrum Shaping using Structural Modifications Dr. Jason Blough, Dr. James DeClerck, & Mr. Charles VanKarsen (Michigan Technological University), Mr. David Soine (Honeywell FM&T)		Investigation on Critical Pressure of Deformed Ring Stiffened Cylinders Caused by UNDEX Mr. Jun Wang (China Ship Science Research Center)
10:20	Fixture Evaluation for Shock Testing Mr. David Soine & Mr. Richard Jones (Honeywell FM&T)	Method of Designing Electronic Assemblies without Potting for Gun Launched Applications Through the use of Additive Manufacturing Mr. Steven Manole, Mr. Christopher Stout, Mr. Nickolas Baldwin, Mr. Richard Granitzki, Mr. James Caplinger, Mr. Douglas Weinhold, & Mr. Alfred Rotundo (ARDEC)	Investigation on Fluid-structure Interaction of Ship Structures with Anechoic Coating Mr. Zeli Lou & Dr. Jianhu Liu (China Ship Science Research Center)
10:40	Consideration of SRS Decayed Sine Tone Frequencies Ms. Julie Harvie & Dr. Michael Starr (Sandia National Laboratories)	3D FE and 2DOF Simulations of Ground Shock Experiments – Reflection Pressure Time History Dependency due to the Structure’s Stiffness and Mass Dr. Leo Laine (LL Engineering AB), Dr. Morgan Johansson (AF Infrastructure), Mr. Ola Pramm Larsen (CAEwiz Consulting AS)	Investigation on Distortion Effect in Underwater Explosion Pressure Measurement Caused by Acceleration Mr. Xianpi Zhang, Dr. Jianhu Liu, Prof. Jianqiang Pan, Mr. Haibin Mao, & Ms. Jing Yang (China Ship Science Research Center)
11:00	Design of a Resonant Plate Shock Fixture to Attenuate Excessive High-Frequency Energy Inputs Dr. Carl Sisemore & Mr. Matt Spletzer (Sandia National Laboratories)	Mechanical Response of Stiff Spherical Components in a Compliant Medium of a Closed System under Externally Applied Impact Loading Dr. Catherine Florio (US Army ARDEC)	Investigation of the Driving Power of Contact UNDEX to Metal Sheets Dr. Jian-Hu Liu (China Ship Scientific Research Center)
11:20	Understanding the Effect of Embedded Shapes in a Polymeric Composite under Shock Capt. Hayley Chow, Jacob Dodson, & Janet Wolfson (Air Force Research Laboratory), Mr. Christopher Green & Mr. Geoff Gwaltney, (Michigan Technological University, Keenwa Research Center)	Research on Conservatism of Shock Stress Reduction Factor in Stress Evaluation of Stainless Steel Piping by Elasto-Plastic Design Prof. Xuede Chen, Dr. Li Pengzhou, Dr. Sun Lei, Mr. Li Xihua, & Mr. Liu Zicai (Nuclear Power Institute of China)	Investigation of Underwater Explosive Effects in close Proximity or Contact to an Air-backed Plate Mr. Zhangtao Zhou (China Ship Scientific Research Center)
11:40			The Equivalence of Shock Environments of the Real Ship and the SFSP to a Heavy Resilient Mount Equipment Prof. Jianqiang Pan, Mr. Bin He & Mr. Xuebing Chen (China Ship Scientific Research Center)

	<p>SESSION 31</p> <p>Blast - Numerical Comparisons 10:00am-10:40am / Limited Dist. D 10:40am-11:10am / Limited Dist. C</p> <p>Chair(s): Mr. Robert Browning (US Army ERDC) Mr. Vincent Chiarito (US Army ERDC)</p>	<p>SESSION 32</p> <p>DS: Ground Based Flight Simulation 10:20am-11:20/ Limited Dist. C</p> <p>Chair(s): Mr. Richard Jepsen (Sandia National Labs)</p>	<p>TRAINING</p> <p>Introduction to Heavyweight Shock Testing 10:00am-Noon / Unlimited Dist. A</p>
<p><i>All Presenters and Chairs (for Oct 20) are Required to Meet at 7:00AM in Borgne for Presentation Loading</i></p>			
	<p><i>Meeting Room: Borgne</i></p>	<p><i>Meeting Room: Maurepas</i></p>	<p><i>Meeting Room: Bayside C</i></p>
10:00	<p>Computational and Experimental Comparison of Complex Components under Mechanical Shock</p> <p>Mr. Jonathan Hong (ARA), Dr. Janet Wolfson (Air Force Research Laboratory)</p>		
10:20	<p>New Approach to Modeling Blast Wave Phenomenon</p> <p>Mr. Justin John, Mr. Stephen Recchia, & Mr. David Geissler (US Army ARDEC)</p>	<p>The Importance of Combined Environment Testing</p> <p>Mr. Edward Romero & Mr. Richard Jepsen (Sandia National Laboratories)</p>	<p style="text-align: center;">Introduction to Heavyweight Shock Testing</p> <p style="text-align: center;">10:00am—Noon Mr. Travis Kerr (HI-TEST Laboratories)</p>
10:40	<p>Experimental and Numerical Performance Evaluation of a Tower Component Subjected to Blast Loading</p> <p>Mr. Robert Browning, Mr. Vincent Chiarito, Dr. James Baylot, Mr. Donald Nelson, & Mr. John Geringer (US Army ERDC)</p>	<p>Superfuge: Adding Spin to the Vibrafuge</p> <p>Mr. David Siler, Mr. Ed Romero, & Mr. Richard Jepsen (Sandia National Laboratories)</p>	<p>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 setup, test operations, instrumentation interpretation, and reporting. Construction and use of the floating shock platforms (FSP, IFSP, and LFSP) will be covered. MIL-S-901 test requirements applicable to heavyweight shock testing will be discussed.</p>
11:00	<p>*Investigation into Unresolved Discrepancies between Airblast Codes and a Historical Set of Shock Tube Experiments</p> <p>Mr. Andrew Barnes, Dr. James O'Daniel, Dr. Greg Bessette, & Dr. Carol Johnson (US Army ERDC)</p>	<p>Adding Flight Shock Environments to Superfuge Capability</p> <p>Mr. Richard Jepsen, Mr. Troy Skousen, & Mr. Edward Romero (Sandia National Laboratories)</p>	
11:20			

(AB #) Abstract Book Page Number / * Short Presentation (10 min.)

<p>1:00-2:30</p>	<p>S&V Technical Advisory Group Meeting</p> <p>The annual meeting of the members of the SAVE Technical Advisory Group (TAG) will convene to review the 87th S&V Symposium and discuss plans for 2017.</p>	<p>Meeting Room: Bayside C</p>
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Boeing	m+p international
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¹ Hosting the Dinner Social (100% commercially hosted) on Wednesday Evening

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Applied Physical Sciences

Bill Gregory
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Applied Physical Sciences Corporation is a Research, Development and Engineering consulting firm specializing in Underwater Explosion (UNDEX) and In-Air Shock Analysis and Design, Ballistics, Platform Survivability, Composite Materials, Acoustics, Vibration and Marine Hydrodynamics. APS provides support, services and innovative products to the National Defense R&D community and the commercial market. APS consists of over 100 engineers (28% PhD and 44% M.S.) and technicians whose capabilities range from core mathematics and physics, theory application, design and analysis evaluation, optimization and testing.



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Bodie Technology - Specialists in properly handling noisy data via Digital Signal Processing (DSP). Our unique expertise benefits users of Transient Dynamics Simulations (Abaqus/Explicit, LS-Dyna, Virtual.Lab Motion ...) and Engineers/Technicians working with Experimental Measurements. Those trying to correlate/interpret transient simulations and experiments find our Kornucopia® software, Customizable Training, and Consulting highly valuable.



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Boeing is the world's largest aerospace company and leading manufacturer of commercial jetliners and defense, space and security systems. A top U.S. exporter, the company supports airlines and U.S. and allied government customers in 150 countries. Boeing products and tailored services include commercial and military aircraft, satellites, weapons, electronic and defense systems, launch systems, advanced information and communication systems, and performance-based logistics and training



Brüel & Kjær

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Brüel & Kjær Sound & Vibration Measurement A/S supplies integrated solutions for the measurement and analysis of sound and vibration. As a world-leader in sound and vibration measurement and analysis, we use our core competences to help industry and governments solve their sound and vibration challenges so they can concentrate on their primary task: efficiency in commerce and administration.



Bluejay Robinson
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Correlated Solutions offers non-contact strain and deformation measurement solutions for materials and product testing. The VIC-3D HSVI System has recently been added to the product line, which enables full-field 3D viewing, measurement, and analysis of full-field operational deflection shapes (ODS's) that occur from transient events. These measurements can be made on sample sizes ranging from microns to meters and time scales as small as nanoseconds. Three-dimensional displacements, strains, velocities, and accelerations are all computed for thousands of data points at any given frequency. Our scientists and engineers have specialized in deformation measurements for over 60 years and are recognized as world leaders and the inventors of Digital Image Correlation.

EXHIBITOR DESCRIPTIONS (CONT.)



Crystal Instruments (CI) is a leading worldwide supplier of vibration controllers, portable dynamic signal analyzers, and dynamic measurement systems for product testing, machine monitoring, and vibration and acoustic analysis. CI's products are used across a wide range of industries, including aerospace, defense, and medical device manufacturing.



Dayton T. Brown, Inc. is an A2LA / NVLAP accredited*, independent engineering and testing lab. Our facility stands apart from the rest by providing a full spectrum of engineering and testing services. For over 60 years, our goal has been to provide our customers with competitive pricing, low project cost and impeccable services. At DTB, we are committed to helping you successfully meet all of your goals. Our lab's low set-up costs and reduced time-to-test will satisfy your most demanding and complex test objectives. No other testing lab can offer the host of testing services that we can provide to you in one location with a 24/7 schedule.

*Please refer to our website for testing covered under Scopes of Accreditation.



Dewesoft is a total solution company. We do complete hardware design, manufacturing, software development, sales, marketing and support within the same organization. Dewesoft was founded back in year 2000. Today our products are used in many applications by global market leaders around the world. We positioned ourselves between global market leaders with innovative software and hardware solutions. We gained trust by keeping close relations with our customers and offering best possible support on all levels from sales down to technical support.



Dytran Instruments, Inc. is a leading designer and manufacturer of innovative piezoelectric and MEMS type sensors. Their expansive product line includes piezoelectric and MEMS type accelerometers, force sensors, pressure sensors, impulse hammers, cable assemblies and support electronics. Dytran sensors serve in shock, ballistic, modal analysis, structural dynamics, NVH, ESS and crash applications to name a few. Their sensors are getting "smarter" with the addition of TEDS (Transducer Electronic Data Sheet) and MEMS capabilities. Dytran is always looking forward to new challenges.



At **E-Labs**, we offer the ability for our customers to access state of the art facilities and personnel. E-Labs personnel have over 40 years of hands on laboratory testing experience within all testing disciplines for the aerospace, automotive, military, commercial and the IT industries. We're a Full Service Testing Laboratory for Industrial, Commercial and Utility Testing, offering Climatic Testing for issues such as Salt Fog, Sand and Dust, Immersion Testing and more. We also offer full EMI and EMC Testing, and Dynamics Testing such as Mechanical Shock, Lightweight Hammer Shock, and Vibration Testing.



For over 60 years, the name **HBM** stands for reliability, precision and innovation all over the world. HBM's product range covers sensors, transducers, strain gages, amplifiers and data acquisition systems as well as software for structural durability investigations, tests and analysis. The potential fields of application can be found in every branch of engineering and industry in both virtual and physical test and measurement.



Hi-Techniques has been a leader in High Performance Data Acquisition Systems for nearly 30 years. Initially founded as a spin off of Norland Corporation, Hi-Techniques has specialized in transient recorders, data acquisition systems and high resolution Digital Oscilloscope products for a variety of applications and markets. Our latest product range, the Synergy, is Hi-Techniques' 7th Generation of Data Acquisition Products. Designed from the ground up, Synergy offers unparalleled performance and flexibility in data acquisition.

EXHIBITOR DESCRIPTIONS (CONT.)



Lauren Yancey
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HI-TEST Laboratories, Inc. is a world-class provider of single-source test program solutions for industry and government, including research, design, testing and evaluation. The company's testing facility is based in Arvon, VA and offers a full spectrum of testing including standard MIL-S-901D lightweight, medium weight, and heavyweight testing, MIL-STD-167 Types I and II vibration testing, MIL-STD-740 noise and MIL-1399 inclination testing. In addition to testing, HI-TEST engineering is experienced in finite element analysis, transient loading, structural mechanics, and non-linear analysis. HI-TEST is a certified HUBZone Small Business.



Sean Murphy
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Huntington Ingalls Industries (HII) designs, builds and maintains nuclear and non-nuclear ships for the U.S. Navy and Coast Guard and provides after-market services for military ships around the globe. For more than a century, HII has built more ships in more ship classes than any other U.S. naval shipbuilder. Employing nearly 38,000 in Virginia, Mississippi, Louisiana and California, its primary business divisions are Newport News Shipbuilding and Ingalls Shipbuilding.



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IMV Corporation engages in the design, production, and sale of dynamic simulation systems and measuring systems. The company also provides test house, measuring analysis, and other consulting services for vibration tests. It offers vibration test systems that include energy-saving type, single and multi axis basic, compact type, and temperature, humidity, and vibration combined type systems, as well as vibration controllers. IMV Corporation was founded in 1957 and is headquartered in Osaka, Japan.



Greg Hoshal
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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.



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ITT is a diversified leading manufacturer of highly engineered critical components and customized technology solutions for growing industrial end-markets in energy infrastructure, electronics, aerospace and transportation. Building on its heritage of innovation, ITT partners with its customers to deliver enduring solutions to the key industries that underpin our modern way of life. Founded in 1920, ITT is headquartered in White Plains, NY, with employees in more than 15 countries and sales in more than 125 countries.



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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.



Rich Cadille
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Kistler Instrument Corporation will exhibit dynamic pressure and force sensors, along with accelerometers used in many shock and vibration applications. New this year will be PiezoStar, high temp, multiple-ranged, piezoelectric triaxial accelerometers along with a high g, high temp 8715 miniature accelerometer. Applications engineering support available at our booth.

EXHIBITOR DESCRIPTIONS (CONT.)



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Kulite Semiconductor Products, Inc. is a leading name in the transducer industry on a worldwide level. Kulite is the first name in pressure transducers for scientists and engineers working at the cutting edge of research and design in their fields.



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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.



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Meggitt Sensing Systems is the Meggitt division specializing in sensing and monitoring systems. We measure physical parameters in the extreme environments of aircraft, space vehicles, power generators, nuclear, oil and gas installations and test laboratories. Meggitt Sensing Systems has operated through its antecedents since 1927 under the names of Ferroperm Piezoceramics, Lodge Ignition, Endevco, Sensorex, ECET, Vibro-Meter and Wilcoxon Research. Today, their capabilities and facilities have been integrated under one Meggitt division to provide complete systems from a single supply base.



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Micron Optics, Inc., is an established leader of innovative optical components and laser-based equipment that advance the quality of optical measurements, allowing the sensing, imaging and telecommunications industries to make the critical measurements they need. The Micron Optics comprehensive product portfolio of tunable optical filters, swept lasers, optical sensors and sensing interrogators delivers the highest degree of measurement precision, resolution, and accuracy required for customers to yield superior, advanced solutions.



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Midé Technology Corporation is an engineering company that develops, produces, and markets smart technology products and materials - primarily for the marine, aerospace, automotive, research, and manufacturing industries. Our products include; Hydroactive Seals for bulkhead shafts in ships, packaged (QuickPack), & conformable (PowerAct) piezoelectric sensors and actuators; Quickpack High Voltage Piezo amplifiers; Volture™ vibration energy harvesting systems, and Shape Memory Alloy Starter Kits. Mide also provides engineering, and forensic analysis consultation services.



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With over 350 highly qualified staff, **Müller BBM** is one of the leading engineering companies for consultancy services, testing and planning in all fields of acoustics, building physics and environmental protection. We examine the effects of sound, vibration, heat, humidity, odours and harmful substances, in addition to the effect of electromagnetic waves on humans, on machinery and on the environment. We quantify, evaluate, and shape these effects, offering you complete one-stop solutions.



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Data Physics, Team and **Lansmont** are in the business of measuring, simulating and analyzing the effects of vibration, noise, shock and other environmental variables for the benefit of our industry customers. Our combined capabilities and expertise make us a leading global provider of test and measurement solutions.

Data Physics provides a complete range of electrodynamic shakers, vibration controllers and dynamic signal analyzers. Team manufactures high performance hydraulic vibration systems, high frequency servo valves and low noise hydrostatic bearings and couplings that offer unparalleled performance. Lansmont Field-to-Lab® product solutions measure real world dynamics for laboratory simulation.

EXHIBITOR DESCRIPTIONS (CONT.)



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National Technical Systems (NTS) offers a full range of engineering solutions; from product design, development and testing to systems integration, project management and managed services at laboratories located across the US. Our testing capabilities include MIL-S-901D, MIL-STD-167, MIL-STD-810, MIL-STD-461/461, RS 105, DO-160, MIL-STD 202, and MIL-STD 883.



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NovaStar Solutions is a leading provider of new IT hardware and engineering software, IT asset management, and instrument calibration services. Our growth since 1998 is fueled by excellent service resulting in high levels of customer satisfaction. Located in Livonia, MI NovaStar serves automotive, manufacturing, aerospace, medical device makers, nuclear energy companies, and major universities among many other diverse businesses.



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As a global leader in aerospace and defense technologies, **Orbital ATK** designs, builds and delivers space, defense and aviation-related systems to customers around the world both as a prime contractor and as a merchant supplier. Our main products include launch vehicles and related propulsion systems; satellites and associated components and services; composite aerospace structures; tactical missiles, subsystems and defense electronics; and precision weapons, armament systems and ammunition. Headquartered in Dulles, Virginia, Orbital ATK employs approximately 12,000 people in 18 states across the U.S. and several international locations.



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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.



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Polytec is the market leader for non-contact, laser based vibration and velocity measurement instrumentation. Our innovative solutions allow our customers to maintain their own technical leadership across many fields.



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Precision Filters manufactures high performance instrumentation for test measurements including Signal Conditioning for static and dynamic strain and shock and vibration. PFI also carries lines of Programmable Switching Systems and portable Filter/Amplifier Systems. Rely on a single source for Signal Conditioning and Switching products designed to provide high performance at reasonable cost.



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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.



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Spectral Dynamics (SD) is a technically innovative company that has served the Shock and Vibration community continuously for 54 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.

EXHIBITOR DESCRIPTIONS (CONT.)



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The *Shock and Vibration Literature/Information Table* is sponsored by **Taylor Devices, Inc.**, designers and manufacturers of components and systems for the control of shock and vibration. Founded in 1955, Taylor Devices' products are used world-wide for energy absorption and control, damping, weapons effects, MIL-S901D, vibration control, and seismic protection.



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Vibration Research (VR), leading innovator in vibration control, offers testing products, software and support with unrivaled value. Our VR9500 Revolution Vibration Controller and VibrationVIEW software includes patented innovations used by world-wide testing labs and engineers. iDOF, FDS, FDR, and Kurtosis are some of VR's applications that ensure accurate, fast vibration testing.



VIBRO/DYNAMICS® LLC

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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. Benefitting from Socitec's long track record of applications and expertise, Vibro/Dynamics is positioned to serve the North and South American markets with a wide range of vibration and shock isolation solutions.



AMETEK
MATERIALS ANALYSIS DIVISION

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Vision Research designs and manufactures a broad range of high-speed digital imaging systems that are used in all military, industry, academic and entertainment sectors. Marketing under the Phantom® brand, our cameras allow you to analyze physical phenomena when it's too fast to see, and too important not to™.

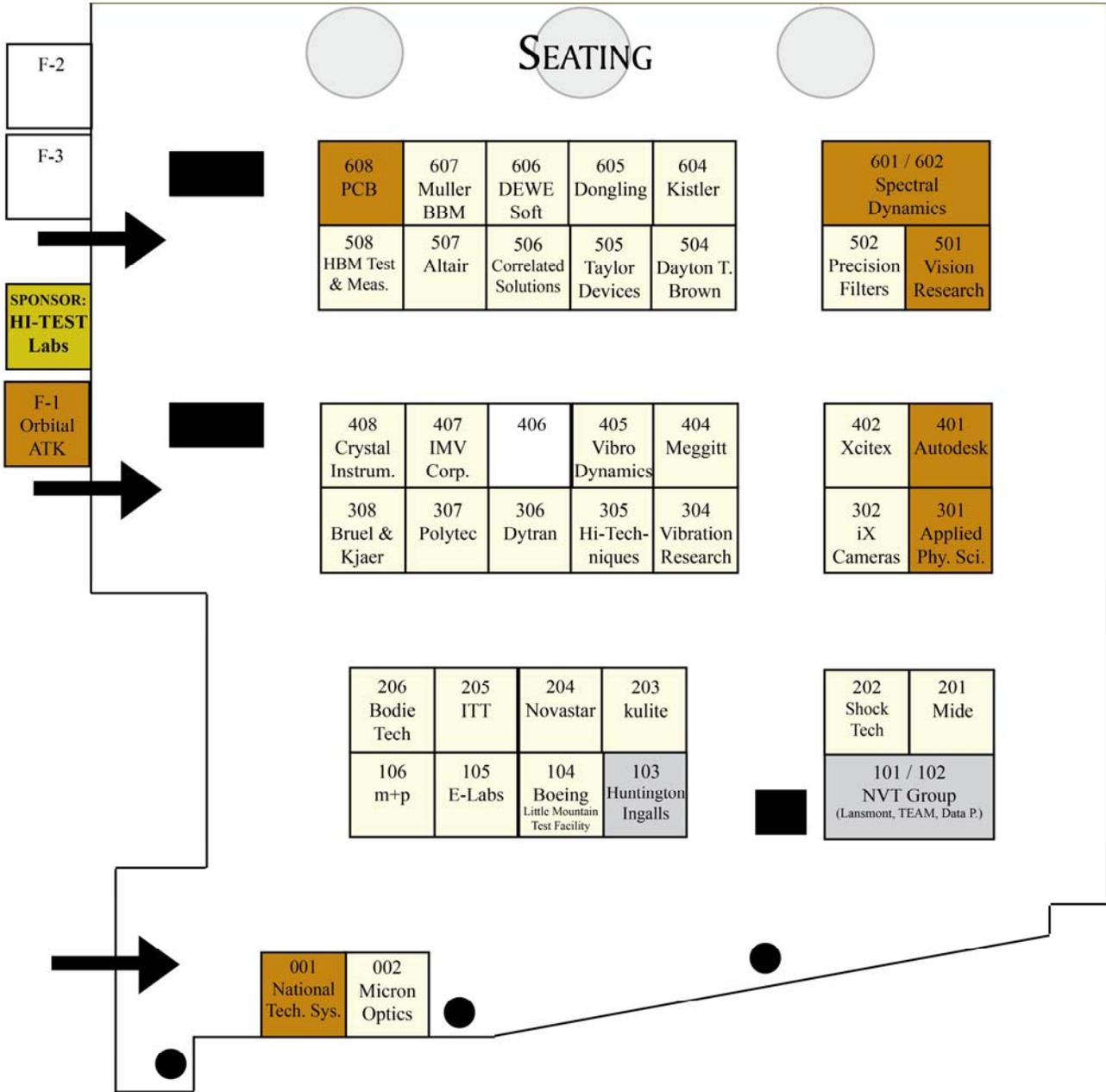


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Xcitex is an innovator in the industries of motion analysis and video-based motion capture. ProAnalyst® is the world's leading software for extracting ("tracking"), analyzing, and presenting motion from pre-recorded video. MiDAS DA software combines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

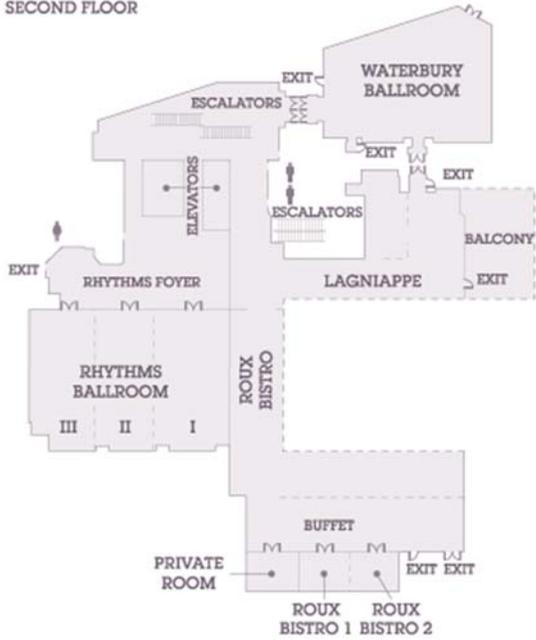
EXHIBITOR LAYOUT

Napoleon Ballroom

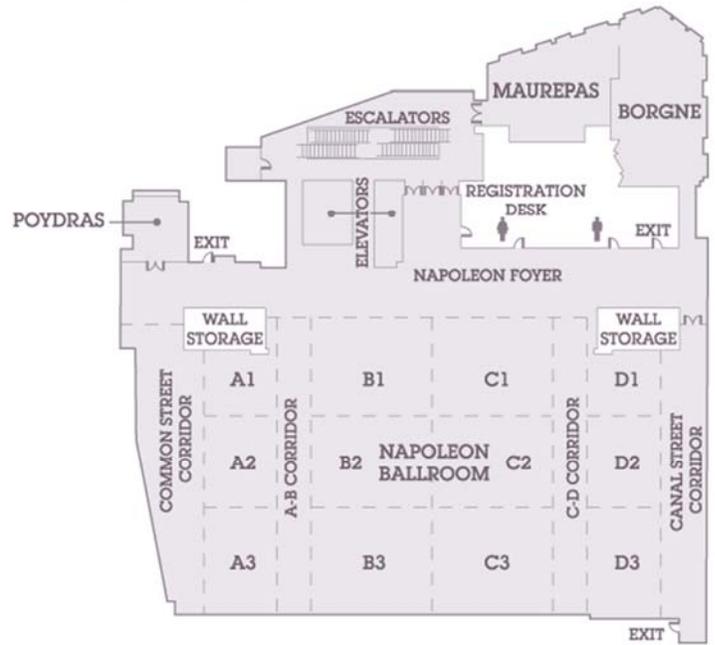


SHERATON NEW ORLEANS MEETING SPACE FLOOR PLANS

SECOND FLOOR



THIRD FLOOR



FOURTH FLOOR

